Air Force Civil Engineer Center / Minot AFB
Dorm Master Plan – Renovate Dorm 276

FINAL ISSUED FOR CONSTRUCTION

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BASIS OF DESIGN & OTHER DELIVERABLES

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ENGINEERING

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ARCHITECTURAL

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Design Codes and Standards

The latest edition of the following design codes will be utilized on this project:

Applicable Military Criteria:

UFC 1-200-01	General Building Requirements, with Change 2	07-01-2013
FC 1-300-09N	Navy and Marine Corps Design Procedures Revised	05-01-2014
UFC 3-101-01	Architecture	11-28-2011
UFC 3-600-01	Fire Protection Engineering for Facilities, with Change 3	09-26-2006
UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings, with Change 1	02-09-2012
	Unaccompanied Housing Design Guide	01-2006

Applicable NFPA Codes:

NFPA	Life Safety Code	2015

Accessibility:

ABA	Accessibility Standard for Department of Defense Facilities	10-31-2008

Applicable Building Codes:
International Building Code (Per UFC 1-200-01 Requirements) 2012

Narrative

The intention of the Dorm 276 renovation project is to bring this dormitory, designed in 1958, in line with the current Dorm 4 Airmen Floor plan standard. This standard has been used as the basis for the new dormitories that have been constructed on the Base.

The Dorm 4 standard provides individual airmen rooms each with their own restrooms and closets and a shared kitchen and dining/living space. However due to the width of Dormitory 276 it is not feasible to provide four (4) bedroom shared accommodations with a living space. In lieu of this, the standard accommodations in Dormitory 276 will be two (2) bedroom suites with a shared kitchen/living space. The two bedroom standard configuration minimizes the amount of space within the unit denoted to internal circulation and affords the most efficient layout within the confines of the existing building shell. This two bedroom configuration is typical throughout the building, except on each floor there will be one unit with three (3) bedrooms and a shared living space. All of the two bedroom and three bedroom suites stack vertically to facilitate service runs.

Within the constraints of the existing structure the suites and public spaces will be designed to provide spaces comparable to the spaces that have been provided in the recently constructed dormitories. Dormitory 276 has floor to floor heights of only 9’-4” which severely restricts the ceiling heights that can be provided in the remodel. The unit layout has been predicated by the width of the existing building and also the column grid – typically 12’-8” but 13’-4” in certain areas.

The existing building has 35 double units with shared bathroom accommodations accommodating 70 airmen. The new configuration will provide 26 suites – 23 two (2) bedroom units and 3 three (3) bedroom units serving 55 airmen. All units will have a shared kitchen/dining/living space. The relatively narrow width of the existing building as compared to what has been provided in the new dormitories means that not only will the bedrooms, but also the shared spaces, will have windows to the exterior.

Each unit will also include a washer/dryer unit rather than the shared laundry facility the building currently has. All of the airmen’s bedrooms will have their own personal closet and bathroom.

The existing entrance will be remodeled and opened up to the corridor. Mail boxes and a key kiosk will be provided in a mail room directly adjacent to the building vestibule.

The central corridor will be widened from the current very narrow 4’-4” corridor width to 5’-0”. The corridor will also provide a widened area (7’-0” wide) at the entrance to the units to further alleviate the constricted, claustrophobic feel of the existing circulation corridor in this dormitory.

Each floor will have its’ own dayroom. These will be located in the location of the existing dayrooms in the portion of the building where the floor width was not widened as part of the 1983 renovation. These areas will also have the wall between this room and the circulation corridor removed. This is similar to what has been provided in the new dormitories, and in this case will provide visual relief and views to the exterior from the corridor.

The ceiling height of the corridor will be raised from the existing 7’-0” ceiling height. The goal is to achieve a minimum height of 7’-6” for the corridor. Dayrooms will have ceiling heights of 8’-0”.

Within the units the areas adjacent to the Corridors - the kitchen, bathrooms, laundries and closets, and corridor in the three bedroom units - will typically have ceiling heights of 7’-6’ to accommodate services in the space above the ceiling. The shared spaces and airmen’s bedrooms in the units will have ceilings at a height of 8’-0” typically. In areas where the slab was depressed at the original shower room locations ceiling heights will be reduced by 2” to a height of 7’-10” to accommodate services in the narrow space between the new ceiling and the existing concrete structure above.

Interior walls will typically be gypsum board on steel studs. Demising walls between units, walls between units and the public corridor, and bedroom walls within the units will extend to the underside of the structure above; and will all have acoustical batt insulation to provide acoustical privacy for the units and bedrooms. Ceilings will be suspended gypsum board.

At all exterior walls which have a gypsum board interior finish (all occupied rooms), 3” of closed cell spray foam insulation is being provided to increase the thermal performance of the building, and help the building attain LEED Silver certification.

Walls between suites, and between suites and corridors or shared common areas will have a Sound Transmission Class (STC) of at least 50. Floor and ceiling assemblies will have an STC of at least 55 and an Impact Insulation Class (IIC) of at least 60.

Access doors will be provided to access services where required. Interior doors will typically be wood veneer with painted hollow metal frames.

There will be minimal work on the exterior of the building. The existing windows will be replaced with new thermally broken insulated glass windows in aluminum frames. The new windows will meet UFC Anti-Terrorism Force Protection (ATFP) requirements. The interior lites will be laminated glass and the frames will be anchored to resist the designated blast loads for dormitory facilities. New louvers will also be provided and anchored to meet ATFP requirements. New hollow metal doors and frames will be provided at exterior stairways doors and exterior doors to mechanical, electrical and storage spaces. New aluminum storefront entrance doors and frames conforming to ATFP criteria will be installed at the entrance to the facility.

Card key access will be provided to the building off the vestibule and in the stairwells to the corridors to provide shelter when entering the building from the harsh winter conditions experienced in Minot. Each suite will have card key access with individual card key access provided to each of the airmen’s individual bedrooms.

In the exiting exit stairways guardrails will be replaced with new guardrails and handrails conforming to current IBC requirements.

Mechanical, electrical and communication rooms and closets will typically re-use existing mechanical and service spaces where practical. These spaces will have exposed concrete structure above.

Janitors closets will be provide for each level. This dormitory only serves able bodied airmen and has no elevator. It is not required to be fully accessible. However an accessible restroom off the main corridor will be provided on the first floor of this dormitory.

The goal of the dormitory renovation is to provide a first class remodel that will provide high quality shared dormitory units and amenities for the airmen housed therein. To the fullest extent possible within the constraints of the existing structure, spaces and finishes will match the level of accommodations and finishes afforded in the new dormitories that have been recently built at Minot Air Force Base.

INTERIOR DESIGN

Interior Finishes

The intention of the renovation of Dormitory Building 276 is to bring this dormitory, designed in 1958, up to current dormitory standards. The current standard has been used as a basis of design for the new dormitories that have been constructed on the Base. The dormitory renovation project will provide high quality dormitory units as well as amenities. Interior finishes will not only be aesthetically pleasing, but will also be functional, durable and easy to maintain.

The new configuration will provide 26 suites: 23 two (2) bedroom units and 3 three (3) bedroom units, which will serve a total of 55 airmen. All units will have a Shared Living Space (that will include a dining area) and Kitchen. All airmen will receive their own private Bedroom, Bathroom and Closet.

The Shared Living Space, Bedrooms and Closets will all receive carpet with rubber base. The majority of the walls will be painted a neutral beige color with subtle accent paint colors used throughout. The Bathrooms, Kitchens and Laundry Closets will receive a durable vinyl sheet flooring with rubber base and neutral painted walls. An integral prefabricated bath/shower unit will be provided in the Bathrooms. The Bathroom vanity will be a solid surface material with an integral solid surface sink and backsplash. The Kitchen countertop will be a solid surface material with a full height solid surface backsplash and include a double stainless steel sink. All cabinets will be a high pressure plastic laminate and will match the wood doors. All doors within the suite will be a solid core wood door with a stained veneer finish.

The existing entrance to the building will be remodeled and opened up to the main circulation corridor. New aluminum storefront entrance doors and frames will be installed at the entrance to the facility. Highly durable walk off mat carpet tiles with rubber base will be installed wall to wall within the vestibule. A durable, slip resistant porcelain tile with coordinating porcelain tile base will be provided at the stair landing and within the Mail Room. All walls will be painted a neutral beige color.

All Circulation Corridors and Day Rooms will receive a coordinating carpet with a rubber base. The majority of the walls will be painted a neutral beige color with subtle accent paint colors used throughout.

A durable, slip resistant porcelain tile with coordinating porcelain tile base will be provided at all first floor stair landings. All other stair landings will receive a rubber floor tile. Rubber stairs and treads will also be utilized. All walls will be painted a neutral beige color. New hollow metal doors and door frames will be provided at all exterior stairways doors. Guardrails and handrails will be painted to match the hollow metal doors and door frames.

New hollow metal doors and door frames will also be provided at all exterior doors to Mechanical, Electrical and Storage spaces. Mechanical, Electrical, Communications Rooms and

Janitors Closets will all receive sealed concrete floors and neutral painted walls. Janitor Closets will also receive a neutral beige colored fiberglass reinforced panel, near the sinks.

The accessible restroom off the main corridor will have a durable, slip resistant porcelain tile floor with coordinating porcelain tile base and porcelain wall tile with neutral painted walls above. The vanity will be a solid surface material with an integral solid surface sink and backsplash.
There will be minimal work on the exterior of the building. All new exterior finishes will match existing.

Furniture, Fixtures and Equipment

Most of the existing furniture has been recently replaced and will be reused as much as possible. New furniture will be provided in the common areas, such as the Day Rooms and the Shared Living Spaces. The Day Rooms will receive new lounge chairs, coffee tables and end tables. The Shared Living Spaces will receive new dining tables and chairs. All new furniture will match the style and finish of the existing furniture being reused.

Equipment will include appliances within each of the 26 suites. Each suite will receive a stacked washer and dryer, a full size refrigerator with freezer above, a compact range with oven, a range hood and a microwave. All appliances will be white.

Equipment will also include a key kiosk within the building vestibule.

MECHANICAL/HVAC

Design Codes and Standards

The latest edition of the following design codes will be utilized on this project:

ASHRAE Handbooks:	2010, 2011, 2012 and 2013
ASHRAE Green Guide	
ASHRAE Standard 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Energy Policy Act of 2005	(Public Law 109-58)
Energy Independence and Security Act of 2007	
International Building Code	
International Mechanical Code	
NFPA	National Electrical Code
NFPA 101	Life Safety Code
UFC 1-200-01	General Building Requirements
UFC 1-200-02	High Performance and Sustainable Building Requirements
UFC 3-401-01	Mechanical Engineering
UFC 4-010-01	DOD Minimum Anti-Terrorism Standards for Buildings

Overview

The Basis of Design for the mechanical systems for this project is to provide a new geothermal heat pump system. This will include a new well field to provide a heat source for the heat pumps. New pumps and a pipe distribution system will also be included. Individual heat pumps will be provided in each space with its own thermostat that will be monitored and controlled from the DDC system.

Ventilation air will be provided for the building via the Energy Recovery Ventilator. Air will be ducted into each dormitory unit with distribution only into each bedroom.

A central exhaust system will be provided to exhaust toilet rooms and janitors closets. The energy from this exhaust air will be recovered via an Energy Recovery Ventilator, located on the third floor. Separate exhaust will be provided from both the kitchen range hood and from the dormitory laundry dryers.

The existing radiant heating mechanical system in the building will be demolished except for the recently replaced heating boilers. These will be removed by the contractor for other use by the Air Force 5 CES.

During the Design Charrette, a LEED performance check list was completed. The project will be certified LEED silver. The check list is included in the final submission documentation.

Energy use calculations are provided in this submittal that we used for the Life Cycle Cost Analysis for this project. Calculations for both a Baseline building and the selected ground source heat pump building energy use are included. The Baseline building HVAC system is shown as VAV Rooftops with Hot Water Reheat Coils. This is the required system per LEED requirements to compare against the building we are designing.

Geothermal Heat Pump System

The heat pump system includes individual vertical stack type units placed on the perimeter of the building in each room. Air blows directly into the room from these units without a ducted distribution system. Units are encased into a closet enclosure with access via a hinged panel on the front of the enclosure. The panel has tamper proof closure device.

The units are selected based on the equipment requirements provided to us by the User Group. Units are selected at water flow rates of 2.5 gpm per ton of cooling. The Base uses Johnson Controls DDC systems exclusively for the purpose of continuity of security for the system. The Base has a single source letter that it has obtained to use only Johnson Controls. New controls will monitor the HVAC systems as stated on the controls drawings.

The heat source for the heat pumps is a new ground loop well field adjacent to the building. The well field design is a ground loop distribution to the heat pumps without a secondary building loop. The final well field we have designed indicates 36 wells are required. Well bore hole data is included in the Appendix.

Water distribution from the well field is from one pump, with a standby pump, located in mechanical room 1010. All water comes from the well field, into a supply water distribution header, into the building and back into a return water header and then into the well field bore hole and recirculated. Piping is designed to provide relatively equal pressure drops to four distribution headers, located at the building perimeter, under each vertical riser to the heat pumps. This design facilitates equal balancing of the water flow rate to each header. Piping is located in the first floor ceiling space.

Energy Recovery Systems

The ventilation requirement for the building requires the use of an energy recovery system. Exhaust from toilets/janitor closets is ducted to an air to air energy recovery ventilator (ERV) to recapture energy from the exhaust airstream. This unit uses a heat wheel to transfer energy from the exhaust airstream and recapture it, providing preheating/precooling of the ventilation airstream. A supplemental split system heat pump and direct expansion preheating/precooling coil is required to add additional energy into the ventilation air.

The Energy recovery ventilator is located on the third floor in a mechanical space now housing a ventilation air handler that is being removed. The split system heat pump is also located in this room.

Ventilation air is introduced via a new intake louver on the second floor. Relief air is via a relief air louver at the mechanical room on the third floor. The use of two separate louvers provides considerable vertical separation to minimize recirculation of air.

The failure of the components of the ERV will cause the system to shut down, and exhaust will not be taken from the facility. With the exhaust shut down, makeup air is suspended and ventilation is not provided temporarily while the ERV is repaired. This is to avoid the cost of a backup system for emergency ventilation.

Included in the calculations are the design conditions that are entering and leaving the ERV. They also show the psychrometric conditions of the air as energy is transferred from the exhaust airstream to the ventilation airstream. Moisture in the airstream is transferred also. The calculations are performed for the elevation at Minot AFB of 1630 feet.

The load calculations show input data for calculating the energy used by the ERV. This energy usage is not separated in the output data from the other systems.

Humidification System

We have provided humidification for this project with a duct mounted steam distribution manifold. This is supplied by an electric steam humidifier. To prolong electric element life in the humidifier, water for steam production is provided from a reverse osmosis (RO) unit. The RO unit has water supplied to it by a water softener (see the plumbing drawings) and distribution piping of polyethelene (PEX) to eliminate corrosion in the line (requested by the BASE personnel). This softened water meets the requirement of less than 1 grain hardness as required by the unit manufacturer.

Air Distribution System

Ventilation air is distributed to the various dormitory spaces via a ducted system. This system is insulated to minimize energy loss from the ductwork. Make up air shall meet the requirements of ASHRAE standard 62.1. The air is ducted from the energy recovery unit and routed above the ceiling space of the corridor on each floor. This air is delivered at temperatures as close as possible to what is being maintained in the spaces, with some variation due to the cycling of the split system heat pump. Air is ducted through the corridor wall to the dormitory space and then routed to each bedroom in the space.

Ventilation air is being distributed into the lounge areas and other spaces on each floor as required by ASHRAE 62.1 calculations.

Building Exhaust Systems

Exhaust air from the bathrooms is via vertical risers routed into the existing attic space. An exhaust duct running horizontally in the attic space collects these risers and is routed to the energy recovery unit. This duct is heavily insulated so that heat transfer into the attic space is minimized and energy recovery is maximized.

The range hood in each kitchen space has a dedicated exhaust duct connected to it. The duct runs horizontally above the ceiling directly through the exterior wall. Termination of the exhaust is via an aluminum wall cap with a gravity backdraft damper.

The laundry dryer in the joint living space has a dedicated exhaust duct connected to it. The duct runs horizontally above the ceiling directly through the exterior wall. Termination of the exhaust is via an aluminum wall cap with a gravity backdraft damper. Routing is shown to utilize a maximum of three 90 degree elbow equivalent in the dryer exhaust. This is to maintain a maximum of 35 foot equivalent duct length per the IMC code. A separate calculation of this ductwork is included with the other calculations we are providing.

Equipment Sizing And Building Loads

The block cooling load for the building is slightly less than twenty four tons, based upon bringing the building envelope up to ASHRAE 90.1 standards. However, the individual room heat pump units are sized based on the heating capability of the heat pump rather than cooling, due to the severe winter temperatures experienced at Minot AFB. The system is designed on nominal ¾ ton vertical stack heat pumps. Equipment is sized to match the heating load and as a result the cooling may be oversized by a factor of three. This is acceptable because heating represents 48% percent of the ground loop load and cooling only represents 16 percent of the ground loop load. Another factor in unit oversizing is that all the room units are identical which simplifies maintenance and reduces maintenance cost by precluding the necessary training and parts storage for multiple sizes of units.

The energy recovery unit is sized for a maximum ventilation requirement of 2800 cfm. This is sized for a maximum of 20% additional air above the ASHRAE 62.1 requirement due to slight positive pressurization over the exhaust air requirements.

The exhaust requirement for the toilets/janitor closets, and other areas, is approximately 2300 cfm. All of the air is routed to the ERV on the third floor.

The pump for the water distribution system to the heat pump units is sized at 100 gpm. There is a secondary backup pump in the event the main pump experiences a failure. The distribution system also has supply and return headers, an air separator and expansion tank. The number of water circuits tied to the distribution headers are shown to be 4 each supply/return with the well field designed for 36 wells total.

Life Cycle Cost Analysis (LCCA)

The LCCA shows that the the proposed Geothermal Heat Pump System has the lowest life cycle cost compared to the Fan Coils with Hot Water Reheat, or Rooftop VAV (baseline) with Hot

Water Reheat as indicated in the report. Included with this submittal are the detailed input and output files for this analysis. Refer to the LCCA study report.

Mechanical Equipment and Materials

Heat pumps

The design basis for this system is Trane Corporation vertical stack heat pumps. Trane was mentioned to the design team to be an acceptable manufacturer for this product.

The split system heat pump for the preconditioning of ventilation air is also designed around Trane equipment. This unit is a horizontal type exposed in the mechanical room.

Energy recovery ventilator

The design basis for the energy recovery ventilator is Greenheck, Inc. This manufacturer meets our space requirements for the required layout in the existing mechanical equipment room.

Water circulation pumps

The design basis for inline circulation pumps is Bell and Gossett, Inc. The accessories for this pump system are also Bell and Gossett, Inc. equipment.

Control Systems

Johnson Controls, Inc. is the provider of the existing Base DDC system controls and will provide the controls for this project. The DDC system will provide proper operation and sequencing of the energy recovery ventilator and proper operation of the water circulation pumps. The system will also be utilized for air temperature sensing and control as shown on the control drawings. The DDC system shall meet the minimum point requirements as stated in UFC 3-410-01.

Water distribution piping

The piping for the geothermal water distribution piping is HDPE black pipe (high density polyethylene) in both the rigid and flexible tubing type piping. The fittings and joints are to be butt fused welded in inaccessible locations. Additionally, copper piping is proposed for an alternate to the HDPE pipe only in the first floor mechanical equipment room 1010.

Duct distribution systems

The duct system is designed in accordance with industry standards and the SMACNA guidelines. The insulated exhaust system in the attic space is to be wrapped with polyisocyanurate rigid foam to an R value of at least 20.

Air devices

Titus is the basis of design for air devices. Aluminum devices are proposed throughout the building to provide corrosion resistance in any humid locations.

PLUMBING

Design Codes and Standards

The latest edition of the following design codes will be utilized on this project:

ASHRAE Handbooks:	2010, 2011, 2012 and 2013
ASHRAE Green Guide	
ASHRAE Standard 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Energy Policy Act of 2005	(Public Law 109-58)
Energy Independence and Security Act of 2007	
International Building Code	
International Plumbing Code	
NFPA	National Electrical Code
NFPA 101	Life Safety Code
UFC 1-200-01	General Building Requirements
UFC 1-200-02	High Performance and Sustainable Building Requirements
UFC 3-401-01	Mechanical Engineering
UFC 3-420-01	Plumbing Systems
UFC 4-010-01	DOD Minimum Anti-Terrorism Standards for Buildings

Existing Conditions

The current plumbing systems in this three-story building consist of a sanitary, waste and vent piping system, a domestic cold water, hot water and hot water circulating water system, a single public restroom is located on the first floor. Janitor sinks and single basin electric water coolers are located at the same stacked location of the building on all floors. Resident bed rooms have individual lavatories and shared toilet and bath rooms between each pair of bed rooms. There are no kitchen facilities.

The 5” sanitary sewer exits the building through the north foundation wall approximately 45’ from the northwest corner of the building.

Roof drainage is provided by gutters and exterior downspouts.

A 2 1/2” water service enters the building through the south foundation wall into the pipe trench and rises up in the boiler room.

Domestic hot water is provided by gas fired water heaters and storage tanks.

Design Considerations

The plumbing upgrades planned for this building include a complete demolition and removal of all interior plumbing system components. Demolition and removal includes components located in the pipe tunnel below the first floor level. Under slab piping not being reused will be sealed off and filled with grout. Under slab piping being reused will be thoroughly cleaned and defective sections replaced. Existing vent through the roof piping will remain to just below roof for connection new vent piping avoiding unnecessary cutting and patching of the roof.

New domestic water system piping will be Type L copper with brazed or soldered sweat joints. Valves will be full port ball type. The new domestic water service will be 4 inches until it enters the boiler room where it will reduce to 2 ½ inches and have a new water meter and backflow preventer.

Sanitary waste and vent system piping will be cast iron no-hub above grade and hub and spigot below grade. A new 6” sanitary sewer will exit the building at the same location that the current 5” (to be demolished) sanitary exits. The new 6” sanitary sewer will extend to 5 feet beyond the building exterior wall for continuation by Base Utilities Inc.

Fixtures

Dual level electric water coolers will be provided on all floors.

Water closets in all resident bathrooms will be floor mounted 1.28 gpf fixtures with flush tanks.

Water closet in the public restroom will be floor mounted 1.28 gpf with manual flush valve.

Countertop lavatory basins will be integral with the countertop and have single lever ceramic cartridge washerless 0.5 gpm faucets.

Kitchen sinks will be double bowl stainless steel drop-in with two handle ceramic cartridge washerless swing spout 1.5 gpm faucets.

Mop basins will be floor mounted 24” x 24” x 12” high terrazzo with stainless steel caps on all curbs and have a wall mounted two handle faucet including hose thread spout, vacuum breaker, bucket hook, and wall brace.

Combination bathtub/shower units will be four piece fiberglass and will have wall mounted 1.5 gpm shower heads on swivel ball joints, tub spout, and pressure-balancing mixing valves with integral diverter.

A recessed white powder coated steel cold water outlet box with brass quarter turn valve will be provided at each refrigerator location for connection of ice makers.

A recessed white powder coated steel hot and cold water outlet box with brass quarter turn valves, water hammer arresters, and 2” drain outlet connection will be provided at each clothes washer location.

A floor drain will be provided at each clothes washing machine and in the first floor public rest room.

A new domestic water heating system will be provided. It will consist of two 96 percent thermal efficient natural gas fired 119 gallon, 300,000 BTU/HR input water heaters, an expansion tank, circulating pump, and a thermostatic mixing valve. Water will be stored at 140 degrees F and tempered to provide 120 degrees F water to the building. Each heater is sized to provide 75 percent of the maximum domestic hot water demand.

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FIRE AND LIFE SAFETY

Design Codes and Standards

The latest edition of the following design standards and codes shall be utilized on this project:

ABA	Architectural Barriers Act, Accessibility Standard for Department of Defense Facilities
ABA	Accessibility Standard for Department of Defense Facilities
FED-STD-795	Uniform Federal Accessibility Act
IBC	International Building Code, as amended by UFC 1-200-01
NFPA 1	Fire Code
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 13R	Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
NFPA 14	Standard for Installation of Standpipe and Hose Systems
NFPA 24	Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	National Electric Code
NFPA 72	National Fire Alarm and Signaling Code
NFPA 80	Standard for Fire Doors and Other Opening Protectives
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating
NFPA 101	Life Safety Code
NFPA 220	Standard on Types of Building Construction
NFPA 291	Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 720	Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment
UFC 1-200-01	General Building Requirements
UFC 3-600-01	Design: Fire Protection Engineering for Facilities
UFC 4-010-01	DOD Minimum Anti-Terrorism Standards for Buildings
UFC 4-021-01	Design and O&M: Mass Notification Systems

Existing Conditions

Dormitory Building 276 on Minot AFB was designed in 1958 and erected in 1960. It was remodeled in 1983 adding 4'-6" feet in width to both long sides of the building (9'-0" total). The building is a 3- story dormitory building housing Type R-2 occupancy per IBC and Residential Occupancy - Dormitory Building per NFPA 101. At the completion of the remodel the NFPA occupancy would change to "Residential - New Apartment Building" occupancy due to adding the kitchen function inside each apartment.

Modifications to the building are estimated to be less than 50% of the building's replacement cost. Almost 100% of the floor area of the building is being remodeled and per UFC 3-600-01, renovated areas will meet requirements for new construction. Additionally, this will require the building be brought into compliance with UFC 4-010-01 which will require a Mass Notification System be installed.

Construction Type
The building is constructed of non-rated, non-combustible materials except for a sloped roof assembly retrofitted to the building, which is constructed of fire treated wood framing. The building is of Type IIB construction per IBC and Type II (000) construction per NFPA 220 being constructed of cast-in-place concrete with an addition of steel and concrete. A roof constructed of fire treated wood trusses is allowed by IBC section 603.1.3 in Type IIB construction. UFC 3-600-01 section 2-1.3 requires a 2 hour concrete or masonry fire separation between Type IIB buildings and roofs of Type V combustible construction to be considered Type IIB construction. The 1983 addition is not of concrete; therefore the building is classified as Type V construction despite being of cast concrete construction. The attic is divided by draft stopping separating the space into areas 3,000 sf or less.

Life Safety

NFPA 101, applicable occupancy chapter criteria and referenced criteria shall be utilized to establish life safety features in the building. All means of egress requirements shall be met in accordance with NFPA 101 “Life Safety Code”, including exit widths, travel distances, common path of travel, dead end corridors, illumination and exit signs.

Occupancy Type
Per the IBC, this building has an occupancy classification of Group R-2 with incidental Group S-1 use. Per NFPA 101, building has an occupancy classification of Residential, New Apartment Building (NFPA 101, Chapter 30) with incidental storage as allowed in Section 6.1.14.1.3.

Occupant Load
The building occupant load is calculated based on the residential occupancy load factor of 200 gross sf/ person prescribed in NFPA 101 Table 7.3.1.2 for residential apartment use area. Assembly use areas are based on an occupant load factor of 15 net sf/person. See sheet GI101 for breakdown of occupant use areas. The mechanical and electrical rooms with exterior exits are calculated using an occupant load factor of 500 gross sf /person.

IBC Allowable Area
Allowable floor areas are based on the building R-2 Residential occupancy, Type VB construction and full frontage increase. The tabular value per IBC Table 503 is 7,000 square feet. Incorporating the frontage increase (5,250 sf) results in a maximum allowable area per floor of 12,250 sf. The 9,800 sf area per floor of this building is within the allowed area limit. It is noted that IBC does not allow for area increase for sprinkler installed according to NFPA 13R.

The tabular value for building height is 2 stories/40 feet. Incorporating the sprinkler increase (1 story/20feet) per IBC section 504.2 related to Residential occupancies results in a maximum allowable height of 3 stories/60 feet. The building having 3 stories and a height equal to or less than the allowed height and stories.

Therefore the building's existing height and area comply with Type VB construction limitations.

Fire Department Access
Per UFC 3-600-01, Section 2.10, all-weather access roads are provided with pavement, starting from the road and terminating no further than 10 m / 33 ft. from the building. The existing fire department access is adequate and no changes are required.

Number of Exits
The three primary exists available to the occupants and spacing of exits is in compliance with NFPA 101 Life Safety Code. See the drawing GI101 for specific exit arrangement and information on actual travel distances. The electrical room on the ground floor has a single exit but travel distance falls within the allowed common travel path limit of 100 ft. allowed by NFPA 101 section 7.12.1 complying with the requirement allowing a single exit.

Exit Access Travel Path
This includes limiting travel within the apartment to 125 feet to reach the corridor. Once in the corridor the distance to an exit shall be limited to 200 ft. Dead-end corridors and common path of travel in corridors is limited to 50 feet. This design has no dead-end corridors or common paths in the exit access, noting that travel within the apartment is exempt from being included in the common path. Exit access will be arranged to maintain 7'-6" of headroom with obstructions projecting down into the required egress path reducing headroom to no less than to 6"-8" in one third of the space. See the drawing GI101 for specific egress travel distances.

Fire Separation
Vertical exit enclosures are specified to have 1 hour fire barriers and 1 hour doors. Rooms housing mechanical equipment with combustion equipment or storage outside apartments shall be separated from the rest of the occupancy by a 1 hour fire barriers and 45 minute doors. Corridor and apartment walls and floor-ceilings are required to be separated by ½ hour minimum fire rated assemblies and 20 minute doors. There is no UL listed ½ hour fire barrier assembly. Additionally most walls are specified to be constructed of 5/8" Type-X gypboard, which is the primary requirement in construction of most UL listed 1 hour fire barriers. As a result these walls are specified to be 1 hour construction. The floor/ceiling assembly between the first and second floor and between the second and third floor must be ½ hour fire rated to provide vertical fire separation between the apartments.

Duct Penetrations of Fire and Smoke Rated Structures
Ducts penetrating fire rated horizontal assemblies shall be protected in accordance with NFPA 90A requirements. Ducts penetrating more than one floor assembly will be wrapped in fire rated insulting duct wrap meeting ASTM E 119, creating a shaft enclosure. Fire dampers will be located at the highest and lowest floor or roof assembly penetrated and at all ducts branching out in-between. Ducts penetrating only a single floor or roof assembly will have a horizontal fire

damper located at the floor penetration. Access hatches will be provided in walls and ceilings of fixed construction as needed for access to the fire dampers for proper maintenance and testing. There are no walls with a required fire rating exceeding 1-hour. Therefore per UFC 3-600-01 2-11.5, duct penetrations of walls other than shaft enclosures will be protected with a listed through penetration fire system.

Attic Draftstopping

When the sloped roof was added in the 1983 remodel, the attic was divided with walls listed to be of 1-hour fire resistance dividing the attic into spaces ranging from 2,000 square feet to 1,330 square feet. Doors with automatic closers in these walls provide access to all the attic spaces. Access to the attic is from the access hatch in the center stair. NFPA 101 section 8.6.11.1(2) requires unoccupied attics to be provided with draftstops enclosing areas no larger than 3,000sf. Per UFC 3-600-01 sections 2-1, drafstopping, being a life safety feature to prevent the spread of smoke, is not required to comply with the IBC Section 717 requirement that draftstopping be aligned with dwelling unit separation walls.

Vertical Exit Enclosures

Existing exit stair fire separation has been compromised by years of wear and tear and modifications. Unprotected penetrations, hand rails, fall protection, and opening protection must be brought up to current standards. Magnetic door hold-opens are being provided on the doors from the center corridor to the center stair to increase the life of the doors and provide an alternative to the door stops currently in use in violation of the building and life safety codes.

Accessible Means of Egress

Only able-bodied airmen will be assigned to this building. Because of this, as directed by the DoD ABA standard, accessibility requirements are not incorporated in the design.

Egress Lighting

Egress emergency lighting and exit signs will be wired on separate circuits with a central backup power system per base standards. Standard light fixtures will be used for emergency lighting. Battery pack lights will not be used.

Interior Finishes

Interior finishes are specified to be Class A in exit enclosures, Class A or B in corridors and common spaces. Other areas may be Class A, B, or C. Floors in exit enclosures, corridors, and common spaces are specified to be Class I or Class II.

Fire Suppression

Automatic Fire Sprinklers

When remodeled, the building is required to be protected with wet type fire sprinkler systems, one serving each floor of the building. These systems shall be designed in compliance with NFPA 13R as part of a delegated design. Per Section 6.6.6 of NFPA 13R, sprinklers are not required in attics not intended for living purposes or storage and that do not contain fuel-fired equipment.

Standpipe
The base standard requires dry manual standpipes be installed in the two end stairs. Since there is no other space available to locate buildings fire water entrance and fire risers, the water entrance and floor zone control assemblies have both been located in the east stair. The stair enclosure is heated to maintain the space at or above 40 degree F. Being co-located, a combined sprinkler system and wet manual standpipe will be installed.

Fire Protection Pipe
The sprinkler system is specified to be constructed to UFC 3-600-01 and NFPA 13R standards. It is specified to be constructed of schedule 40 ASTM A53B or 135A black iron pipe. Fittings in pipe 2” NPT and less are specified to be screwed type. Fittings in pipe 2 ½” NPT and larger are specified to be welded connections, flanged connections, or roll grooved couplings. While NFPA 13R allows CPVC plastic pipe to be used, plastic pipe was not previously allowed in other recent dorms and was not allowed in this project.

Fire Sprinklers
Sprinklers are specified to be quick response type unless required to be standard type in unfinished areas. Heads are specified to be concealed pendent and/or sidewall type sprinklers with white cover plates in finished spaces, rooms with drop ceilings, and stairs. They are specified to be rough brass upright, pendant, and/or sidewall sprinklers in unfinished spaces.

Sprinkler Coverage Design
Sprinkler density and remote design area will be in accordance with NFPA 13R. Within dwelling units the sprinklers shall be designed to provide 0.05 gpm/ft^2 from four sprinkler heads or number specified in NFPA 13R. Areas outside dwelling unites shall be protection in accordance with FM Data Sheet 3-26 specified in UFC 3-600-01 and NFPA 13 requirements. The hydraulic remote fire sprinkler hazard area is the third floor. Reference attached hydraulic calculations for verification of adequacy of the water supply.

Fire Water Service
A new fire water service line will be constructed to serve the fire sprinkler system from a 4” water main running 5 to 10 feet east of the east stair based on the best site data available. A new post indicator gate valve will be located at the point the new line connects to the existing water main. This will be less than the NFPA 24 required 40 feet from the building. The new 4” service line will have a double check valve backflow preventer with supervised OS&Y valves. A flow switch with drain and test valve assembly will be installed downstream of the backflow preventer. This flow switch will supervise standpipe flow should a hose valve be opened. Floor zone control assemblies will be as shown in UFC 3-600-01 including shut-off valve, check valve, pressure gage, paddle type flow switch, pressure gauges, 2” main drain, and test valve assembly with flow viewport. The main drain and test drain lines will be connected to a common drain line discharging to the outside on a splash block outside the building.

Fire Department Connection

A fire department connection (FDC) is specified to be on the east face of the east stair of Dorm 276 which is well within 45 m (150 ft) from the fire hydrant at the Northeast corner of the building, as required by UFC 3-600-01. The FDC is designed to have two 2½" hose connection in a "y" pattern. A ball drip valve is required to drain the line between the check valve and the FDC.

Sprinkler System Support

Fire protection piping will be supported directly from the building's structural members. Seismic criteria as outlined in NFPA 13 is not required due to the building being a Seismic Class B facility . No other equipment or materials will be allowed to be supported from the fire protection support system. Pipe penetration through exterior walls and foundations will use pipe sleeves with the voids filled with silicone on non-rated walls. Penetrations of fire rated assemblies will be protected with a listed 'through penetration fire stop" assembly.

Escutcheons

Escutcheons shall be installed where exposed pipes penetrate a wall in a finished room. Escutcheons shall also be installed at semi-recessed sprinklers. System Painting and Identification All exposed sprinkler system piping in finished areas is specified to be painted in facility coordinated color. Piping in unfinished areas will not be painted. All piping will be provided with identification and flow markings at, not to exceed, intervals of 7.9 m (26 ft). System signage will be provided per the requirements of NFPA-13R.

Fire Water Supply

A fire hydrant flow test on the water line that will be used to supply the new sprinkler systems was performed. Hydraulic calculations indicate the building's fire water supply is sufficient to meet the calculated fire flow without the need for a fire pump. The fire protection Contractor will be required to provide their own conformation flow test to verify current pressure and flow at the time of final design and construction of the fire protection system.

Manual Fire Extinguishers

Portable fire extinguishers are not required by UFC 3-600-01 or NFPA 101 for apartment occupancies that are fully sprinkled. Portable fire extinguishers are provided in accordance with Base standards.

Fire Alarm and Mass Notification System

Existing System

The existing conventional fire alarm system does not meet the current UFC 3-600-01 requirement for fire alarm system to be addressable. The existing fire alarm system will be demolished, returning the panel to the Government and an addressable voice evacuation Fire Alarm System shall be provided throughout the facility. The fire alarm control panel is specified to be located adjacent to the main entrance.

Mass Notification

This project's cost is projected to trigger compliance with UFC 4-010-01 requirements, including installing a new Mass Notification System. This system will be integrated with the fire alarm system. A combined Fire Alarm and Mass Notification System (MNS) will be specified to meet the requirements of UFC 3-600-01 and UFC 4-021-01.

Fire Alarm Initiation

The new system will include

a. MANUAL PULL STATION: Manual Pull Stations shall be located at exits and as required by NFPA 72.

b. FIRE SPRINKLER FLOW SWITCH: The system shall activate notification appliances on detection of fire sprinkler flow by flow switches serving the building water entrance and each floor zone control valve assembly.

c. FIRE SPRINKLER SUPPLY VALVE TAMPER SWITCHES: The fire alarm shall issue supervisory alarm when fire sprinkler supply valve tamper switches indicate valves are not in proper position.

d. SMOKE AND HEAT DETECTION:

   (1) Within Each Suite: Smoke detectors with sounder bases will be located in each sleeping room and the area outside the door to each sleeping room. Detection of smoke within an apartment suite will cause all sounder bases within that apartment to sound and issue a supervisory alarm to the central fire alarm reporting station.

   (2) Over Fire Alarm Panel: A smoke detector shall be provided above the fire alarm control panels and as required by NFPA 72. Activation will initiate building evacuation.

   (3) Duct Smoke Detection: Supply and return duct smoke detectors shall be required on all HVAC units greater than 2000 CFM in capacity as required by NFPA 90A. Each duct smoke detectors will have a remote test station and indicator light.

   (4) Adjacent to magnetic door hold-opens: A smoke detector located per NFPA 72 on the ceiling near doorway held open with a magnetic door holder when activated will cause the door holder to release and close.

e. CARBON MONOXIDE DETECTION: A single Carbon Monoxide (CO) detector is shown to be located on the ceiling of the mechanical room in which the natural gas water heaters are located. On detection of CO above the alarm set point, the voice evacuation message for CO and the mass notification strobes will be activated. The voice evacuation message will consist of a temporal 4 tone followed by a voice message to evacuate the building.

Mass Notification Message Initiation
The new system will have stations to initiate 8 prerecorded messages or a live voice message on each floor. This will be located at the FMCP (Autonomous Control Unit) on the ground floor. This will be located in the main corridor near the center stair. A local operator console will be located in roughly the same location on the second and third floors. Prerecored messages will include the fire evacuation message, CO evacuation message, System testing message, “all clear message, as well as four base designated messages. Messages specified to be broadcast at 520 Hz as required for sleeping facilities.

Alarm Notification
Fire alarm notification will be via an emergency voice/alarm communication system providing audible notification in all occupied spaces. Visual notification is specified in common and public areas including mechanical rooms. Housing only able bodied personnel, visual notification is not required in the dorm suites.

Audible Notification
Audible notification will be eight UFC required voice messages and live voice via microphones at Local Operator Consoles. The system will be specified to have audibility of 0.8 or higher as measured on the Common Intelligibility Scale (CIS).

STRUCTURAL

The current, proposed, renovation design for Dorm 276 will include only minimal (if any) changes, modifications or additions to the existing structural design of the building. It is, however, the desire of the AFCEC and Minot AFB to replace the existing exterior doors and windows on the building with windows that will meet UFC Anti-Terrorism Force Protection (ATFP) requirements. This will require structural reinforcing around all existing, exterior doors and windows.

The new reinforcing / support system shall be designed to meet the criteria and requirements of UFC 4-010-01 dated 9 February 2012 with Change 1, Dated 1 October 2013.

Reinforcing / support system design shall include connections to the existing floor framing system at bottom and to the existing roof or floor framing system at the top of the story on which the window or door is located.

If the windows or doors are not perpendicular to the blast then the angle of the blast shall be considered. Reinforcing / support system shall be adequate to support the window or door itself and also the blast load applied to the window or door. Reinforcing / support system shall also be designed to support wind loads in accordance with ASCE 7-10 on the window.

The design for the reinforcing / support system for the new replacement windows and doors shall be fully coordinated and compatible with the new and existing Architectural Design Elements and all other elements of the existing building for the window system.

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ELECTRICAL

Electrical Existing Conditions Narrative

The Electrical Service is located on the first floor in the Mechanical Boiler room. The existing service size is a 400A – 120/208V, 3phase, 4wire Main Distribution Board which consists of (4) Fused Disconnect Switches that feed branch panelboards throughout the building. Each floor has a branch panelboard which feeds circuits to each dorm room, common areas, restrooms, misc. equipment, etc. This existing equipment was installed in 1960. The size of the main service and panelboards is not adequate for this renovation and will need to be upgraded.

This service is fed from a 150KVA pad mounted utility transformer located near the rear exterior of the boiler room. The size of the transformer is adequate for the proposed remodel with additional secondary feeders required.

General Lighting

General lighting in utility spaces consist of 1x4 surface mounted fluorescent industrial strips. This lighting is outdated and needs replaced.

Corridor lighting at each floor consists of recessed 1x4 fluorescent fixtures mounted at the corner of the ceiling/walls alternating down the corridors. This lighting is outdated and needs replaced.

Dorm Room lighting consist surface mounted 1x4 fluorescent wraparounds. This lighting is outdated and needs replaced.

Emergency Lighting

The existing LED exit signs and emergency lighting is served by a 5KVA, 120V, 1phase, 90 minute Central Battery Backup Unit. This equipment is old and needs updated.

Electrical New Service Narrative

The new proposed electrical system will consist of (1) Main Service located in a dedicated Electrical room on the 1st floor with exterior access. The utility company has asked for a CT Cabinet (Exterior) for metering purposes. The service size will be 2000A – 120/208V, 3phase, 4wire. This service will have a distribution section that will serve (3) 600A – 120/208V, 3phase, 4 wire distribution panels, (1) per floor at each floors dedicated electrical room. There will be (1) 200A 120/208V, 3phase, 4wire panelboard to serve all of the mechanical equipment at the first floor and (1) 400A – 120/208V, 3phase, 4wire panelboard on the second floor which will feed the mechanical loads on the second and third floors. Each tenant common suite will have (1) 100A – 120/208V, 1phase, 3wire flush mounted electrical panel to serve either a (2) dorm room suite or a (3) dorm room suite.

Emergency Lighting

New LED exit signs and emergency lights will be served by battery packs in each individual unit. Each battery unit will be rated for 90 minutes of battery life per code.

General Lighting

All lighting inside and outside of the building will be LED. The corridors will have a combination of wall sconces and down lighting. The general spaces will have surface mounted luminaires and where space permits we will utilize recessed downlights. There will be new exterior security lights near the exit doors. All lighting in the common spaces will be controlled by a combination of key'a central lighting controller mounted in the main electrical room.

COMMUNICATIONS

Design Codes and Standards

The latest edition of the following design codes will be utilized on this project:

TIA-568-C.0	Generic Telecommunications Cabling for Customer Premises
TIA-568-C.1	Commercial Building Telecommunications Cabling Standard
TIA-568-C.2	Balanced Twisted Pair Telecommunications Cabling and Components Standard
TIA-568-C.3	Optical Fiber Cabling Components Standard
TIA-568-C.4	Broadband Coaxial Cabling and Components Standard
TIA-569-B	Commercial Building Standards for Telecommunications Pathways and Spaces
TIA-606-B	Administration Standard for the Telecommunications Infrastructure
TIA-607-B	Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
BICSI TDMM	Building Industry Consulting Services International - Telecommunications Distribution Methods Manual (Latest Edition)
BICSI OSPDRM	Building Industry Consulting Services International – Outside Plant Design Reference Manual (Latest Edition)
BICSI ITSIM	Building Industry Consulting Services International – Information Transport Systems Installation Manual (Latest Edition)
NFPA 70	(2011) National Electrical Code
IEEE C2	(2007) National Electrical Safety Code
ANG ETL 01-1-1	(March 2004) Air National Guard Design Policy including (Oct 2006) Tab D
AF ETL 02-12	(June 2002) Communications and Information Systems Criteria for Air Force Facilities
UFC 3-580-01	(2007) Unified Facilities Criteria for Telecommunications Building Cabling Systems Planning and Design
UFC 4-021-02NF	(2006) Security Engineering: Electronic Security Systems
UFC 4-022-01	(2005) Security Engineering: Entry Control Facilities / Access Control Points
TSDS	(2013) Telecommunications Systems Design Standards; 19 Communications Squadron LRAFB, AR

General

The Structured Cabling System consists of interior pathways, telecommunications spaces and equipment, backbone copper and optical fiber cabling and horizontal cabling and terminations.

Job-Site Safety

The project shall include requirements for job-site safety programs and training, as well as a hazardous material communication program consisting of training, procedures and Material Safety Data Sheet (MSDS) accessibility to meet OSHA requirements.

Existing Building Conditions

The existing building contains minimal telecommunications infrastructure cabling and equipment. A telephone demarc exists in the first floor mechanical room and primarily supports connectivity for the fire alarm system and a few selected office drop locations. The cable TV service provider has a separate demarc location for their service and equipment with cable TV drop locations serving selected building common use locations. A security system consisting of security cameras and DVR has been installed in a wall cabinet located in the first floor mechanical room. Cameras have been installed on each floor at the beginning and end of each floor within the building. A single security camera has been installed on the exterior of the building over the main entrance to the building. The building does not have any base data networking capabilities, no card access control capabilities for the external or internal doors and no public address system.

Selective Demolition

The project shall include requirements for selective demolition of communications cabling and infrastructure. The Contractor shall coordinate demolition activities of all passive cabling and devices with the Construction Manager.

Construction Manager shall contact and coordinate with the Local Cable TV and the Local Telephone Service Providers for removal and or demolition of service provider’s cabling and or equipment.

It is expected that all active communications devices including data electronics, broadband distribution amplifiers, uninterruptable power supplies, LCD TV’s, projectors, etc. shall be removed from the project site by Base Communications Staff and Local Service Providers prior to demolition.

Outside Plant Pathway/Cabling

New telecommunications 4’x4’ handholes and associated communications 2-way 4” PVC duct bank pathways shall be provided to Building 276, The new duct bank will installed from Building 214’s existing telecommunications hand hole.

The Local Cable TV and the Telephone Service Provider shall utilize a new telecommunications hand hole near Building 276 for re-routing their OSP coaxial backbone cable and multipair copper telephone cable feeds to the building.

One (1) 12-strand OSP fiber optic cable shall be routed to Building 276. The 12-strand fiber will originate from the main telecommunications room in ITN 120 and will utilize new underground conduit pathways to Maintenance Hole 176.

Interior Pathways

Due to the limitation of space above the drop ceilings of the each floor's corridor, Wall-mounted Snake Tray (or approved equal) shall be installed on each side of the corridor above the drop ceiling to provide a horizontal cabling pathway to support plenum-rated Category 6 UTP cabling and plenum-rated Series 6 coax cabling to telecommunications outlets.

All work area outlets shall be served with a 1" and shall be piped to the corridor. Outlet boxes shall be 4-11/16" sq x 2 1/8" deep with a single gang reducing ring.

Telecommunications Spaces

Standard Equipment

a. One (1) telecommunications room shall be provided on each floor and shall be stacked to provided efficient routing of telecommunications data, voice and video back bone cabling.

b. 84" high by 19" wide equipment racks with an EIA 310 mounting pattern and horizontal and vertical cable management shall be provided as required for termination of cable and mounting telecommunications equipment.

c. Ladder style cable tray shall be provided for cable routing around the perimeter and over the cabinets and racks within the room.

d. New walls shall be covered with ¾" A/C grade plywood to the height of 8', painted white with two coats of fire retardant paint (the fire rating stamp shall not be covered) for wall mounting of equipment.

e. One (1) 110VAC 20A dedicated quad receptacle and one (1) 110V/220VAC 30A dedicated twist lock receptacle shall be provided at each rack and one for each space allocated for future racks and GFGI cabinets (cabinet quantity to be determined). Convenience 110VAC duplex receptacles on a common circuit shall be provided around the perimeter of the room at an interval not to exceed 6'. A minimum of two (2) 20A and one (1) 30A dedicated receptacles shall be provided per space.

f. A Telecommunications Main Ground Bus (TMGB) bar shall be provided in the Main Communications Equipment Room (CER) by the electrical contractor and connected to the Earth Electrode System for telecommunications grounding. The TMGB shall be connected to the main electrical service entrance ground using no smaller than a #1 AWG insulated stranded copper conductor. All telecommunications equipment in the CER (racks, cabinets, cable tray and conduit) shall be bonded directly to the TMGB using no smaller than a #6 AWG insulated stranded copper conductors with two-hole or non-twisting lugs.

g. The TMGB shall be bonded to non-current-carrying metal building parts, such as metal framing, in the ER as required by the NEC.

Entrance Facility (EF)

a. Building 276 currently has a Telephone Service Provider OSP multipair copper backbone cable and a Cable TV Service Provider coaxial backbone cable entering the facility through separate ground floor building entry points for distribution throughout the building.

b. The Communications Equipment Room on the first floor shall serve as the common building entrance facility for the service providers to bring their multi-pair copper and cable TV services in to the building. Three (3) 4” rigid metal conduits shall be provided for the service providers and also the Base IT to bring data, voice and video backbones into building 276. One (1) 4” rigid metal conduit shall be allocated for the telephone service provider multi-pair copper backbone cable; one (1) 4” rigid metal conduit shall be allocated for the cable TV service provider coaxial backbone cable; and one (1) 4” rigid metal conduit shall be provided for the base IT 12-strand OSP fiber optic backbone cable.

c. OSP data, voice and video backbone cables shall be extended from the building’s exterior telecommunications enclosure utilizing three (3) 4” metal conduits to the Communications Equipment Room.

Communications Equipment Room (CER)

a. The main floor shall contain the CER and shall house horizontal cabling terminations for the first floor area, GFGI distribution electronics and backbone copper and fiber terminations for the building. OSP backbones (Data, Voice and Video) shall be extended from the building Entrance Facility (EF) to the CER and terminate in the building entrance protection terminals, patch panels or coiled on the room’s fire-rated backboards.

b. Two telecommunications equipment cabinets (refer to Standard Equipment) shall be provided in the CER.

Telecommunications Room (TR)

a. The second and third floor shall contain TRs that shall be "stacked" over the CER.

b. Fiber, multipair copper and coax backbone cables shall be distributed to each TR from the CER.

c. The horizontal cabling from the second and third floors shall be terminated in the associated floor's TR.

Backbone

All backbone cabling extended to the second and third floor Telecommunications Rooms (TR) shall be riser rated and have the same performance characteristics of the cable being extended.

All fiber optic distribution cable shall be terminated in rack-mounted fiber optic patch panels (FOPP) utilizing "SC" style adapters.

Horizontal Structured Cabling

All horizontal cabling on each floor shall be plenum rated Category 6 utilizing Eight Position / Eight Contact (8P8C) connectors at the faceplate.

Each dorm room bedroom in Building 276 shall have a telecommunication outlet location consisting of two (2) Category 6 UTP drops and one (1) Series 6 coaxial cable and one telecommunication location consisting of (1) Series 6 coaxial cable. Another location in the room will consist of an empty pipe and box for future use and have a blank cover installed. The Category 6 cable shall be terminated on 8P/8C modular jacks and the Series 6 coax cable shall be terminated on an F-series connector. All connectors shall be installed in a flush mounted faceplate.

The common area shared between dorm rooms shall have two (2) telecommunication outlets located on opposite walls each consisting of (1) Series 6 coaxial cable. The Series 6 coax cable shall be terminated on an F-series connector in a flush mounted faceplate.

The common multi-purpose Dayroom area on each floor shall have two (2) telecommunication outlets located on opposite walls each consisting of two (2) Category 6 UTP drops and one (1) Series 6 coaxial cable drop. The Category 6 cable shall be terminated on 8P/8C modular jacks and the Series 6 coax drop shall be terminated on an F-series connector. All connectors shall be installed in a flush mounted faceplate. Horizontal cables shall be terminated following the T568B Pin/Pair assignments.

Wall telephone cabling and termination shall be provided at the main building entrance and other required locations.

Access Control (ACS)
All provisions for the new ACS in Building 276 shall be for a fully functional building access control system consisting of conduit, back boxes, cabling and associated controls equipment. All conduit and boxes shall be routed to the ACS panel location that controls the covered space.

A conduit and junction box pathway shall be provided to support the building's Key Card Entry System at specified building entrance doors.

Internal building doors shall utilize battery powered card reader door locks with the exception of the following room doors: Maintenance Room(s), Electrical Room(s) and Communications Rooms. These doors shall have "keyed" door locks.

A pipe and junction box pathway shall be provided for the Key Card Kiosk located in the main entrance atrium of building 276.

Intrusion Detection System (IDS)
There are no requirements for an IDS System.

Closed Circuit Television (CCTV)
Provisions for a new CCTV shall be for a fully functional building closed circuit TV system consisting of conduit, back boxes, cabling and associated monitoring equipment. Security cameras shall be provided at main entrances and other specified areas.

ENVIRONMENTAL PROTECTION

HazMat inspectors must be licensed in ND

Materials (such as lead paint contaminated waste0 should not be separated.
- Comingled waste should undergo Toxic Characteristic Leeching Test

Base is PCB free
- Leaking light ballasts must be properly disposed of

Fluorescent lights are universal waste
- Must not be broken

Boiler room was abated in 2006 when the new boilers were installed.

Floor tiles and pipe insulation are known to be Asbestos Containing Materials

The existing building is known to have asbestos containing materials as well as lead paint

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SUSTAINABILITY AND ENERGY CONSERVATION

Design Codes and Standards

The latest edition of the following design codes will be utilized on this project:

Applicable Military Criteria:

UFC 1-200-02	High Performance and Sustainable Building Requirements, with Change 3, Chapter 2	03-01-2013

Applicable Third Party Certification Criteria:

LEED NC 2009	U.S. Green Building Council's LEED ® for New Construction and Major Renovation 2009 with Errata	06-01-2010

Narrative

The project has been designed to incorporate sustainable systems and criteria necessary to meet the requirements of the High Performance Sustainable Building Requirements outlined in UFC 1-200-02 where technically feasible and life-cycle cost effective. Additionally, the project has been designed to meet United States Green Building Council's Leadership in Energy and Environmental Design (LEED) certification level of "Silver". The project was registered in www.leedonline.com on September 9, 2015 for LEED NC 2009. The project ID number is 1000061715.

The Project Team has identified a minimum of 50 credits to meet the LEED NC 2009 Silver rating level. A total of 36 LEED Design Phase credits are incorporated into the design of the project. An additional 14 LEED Construction Phase credits are specified to be achieved during the construction phase of the project. Refer to Appendix C for the Air Force Facilities Sustainability Requirements Scoresheet and the LEED NC 2009 Project Checklist.

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APPENDIX A – CALCULATIONS AND CUTSHEETS

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MECHANICAL / PLUMBING CALCULATIONS

MECHANICAL HVAC CALCULATIONS & CUTSHEETS
for Design Analysis Appendix

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Figure 14. Hinged acoustical door

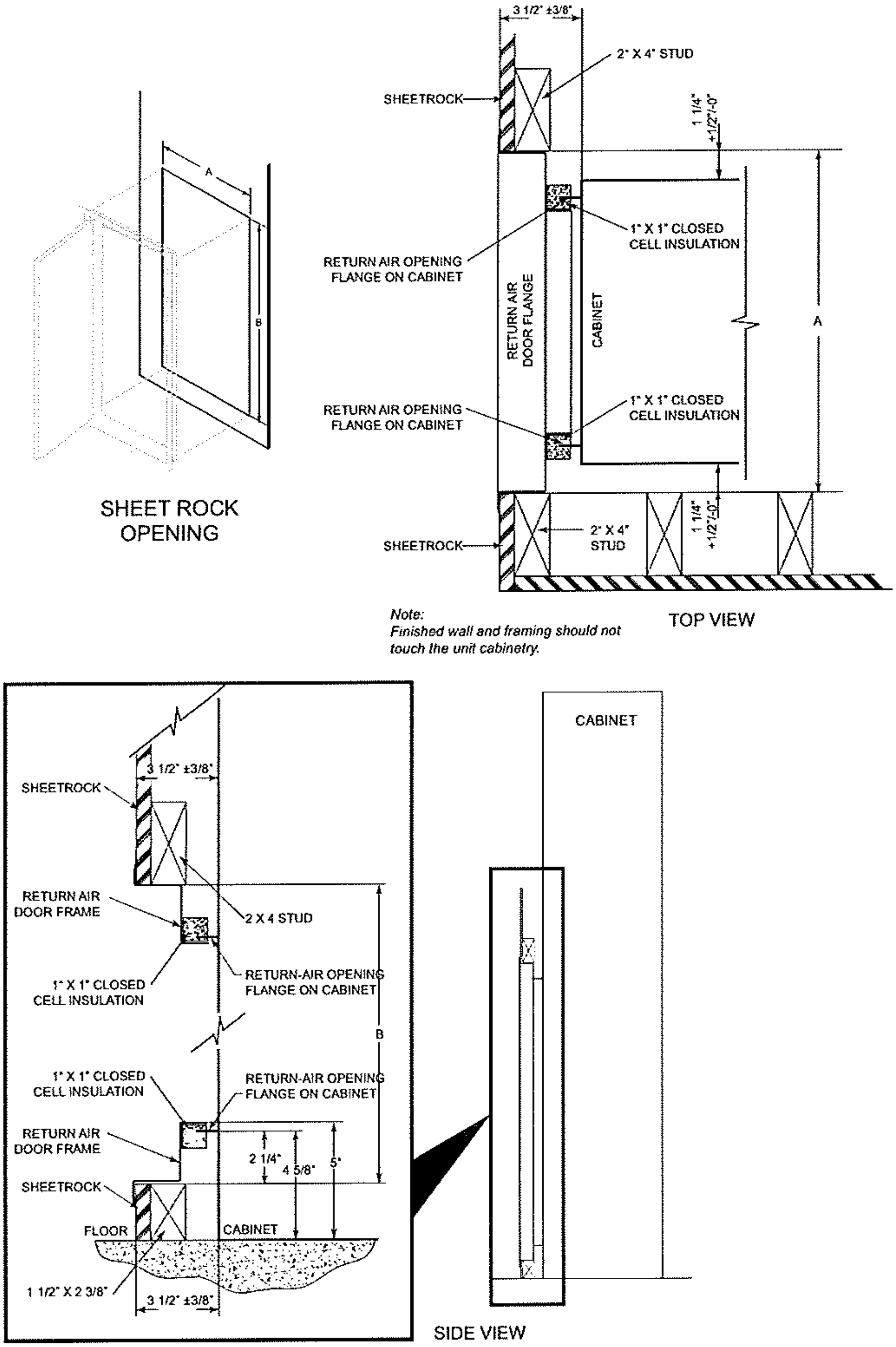


Table 27. Return air hinged acoustical door

Unit Size	A	B
009 012	19¼" (489)	44 1/8" (1121)
015 018	23¼" (591)	45¼" (1149)
024 036	27 1/8" (689)	54 5/8" (1387)

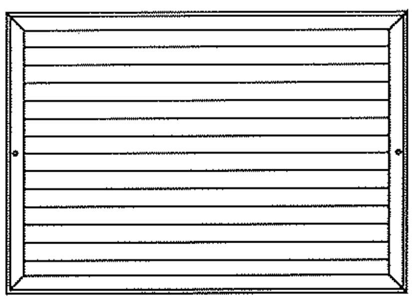
Return Air (hinged) Acoustical Door

The hinged acoustical door is recessed into the wall so that the door is flush with the surface of the wall.

The opening through the wall for the door assembly must be centered with the return-air opening of the unit cabinet. For full installing instructions of the return-air acoustical door, see WSHP-SVN08*-EN.

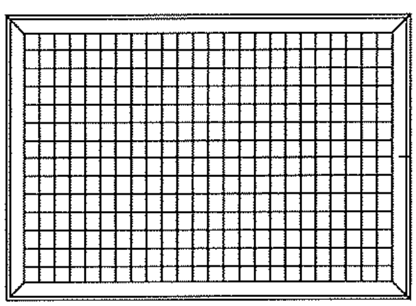
The dimensional data shown is based on Trane's factory supplied return air door.

Figure 15. Single deflection grille



Blades are adjustable for controlling horizontal discharge path.

Figure 16. Double deflection grille



Blades are adjustable for controlling discharge path in both horizontal and vertical paths.

Table 28. Supply air opening size

GET	Single Grille 100% CFM	Two Grille 50% CFM	Three Grille 33% CFM	Top Discharge up to 100% CFM
009, 012	14"W x 14"H	10"W x 6"H	Not Recommended	14"W x 10"H
015, 018	16"Wx12"H	14"Wx12"H	12"Wx8"H	16"Wx14"H
024	22"Wx18"H	14"Wx12"H	12"Wx8"H	16"Wx14"H
036	Not Recommended	16"Wx14"H	14"Wx12"H	17"Wx17"H

Trane Axiom Vertical Stack Water Source Heat Pump

The 3/4-ton through 3-ton vertical high-rise water source heat pump is a floor mounted, "furredin" unit, designed to be hidden from view behind drywall to blend with the room's natural decor.

In multi-story buildings, the units may be stacked one on top of the other to minimize piping and electrical costs. Supply, return and condensate riser piping may be factory mounted to simplify job site installation of the equipment.

The high-rise configuration is often used in hotels, dorms and assisted living facilities where a single unit could provide comfort to a single or multiple room dwelling. Because the units are mounted directly in the space, ductwork is optional.

All water source heat pumps are commissioned, tested and quality certified prior to leaving the factory. This assures global quality standards from controls, water, refrigeration, and aesthetics to the building owner and installing contractor.

Key features of the water source, vertical stack heat pump include:

- Removable/replaceable chassis
- Ducted and free discharge cabinet selections available
- Factory mounted flow control with strainer and isolation valve option
- Plug-in chassis and plug-in thermostat design
- Factory supplied riser options
- Maintenance accessibility for coil fin cleaning
- Extra quiet design includes enhanced and deluxe sound proofing choice
- Through the front high and low pressure service ports accessible
- Tamper proof hinged acoustical door option
- Unit mounted switch and fuse option
- Lower height cabinet for ducted applications
- Auxiliary drain pan
- Rust resistant chassis drain pan
- Intelligent controls

AHRI - ISO Ratings

Model GET

			Water Loop (WLHP)				Ground Loop (GLHP)			
			Cooling 86F		Heating 68F		Full Cool 77F		Full Heat 32F	
Size	Water flow	Airflow	Cooling capacity (BTUH)	EER	Heating capacity (BTUH)	COP	Cooling capacity (BTUH)	EER	Heating capacity (BTUH)	COP
PSC motor										
009	2.1	340	8,200	12.8	10,800	4.6	8,800	14.9	6,600	3.2
012	2.8	440	11,900	13.5	14,100	4.6	12,300	15.1	9,000	3.2
015	3.5	540	14,700	13.1	17,700	4.6	15,400	14.8	11,800	3.3
018	4.2	650	18,100	13.0	22,900	4.5	18,700	14.3	14,800	3.3
024	5.6	820	23,300	13.1	26,600	4.3	24,300	14.9	18,700	3.2
036	8.4	1170	33,700	13.0	41,300	4.3	35,100	14.6	27,300	3.2

			Water Loop (WLHP)				Ground Loop (GLHP)			
			Cooling 86F		Heating 68F		Full Cool 77F		Full Heat 32F	
Size	Water flow	Airflow	Cooling capacity (BTUH)	EER	Heating capacity (BTUH)	COP	Cooling capacity (BTUH)	EER	Heating capacity (BTUH)	COP
ECM										
009	2.1	340	8,300	13.9	10,500	4.6	8,700	16.2	6,500	3.2
012	2.8	440	12,000	14.2	14,300	4.8	12,600	16.5	8,700	3.2
015	3.5	540	14,900	15.0	18,000	5.0	15,600	17.5	11,300	3.5
018	4.2	650	18,500	14.6	22,300	4.6	19,500	17.0	14,200	3.4
024	5.6	820	24,200	16.0	26,300	4.8	25,200	18.4	17,800	3.5
036	8.4	1170	34,200	15.2	40,200	4.6	35,600	17.8	26,300	3.3

Note: Certified in accordance with AHRI Water to Air and Brine to Air Heat Pump Certification Program which is based on ISO Standard 13256-1: 1998. Certified conditions are 80.6°F DB/66.2°F WB EAT in cooling and 68°F DB/59°F WB EAT in heating.

Unit size

	009	012	015	018	024	036
Length (inch)	16	16	18	18	24	24
Height (inch)	77	88	88	88	88	88
Width (inch)	16	16	20	20	24	24

General Data

	009	012	015	018	024	036
Compressor type	Rotary	Rotary	Rotary	Rotary	Scroll	Scroll
Approximate Cabinet weight (lb)	115	115	150	150	195	195
Approximate Chassis weight (lb)	78	97	102	107	164	180
Approximate Total weight (lb)	193	212	252	257	359	375
Filter #1 Size	14x20x1	14x20x1	18x25x1	18x25x1	20x30x1	20x30x1
Water in/out size (FPT) (In)	1/2	1/2	1/2	1/2	3/4	3/4
Condensate size (NPTI) (In)	3/4	3/4	3/4	3/4	3/4	3/4

General Information

Blower/Motor

The blower and motor is located inside the unit cabinet. The blower and motor may be removed from the cabinet through the chassis opening. After removing the chassis, the blower assembly is strapped into the unit cabinet through a single metal, flexible bracket. We refer to this bracket as a housing belly bracket. After detaching one screw at the bottom/front edge of the bracket, the housing and motor are free to be lifted from the fan deck.

Compressor Nameplate

The nameplate for the compressors are located on the compressor shell.

Controls

A 75 VA transformer is factory supplied on this unit configuration. See wiring diagram on chassis access panel for field wiring connection to the 24V mechanical thermostat.

Deluxe 24V Controls

Units containing the Deluxe 24V control design will incorporate a microprocessor-based control board. The Trane microprocessor board is factory wired to a terminal strip to provide all necessary terminals for field connection. The deluxe board is equipped with a random start relay, anti-short cycle timer, brown out protection, compressor disable, unit safety control, diagnostics and a generic relay (which may be available for field use). See p. 14 for diagnostic information.

Power wiring is made at the contactor. The wiring is fed through the left or right conduit tube, and into the cabinet's control box (contactor).

Schrader Connections

Connections for the low and high side of the refrigeration system are located conveniently on the chassis' front beneath a sheet metal plate.

Sound Attenuation

Sound attenuation is applied as a standard feature in the product design. The enhanced reduction package includes a heavy gage base plate, and gasket/insulation around the compressor enclosure.

An optional deluxe sound reduction package is also available. It includes a heavy gage base plate, gasket and insulation around the compressor enclosure, and vibration isolation between the chassis and cabinet. An additional dampening treatment is applied around the compressor enclosure to achieve greater acoustical reductions.

Unit Description

Before shipment, each unit is leak tested, dehydrated, charged with refrigerant and run tested for proper control operation.

Unit Nameplate

The unit nameplate is located at the front of the unit. It includes the unit model number, serial number, electrical characteristics, refrigerant charge, and other pertinent unit data.

Water Connections

½" or ¾" water connections are located on the chassis's upper section and clearly labeled for water-in/out hose to riser hook-up.

Water-to-Refrigerant Coils

The co-axial water-to-refrigerant heat exchanger for the ¾ ton through 3 ton equipment is constructed of copper or cupro-nickel (option) for the water section and stainless steel for the refrigeration section.

The heat exchanger is leak tested to assure there is no cross leakage between the water and refrigerant gas.

ZN510 Controls

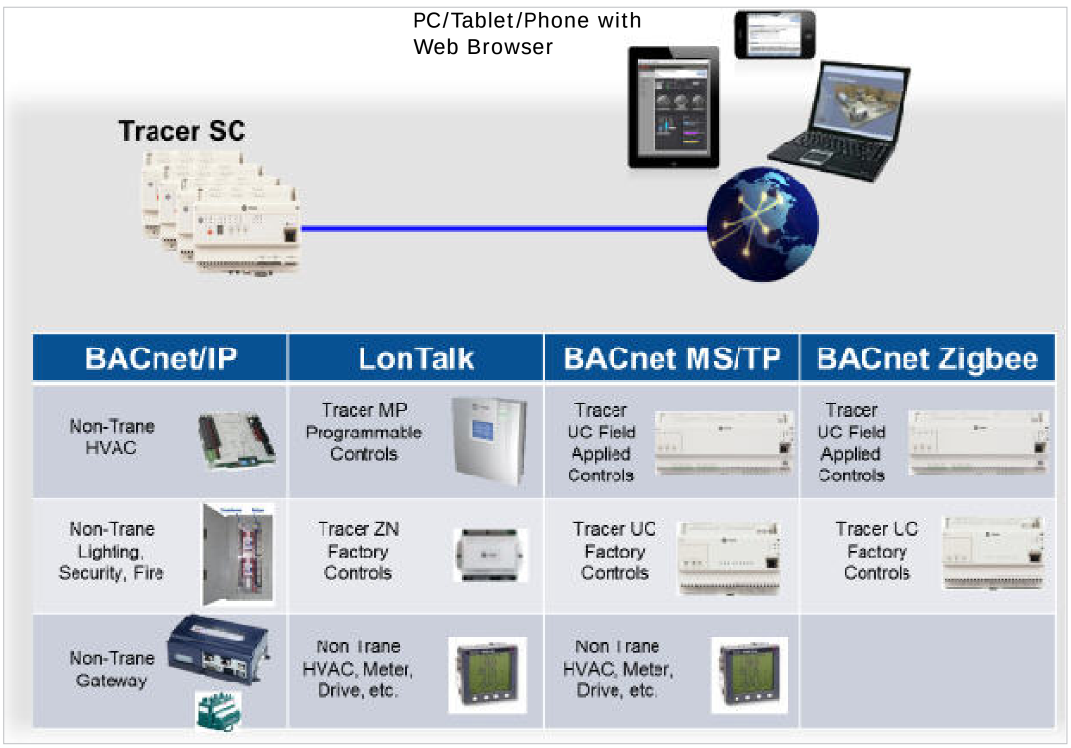
Units incorporating the ZN510 control option design will include a digital LonTalk™ certified control board. The control board will support such options as: random start delay, heating/cooling status, occupied/unoccupied mode and fan/filter status.

Power wiring is made at the contactor. The wiring is fed through the left or right conduit tube, and into the cabinet's control box (contactor). See manual WSHP-IOP-2 for diagnostic information.

Tracer SC System Architecture

Tracer SC is at the heart of a Tracer building automation system. Tracer SC provides a web-based front end for your facility that can be accessed with most PCs, tablets and smart phones. Tracer SC includes powerful, factory-engineered applications that are designed to provide the perfect balance of energy efficiency and user comfort. Tracer SC communicates with a variety of Trane and non-Trane controllers using open, standard protocols, including BACnet and LonTalk. A diagram depicting the high-level system architecture is shown in Figure 1.

Figure 1. Tracer building automation system structure



BAS R'newal™ Program

BAS R'newal is a new Trane building control systems upgrade program that helps customers transition to our current Tracer SC system. The program makes it easier to upgrade existing installed Tracer systems and non-Trane systems to the latest technologies including web-access, mobile access, intuitive user interfaces, and advanced features enabled by Trane Intelligent Services (TIS). The BAS R'newal program is enabled by Tracer Communication Bridges, the details of which can be found in the following section.

Find out more about BAS R'newal at http://www.trane.com/commercial/north-america/us/en/services/upgrade-improve/r_newal_-programs.html.

Tracer® Communication Bridges

Tracer® Communications Bridges integrate legacy control products into current Tracer systems for monitoring and control purposes. See Figure 2, p. 9 for a Tracer SC configuration that includes Tracer communication bridges.

Tracer Communications Bridges use legacy communications protocols to access points stored in previous-generation field-level controllers. The Bridges then convert the points to BACnet objects and properties, which makes them available for system use through the BACnet/IP communications protocol.

Comm2 to BACnet/IP

This bridge is used to integrate up to three UCP1-controlled chillers (CenTraVac and Series-R) into Tracer systems for monitoring and control purposes. For more information, refer to the "*Comm2 to BACnet/IP Product Data Sheet," BAS-PRC070*.

Comm3/4 to Tracer SC (enables the BAS R'newal program)

This bridge enables Comm3 and Comm4 devices to be integrated into Tracer SC systems, similar to current generation devices. The latest features and capabilities of Tracer SC can be accessed without needing to replace the existing Comm3 and Comm4 devices. For more information, refer to the "*Comm 3/4 to Tracer SC Product Data Sheet," BAS-PRC084.*

N2 to BACnet/IP (enables the BAS R'newal program)

This bridge integrates Johnson Controls, Inc., N2 communicating controllers into Trane Tracer control systems. The N2 Bridge converts the N2 controllers into virtual BACnet devices for easy integration into Tracer SC. For more information, refer to the "*N2 to BACnet/IP Product Data Sheet," BAS-PRC082*.

Tracer SC Facilities

A Tracer SC facility is defined as one Application SC and one or more associated Base SCs. A single building or site can contain more than one facility. See Figure 2 for an example of an SC facility configuration.

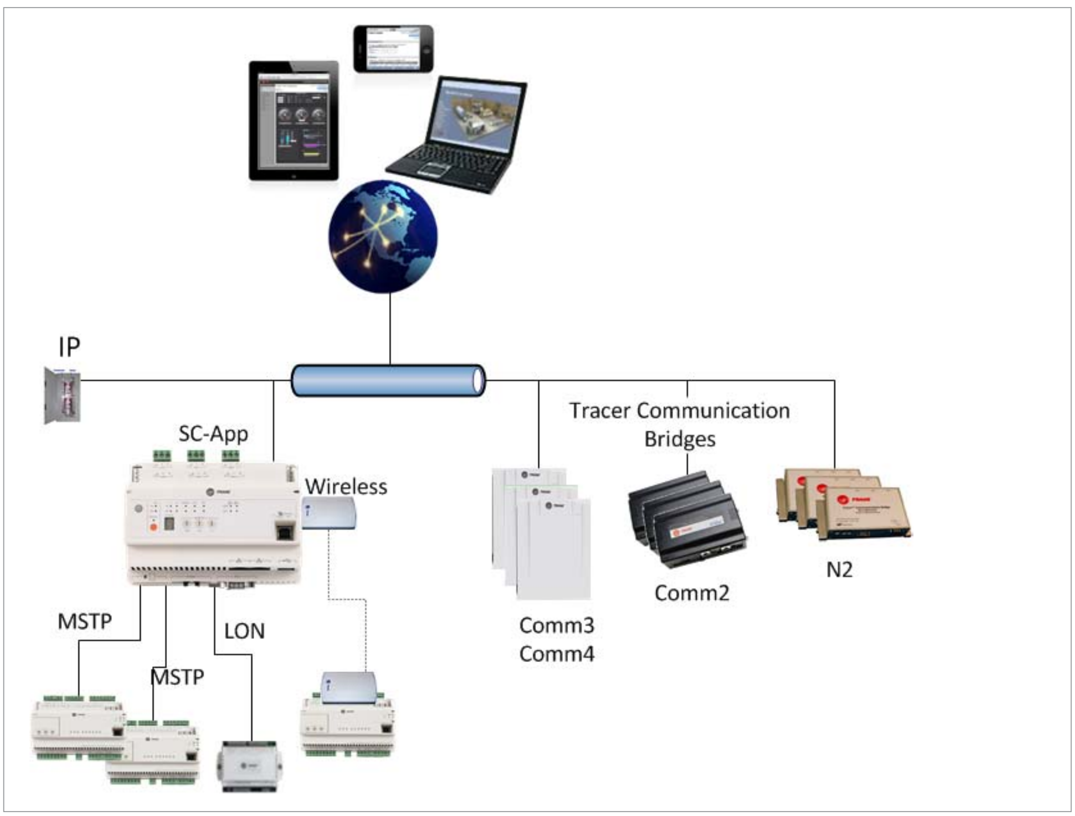
The following attributes apply to Tracer SC facilities:

- A Tracer SC facility is limited to one Application SC.
- A Tracer SC facility has one or more Base SCs.
- A Tracer SC facility can support a maximum 240 devices.
- A Tracer SC facility may be limited to 120 devices depending on the communications involved (see the following table for device capability).

Device Capability

Communication Type	Single SC	Multi SC
Air-Fi™ Wireless	Up to 120 devices	Up to 240 devices
BACnet/MSTP	Up to 120 devices	Up to 240 devices
BACnet/IP	Up to 240 devices	Up to 240 devices
COMM 3/4/LON (individual or any combination)	Up to 120 devices	Up to 120 devices

Figure 2. Example of a single SC facility configuration



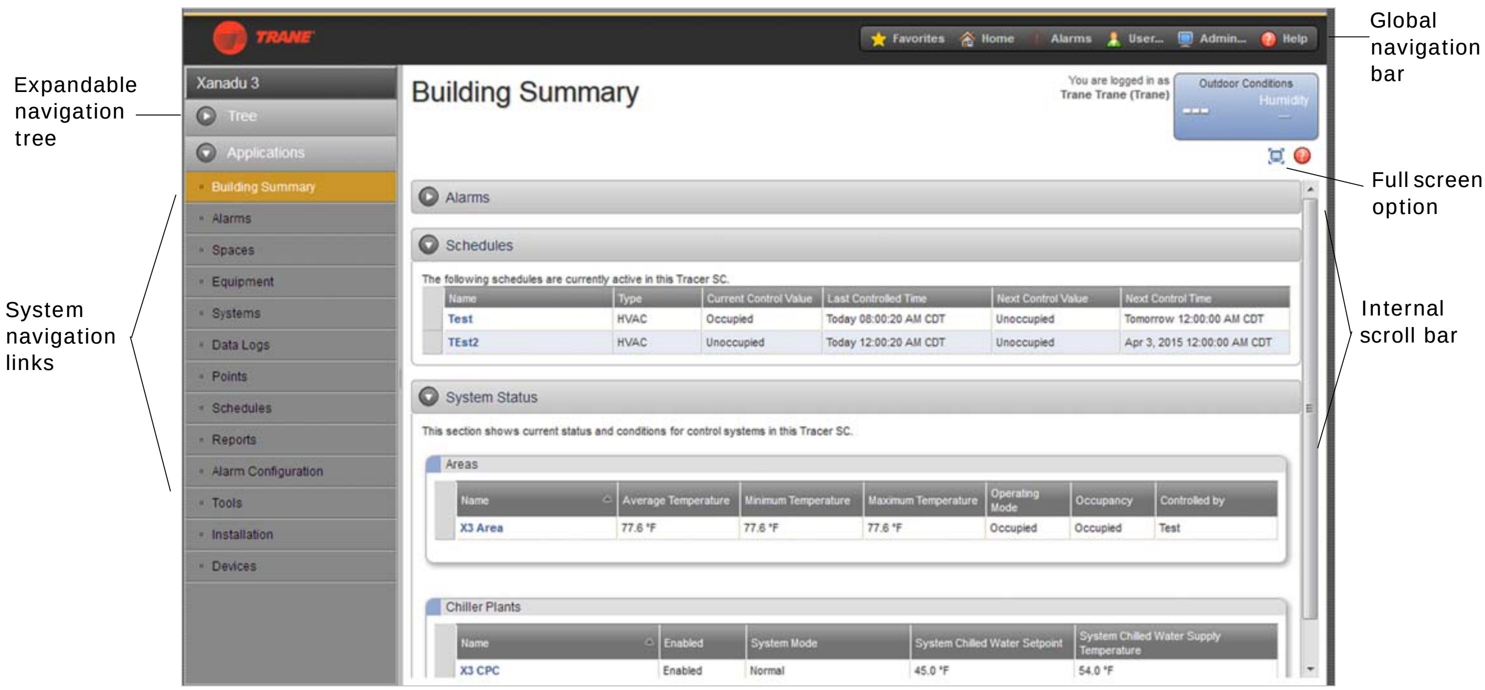
![TRANE logo]

User Interface

The Tracer SC user interface provides an easy way for building operators to set up, operate, and modify a building automation system. The home page (Figure 3) contains system status information and links to navigate to all areas of the system.

The main features of the user interface are described in this section.

Figure 3. Tracer SC user interface



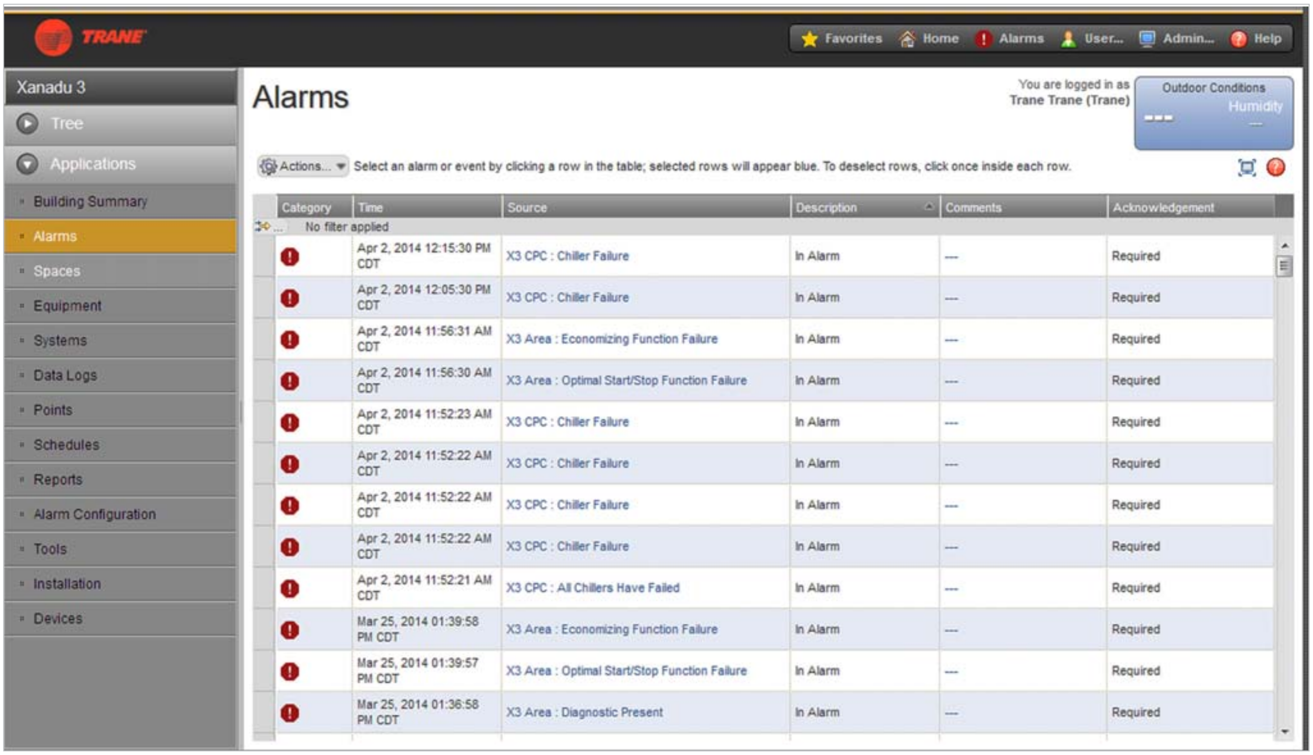
Alarms

Events are occurrences that are detected by a Tracer building automation system. They can include diagnostics and critical operating conditions, as well as routine procedures.

An event that is triggered by the detection of an abnormal or critical operating condition is generally considered to be an alarm. If a critical alarm exists, an alarm icon flashes in the global navigation bar, which remains visible in the right corner of every page of the user interface.

When the system detects an event, data about the event appears in a log on the Alarms page (Figure 4, p. 11). The data displayed in the log includes when and where the event occurred and whether the operator is required to acknowledge it. An operator can also use the log to add comments about events. Column headings can be used to sort and filter events. They can also be removed or exported from the log.

Figure 4. Alarms log



The alarm handling capabilities of Tracer SC allow users to receive, view, acknowledge, and make comments on building alarms.

Users can categorize alarms to determine how they appear in the Alarm log. A category is assigned to one of 255 priorities. In previous versions of Tracer SC, alarm categories were limited to four types: Severe, Critical, Advisory, and Information. As of Tracer SC version 4.0, users can create additional categories and select an accompanying icon. Benefits of customizing alarm categories include the ability to send a specific alarm to a specific person, and to differentiate critical equipment alarms from others.

Data Logs

Data logs, also referred to as trends, allow users to produce a variety of data samples at defined intervals to show the historical and current status of the facility. Data logs record, in real-time, the value of a data point in the system and the time at which the value was recorded.

Data logs can be viewed in real-time, or at a later time. They can also be printed and saved. With the proper security access, system users can configure (create, delete, and update) and manage (clear, enable, and disable) data logs in the system. (See Figure 5, p. 12 for an example of a data log.)

Unit Control

Unit controllers provide all necessary unit control functions. They operate associated unitary equipment, while ensuring that all built-in safety features are enabled and that diagnostics are issued.

Each controller is designed to operate in stand-alone mode. Therefore, if system control fails, unit operation can continue.

Unit controllers installed on a Tracer SC can be a combination of the following BACnet and LonTalk unit controllers:

BACnet (MS/TP) Unit Controllers Supported by Tracer SC

- Tracer UC210 unit controller for variable-air-volume (VAV) equipment
- Tracer UC400 unit controller for variable-air-volume (VAV) equipment
- Tracer UC400 unit controller for programmable equipment
- Tracer UC800/AdaptiView unit controller for CenTraVac chillers
- BCI-I: BACnet communications interface for IntelliPak system
- BCI-C: BACnet communications interface for chillers
- BCI-R: BACnet communications interface for ReliaTel
- Non-Trane BACnet (MS/TP) devices

BACnet/IP Unit Controllers Supported by Tracer SC

- Tracer UC600 Programmable controller
- Non-Trane BACnet/IP devices

Air-Fi Wireless Unit Controllers Supported by Tracer SC

- Tracer UC210 unit controller for variable-air-volume (VAV) equipment
- Tracer UC400 unit controller for variable-air-volume (VAV) equipment
- Tracer UC400 unit controller for programmable equipment
- Tracer UC600 unit controller for Air Handler (AHU) equipment
- Tracer UC600 unit controller for programmable equipment

LonTalk Unit Controllers Supported by Tracer SC

- Tracer AH540/541 air-handler controller
- Tracer MP501 multi-purpose controller
- Tracer MP503 input/output module
- Tracer MP580/581 programmable controller
- Tracer VV550/551 VAV controller
- Tracer ZN510/511 zone controller
- Tracer ZN517 unit controller
- Tracer ZN520/521 zone controller
- Tracer ZN523 zone controller
- Tracer ZN524 water-source heat pump unit controller
- Tracer ZN525 zone controller

- Tracer CH530 chiller controller
- Tracer CH532 chiller controller
- LCI-C: LonTalk communications interface for chillers
- LCI-I: LonTalk communications interface for IntelliPak systems
- LCI-R: LonTalk communications interface for ReliaTel systems
- Non-Trane LonTalk devices using SCC, DAC, and chiller profiles, devices that support LonTalk standard network generic variables, and devices with Standard Network Variable Types (SNVTs)

Trane Legacy Unit Controllers (Comm3/4) Supported by Tracer SC

Note: *The following devices are supported through the use of Legacy Comm Bridge.*

- Variable Air Volume (VAV I, II, III, IV)
- IntelliPak
- Voyager
- Commercial Self-Contained (CSC)
- Thermostat Control Module (TCM)
- Programmable Control Module (PCM)
- Universal Programmable Control Module (UPCM)
- Terminal Unit Controller (TUC)
- Centrifugal Chillers (UCP2)
- Helical Rotary Chillers (UCP2)
- CGX Chillers
- Series-R Chillers (RTA/RTW)

Trane optimizes the performance of homes and buildings around the world. A business of Ingersoll Rand, the leader in creating and sustaining safe, comfortable and energy efficient environments, Trane offers a broad portfolio of advanced controls and HVAC systems, comprehensive building services, and parts. For more information, visit www.Trane.com.

Trane has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.

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BAS-PRC031N-EN 04 May 2015
Supersedes BAS-PRC031M-EN (28 Feb 2015)

We are committed to using environmentally conscious print practices that reduce waste.

Creason, Craig S.

From: prvs=1637f3b1b9=brian.siegfried.1@us.af.mil on behalf of SIEGFRIED, BRIAN K GS-13 USAF HAF AFCEC/CFSC <brian.siegfried.1@us.af.mil>
Sent: Tuesday, July 21, 2015 10:06 AM
To: Creason, Craig S.
Subject: FW: Minot AFB Bldg 276..Mail room

Craig
Please see below.

/SIGNED/
Brian Siegfried, P.G. GS-13 DAF
Program Manager
Operating Forces O&M Execution Branch
AFCEC/CFSC
210-395-8559, DSN: 969-8559
210-627-7347 cell
brian.siegfried.1@us.af.mil

-----Original Message-----
From: PERREAULT, MATTHEW J MSgt USAF AFGSC 5 CES/CEIHD
Sent: Tuesday, July 21, 2015 10:05 AM
To: SIEGFRIED, BRIAN K GS-13 USAF HAF AFCEC/CFSC
Cc: LONNING, GARY G GS-13 USAF AFGSC 5 CES/CEI; KNICKERBOCKER, TIMOTHY J GS-12 USAF AFGSC 5 CES/CEIH; HEIDT, ANDREW L GS-11 USAF AFGSC 5 CES/CEIHH; ALLISON, MICHAEL T TSgt USAF AFGSC 5 CES/CEIHD; DUZICK, ADAM R SSgt USAF AFGSC 5 CES/CEACU; HYLTON, DERRICK J SSgt USAF AFGSC 5 CES/CEOS; MAPLE, DEREK L SSgt USAF AFGSC 5 CES/CEACU; PARKER, RAVEN M SSgt USAF AFGSC 5 CES/CEIHD; PETERMAN, AUBREE E SSgt USAF AFGSC 5 CES/CEIHD; PURVIS, JOSHUA S TSgt USAF AFGSC 5 CES/CEACU
Subject: RE: Minot AFB Bldg 276..Mail room

Mr. Siegfried,

Here is the process according to the Postal Service Center on base who delivers mail to our dormitories: The mail goes to the US Post Office in Bismarck, ND who sorts the mail for Minot AFB, it then to go the US Post Office in Minot, ND who delivers the base mail to Minot AFB. Dormitory mail is separated from the other mail and goes to the base Postal Service Center. A security forces K-9 unit will search the mail and it is then separated by dorm and delivered. For any packages or registered mail, etc. the receiver will get a notice in their mailbox and has to go to the Postal Service center to pick that those items up.

//SIGNED//
MATTHEW J. PERREAULT, MSgt, USAF
Airman Dormitory Leader Superintendent
DSN: 453-1300
Comm: (701)723-1300

-----Original Message-----
From: HEIDT, ANDREW L GS-11 USAF AFGSC 5 CES/CEIHH
Sent: Tuesday, July 21, 2015 7:59 AM
To: PERREAULT, MATTHEW J MSgt USAF AFGSC 5 CES/CEIHD
Cc: LONNING, GARY G GS-13 USAF AFGSC 5 CES/CEI; KNICKERBOCKER, TIMOTHY J GS-12 USAF AFGSC 5 CES/CEIH
Subject: FW: Minot AFB Bldg 276..Mail room

Matt,

Can you please answer this for Mr. Sidgfried and cc: Mr. Lonning, Tim and me.

Thanks

Andy

-----Original Message-----
From: SIEGFRIED, BRIAN K GS-13 USAF HAF AFCEC/CFSC
Sent: Tuesday, July 21, 2015 7:55 AM
To: HEIDT, ANDREW L GS-11 USAF AFGSC 5 CES/CEIHH
Subject: FW: Minot AFB Bldg 276..Mail room

Andy
Per our discussion, please see question below. Any light you can shed would be most appreciated.

/SIGNED/
Brian Siegfried, P.G. GS-13 DAF
Program Manager
Operating Forces O&M Execution Branch
AFCEC/CFSC
210-395-8559, DSN: 969-8559
210-627-7347 cell
brian.siegfried.1@us.af.mil

-----Original Message-----
From: Creason, Craig S. [mailto:CRAIG.S.CREASON@leidos.com]
Sent: Monday, July 20, 2015 3:51 PM
To: SIEGFRIED, BRIAN K GS-13 USAF HAF AFCEC/CFSC
Subject: Minot AFB Bldg 276..Mail room

Could you please verify for me that the mail that comes into this dormitory has already gone through a central mail receiving room for the Base.

I have a review comment from AFCEC that wants me to address this dorm mail room as though the mail is coming from a total outside source.

Thanks..................

Craig S. Creason, PE

Leidos

O 314.315.8663

F 314.821.8499

1. The Air Entering The ERV is Heated to 95°F with 15% RH (Same as 68°F and 30% RH)

The Moisture Content is ± 30 grains per lb-dry air.

2. The ERV Recovers a significant portion of The Moisture in The Airstream. Conditions Leaving The wheel Are:

61.9 DB / 48.1 WB (See ERV Selection)

The Moisture in The Air at This point is

± 25 grains per lb-dry Air

Therefore 30 - 25 or 5 grains per lb-dry air Needs to be Added to outdoor Air CFM.

3. Outdoor Air Flow:

@ -10°F, We are Bringing in 2000 CFM O.A.

Infiltration: Minimized due to New Windows Added.

Use 0.05 CFM/SF or 716 CFM (per Load Calc)

This number is somewhat insignificant since we are slightly Pressurizing The Building, but Add it to 2000 CFM For Safely Sizing The Humidifier

Therefore → Size for ~~2716 CFM~~ O.A. 2445

→ Correct CFM for Elevation 1630 = Factor = 0.9

Rev 1/8/16

Project/Description: Minot Bldg 276 Renovation	Project No.	Date: ~~7/22/15~~
Isometric Sheet — Sheet: #1 of 2	Design By: [illegible]	Checked By

Notes / Other

Humidity Calculation

leidos

4. How Much Moisture is needed to Raise ~~2716~~ 2445 CFM, 5 Grains/lb-dry air ?

$$\overset{2445}{\cancel{2716}}\ \frac{ft^3}{Min} \times \frac{60\ Min}{HR} \times \frac{1\ lb}{7000\ grains} \times \frac{5\ grains}{lb\text{-}dry\ air} \times \frac{1\ lb\text{-}dry\ air}{10\ ft^3} = 11.7\ \frac{lbs}{HR}$$

(Use $10\ ft^3/lb$ for $-10°F$)

$\boxed{\text{Size Humidifier For at Least } \cancel{11.7}\ 10.5\ \text{lbs/HR of Capacity.}}$

Rev 1/8/16

Project/Description Minot BLDG 276 Renovation	Project No.		Date ~~1/22/15~~
Isometric Sheet	Sheet #2 of 2	Design By CAL	Checked By

Notes / Other

Humidity Calculation (Cont)

leidos

The Engineering Tool Box

www.EngineeringToolBox.com

PSYCHROMETRIC CHART

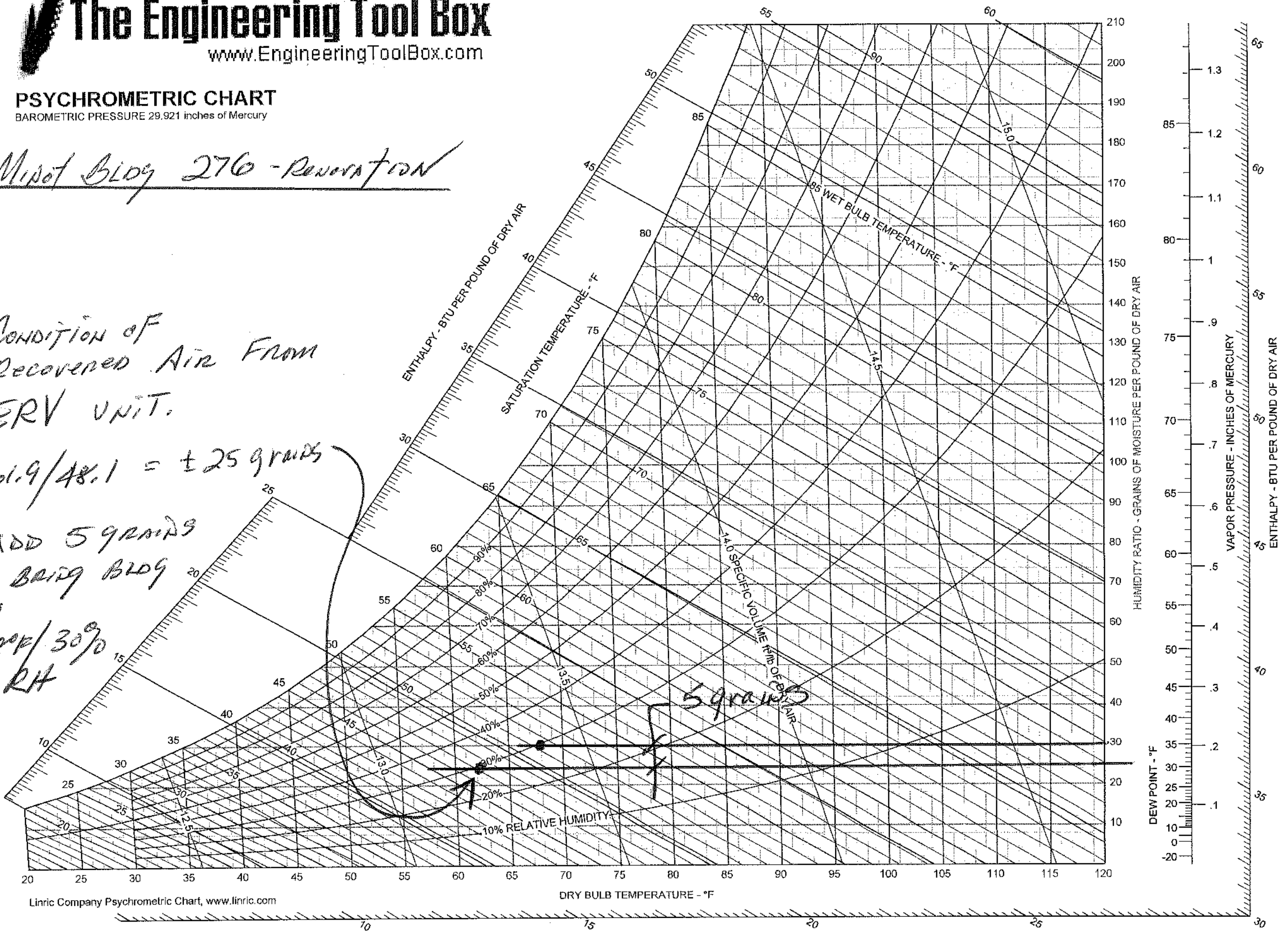
BAROMETRIC PRESSURE 29.921 inches of Mercury

Minot Bldg 276 - Renovation

Condition of Recovered Air From ERV unit.

61.9/48.1 = ±25 grains

Add 5 grains to bring bldg to 68°F/30% RH



Linric Company Psychrometric Chart, www.linric.com

Refer to: Minot ERV Selection Calculations and Performance

Cooling:

Air stream leaving the wheel, before the DX coil, is at 80.1/66.1 h = 30.7

If we cool all the air, supply in summer is 2800 CFM. Cool to 75°F & 50% RH → h = 28

Total load required by the heat pump is:

$$2800 \times 4.5 \times 1.07 \times (\overset{\Delta H = 2.7}{30.7 - 28}) = 36{,}400$$

$$\frac{36{,}400}{12} = \pm \underline{\underline{3 \text{ TONS}}}$$

Heating:

Air stream leaving wheel, before the DX coil, is at 61.9/48.1 → h = 19.2

If we heat all the air, supply in winter is 2000 CFM. Heat to 72/30% → h = 21.8

For Safety

Heat transfer is: ΔH = 2.6

$$2000 \times 4.5 \times (21.8 - 19.2) = 23{,}400 \text{ BTUH}$$

Project/Description: Minot AFB - Bldg 276 - Reno	Project No.		Date: 1/6/16
Isometric Sheet	Sheet	Design By: [illegible]	Checked By

Notes / Other: ERV Heat Pump Load Calculation

leidos

ERV-45-15L

CONSTRUCTION FEATURES AND ACCESSORIES

Unit Overview

Model	Outside Air (CFM)	Exhaust (CFM)	Electrical V/C/P
ERV-45-15L	2,000	1,600	460/60/3

Features
- Exterior housing constructed of galvanized steel
- Blower and Motor Assemblies with steel wheels
- Forward curved steel wheels
- Ball bearing motors
- Corrosion resistant fasteners
- Insulated with 1 in. 3# density insulation
- Internally mounted control center with motor starters, 24 VAC control transformers, control circuit fusing when required
- Single Point Wiring
- Motor Mounted on Adjustable Plate
- Adjustable Motor Pulleys
- Static Free Belts
- Energy Wheel Motor: 1/6 HP

Options and Accessories
- Listed to UL-1995
- Frost Control: Modulating Wheel
- Outdoor Air Filter - 2" MERV 8, 3-16x25
- Exhaust Air Filter(s) - 2" MERV 8, 3-16x25
- Supply Dampers - Motorized Insulated Low Leakage
- Exhaust Dampers - Motorized Insulated Low Leakage
- Fan VFDs: Modulating
- Rotation Sensor
- Double Wall Const. - 24 ga. galv. interior liner
- Hinged Access Doors

Note: Weight does NOT include skid/crating and may vary by 15% based on selected options.
-

ERV-45-15L

PERFORMANCE AND SPECIFICATIONS

Description/Arrangement

Model	Qty	Unit Weight (lb)	Outdoor Air Discharge	Outdoor Air Intake	Exhaust Air Discharge	Return Air Intake
ERV-45-15L	1	1,206	End	End	End	End

Design Conditions

Elevation (ft)	Summer DB (F)	Summer WB (F)	Winter DB (F)
1,631	89	67	-18

Air Performance

Type	Volume (CFM)	External SP (in. wg)	Total SP (in. wg)	RPM	Operating Power (hp)	Motor Size (hp)
Supply	2,000	1.5	1.594	1256	1.34	1-1/2
Exhaust Normal	1,600	0.75	0.814	963	0.61	3/4

Electrical/Motor Specifications

V/C/P	Unit MCA (amps)	Unit MOP (amps)	Enclosure	Supply Motor RPM	Supply Efficiency	Exhaust Motor RPM	Exhaust Efficiency
460/60/3	6	15	ODP	1725	PE	1725	SE

Unit Pressure Drop (in. wg)

Air Stream	Weatherhood	Damper Section	Filter Section	Cooling Section	Heating Section
Supply	0	0.009	0.085	N/A	N/A
Exhaust	0	0.009	0.055	N/A	N/A

Note: The unit base line performance incorporates the pressure drop of the energy wheel.

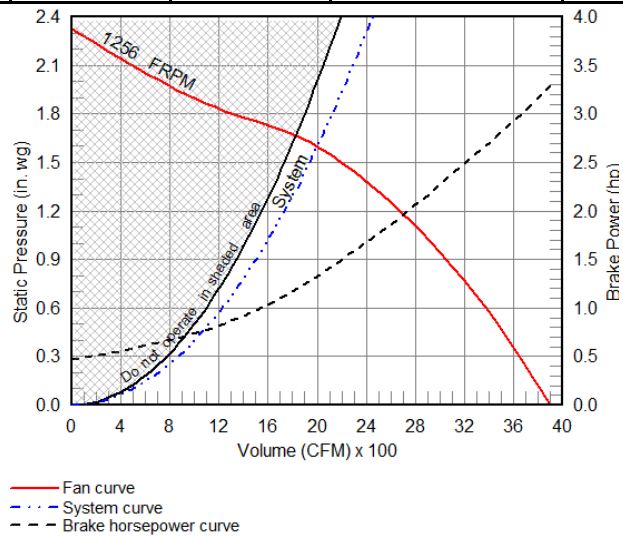
Note: Filter pressure drop is based off of clean filters.

ERV-45-15L

FAN CURVES

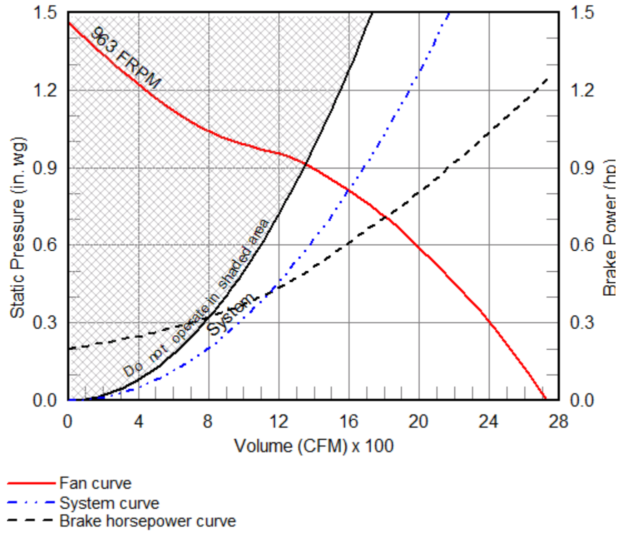
Supply Fan Performance

Volume (CFM)	Supply SP (in. wg)	Total SP (in. wg)	RPM	Operating Power (hp)	Motor Size (hp)	Fan Size	Fan Quantity
2,000	1.5	1.594	1256	1.34	1-1/2	A12-8	1



Exhaust Fan Performance - Normal Operation

Volume (CFM)	Exhaust SP (in. wg)	Total SP (in. wg)	RPM	Operating Power (hp)	Motor Size (hp)	Fan Size	Fan Quantity
1,600	0.75	0.814	963	0.61	3/4	A12-8	1



ERV-45-15L

SUMMER PERFORMANCE

OUTDOOR AIR

Entering Air		**Leaving Air**	
Dry Bulb (F)	89.3	Dry Bulb (F)	80.5
Wet Bulb (F)	67.5	Wet Bulb (F)	66.1
Specific Humidity (gr/lb)	72	Specific Humidity (gr/lb)	73
Enthalpy (BTU/lb)	32.8	Enthalpy (BTU/lb)	30.8
Leaving Air		**Entering Air**	
Dry Bulb (F)	87.9	Dry Bulb (F)	77.0
Wet Bulb (F)	68.4	Rel. Humidity (%)	50
Specific Humidity (gr/lb)	68	Specific Humidity (gr/lb)	74
Enthalpy (BTU/lb)	32.5	Enthalpy (BTU/lb)	30.0

ENERGY WHEEL

EXHAUST AIR

DESIGN AIR FLOW CONDITIONS

Model	Outdoor Air Volume (CFM)	Outdoor Air Wheel Effectiveness	Exhaust Air Volume (CFM)	Exhaust Air Wheel Effectiveness
ERV-45-15L	2,000	70.7	1,600	88.4

OUTDOOR AIR COOLING REDUCTION

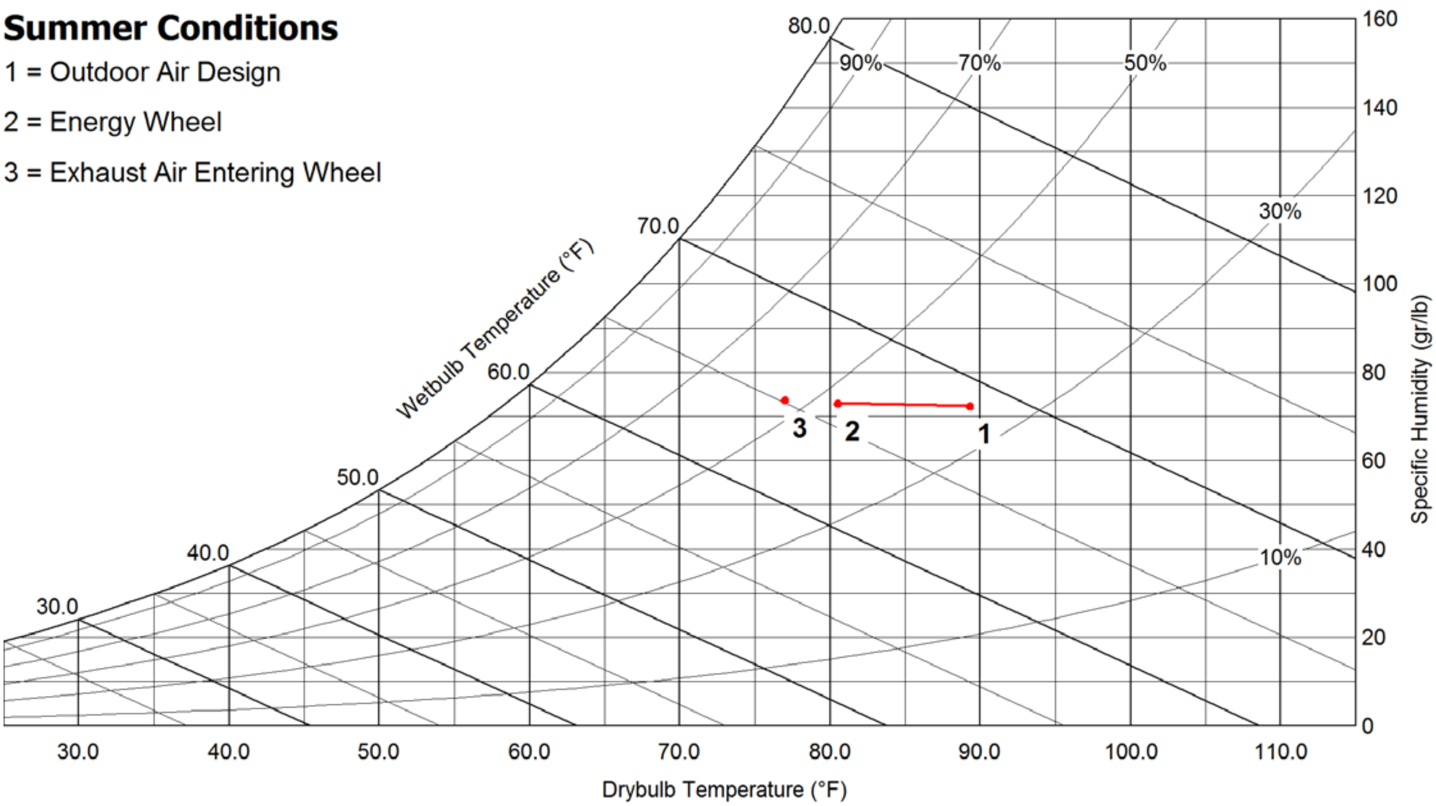
	(BTU/h)	(tons)
OA Load w/o Energy Recovery	25,200.0	2.10
OA Load with Energy Recovery	7,200.0	0.60
Equipment Reduction (tons)		1.50

Summer Conditions

1 = Outdoor Air Design

2 = Energy Wheel

3 = Exhaust Air Entering Wheel



ERV-45-15L

WINTER PERFORMANCE

OUTDOOR AIR

Entering Air		Leaving Air	
Dry Bulb (F)	-18.0	Dry Bulb (F)	42.8
Wet Bulb (F)	-18.7	Wet Bulb (F)	32.8
Specific Humidity (gr/lb)	1	Specific Humidity (gr/lb)	12
Enthalpy (BTU/lb)	-4.2	Enthalpy (BTU/lb)	12.1

ENERGY WHEEL

Leaving Air		Entering Air	
Dry Bulb (F)	-8.0	Dry Bulb (F)	68.0
Wet Bulb (F)	-8.5	Rel. Humidity (%)	15
Specific Humidity (gr/lb)	3	Specific Humidity (gr/lb)	16
Enthalpy (BTU/lb)	-1.5	Enthalpy (BTU/lb)	18.8

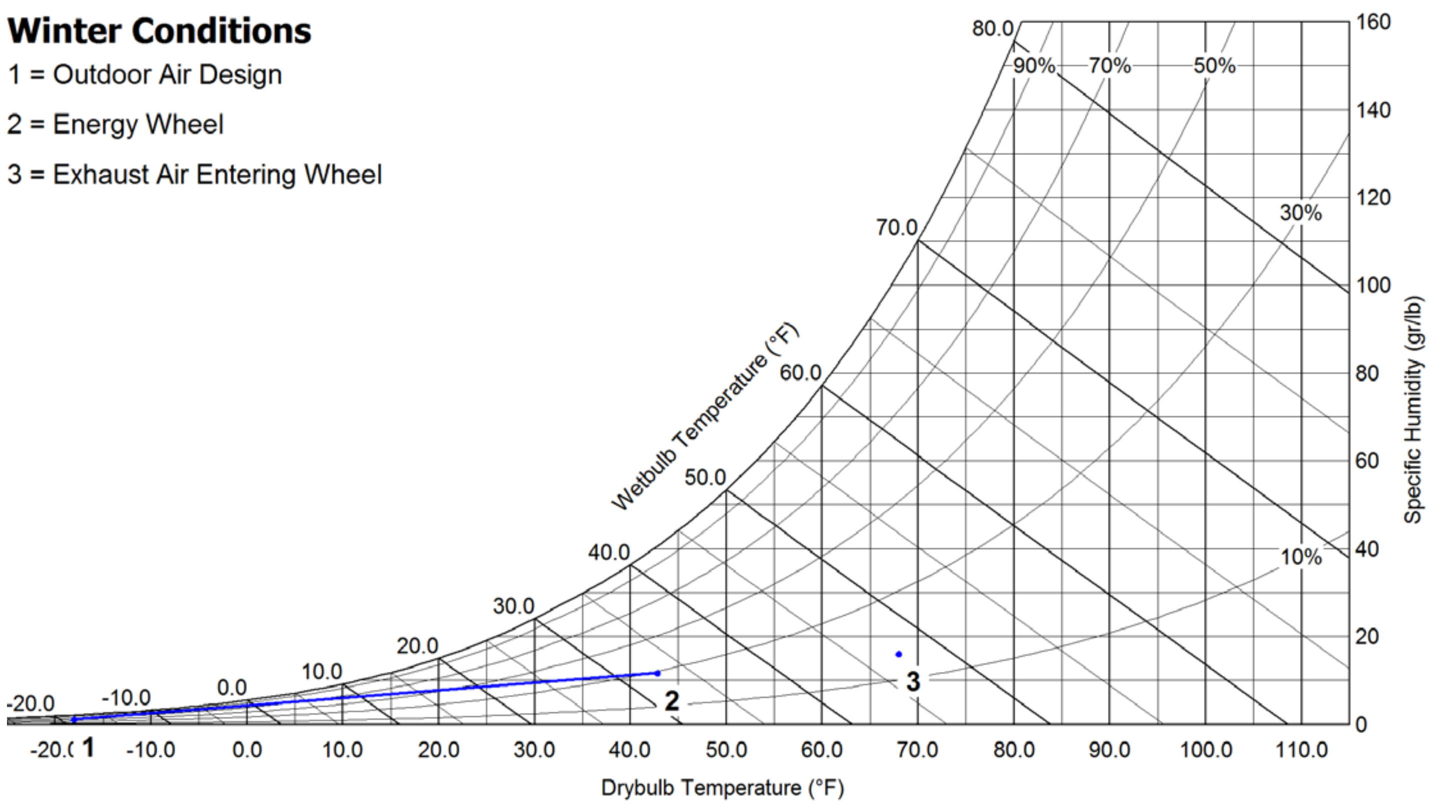
EXHAUST AIR

Design Air Flow Conditions

Model	Outdoor Air Volume (CFM)	Outdoor Air Wheel Effectiveness	Exhaust Air Volume (CFM)	Exhaust Air Wheel Effectiveness
ERV-45-15L	2,000	70.7	1,600	88.4

Outdoor Air Heating Reduction

	(BTU/h)
OA Load w/o Energy Recovery	187,308.0
OA Load with Energy Recovery	54,886.0
BTU/h Reduction	132,422.0



Minot AFB - Temperature Bin Data - Heating

Heating Design - 68F Indoors.

Heat Recovery Wheel Effectiveness = 70%

Outside Airflow = 2000 CFM

Natural Gas: $4.70/MMBtu

Electricity: $0.046/KWH = $13.5/MMBTU; Heatpump COP = 3.2

Temp Range		Mean Temp	dT	Annual Hours	OA BTU	OA Savings
65	69	67	1	502	1089340	762538
60	64	62	6	619	8059380	5641566
55	59	57	11	656	15658720	10961104
50	54	52	16	607	21075040	14752528
45	49	47	21	525	23924250	16746975
40	44	42	26	541	30523220	21366254
35	39	37	31	624	41976480	29383536
30	34	32	36	670	52340400	36638280
25	29	27	41	531	47243070	33070149
20	24	22	46	448	44719360	31303552
15	19	17	51	359	39730530	27811371
10	14	12	56	307	37306640	26114648
5	9	7	61	285	37725450	26407815
0	4	2	66	294	42106680	29474676
-5	-1	-3	71	251	38671570	27070099
-10	-6	-8	76	185	30510200	21357140
-15	-11	-13	81	140	24607800	17225460
-20	-16	-18	86	77	14369740	10058818
-25	-21	-23	91	35	6911450	4838015
-30	-26	-28	96	11	2291520	1604064
-35	-31	-33	101	3	657510	460257
		Total MMBTU			561	393
		Annual Electrical Energy Savings				$ 1,658

Temp Range		Mean Temp	dT	Annual Hours	OA Sens BTUH	OA Sens Savings
105	109	107	29	0	0	0
100	104	102	24	1	52080	36456
95	99	97	19	12	494760	346332
90	94	92	14	58	1762040	1233428
85	89	87	9	114	2226420	1558494
80	84	82	4	196	1701280	1190896
		Total BTUH			6	4
					Annual Savings	$ 18

Cooling savings are insignificant - base savings on heating only.

Fan Energy - Supply-2.52 BHP; Exhaust 1.42 BHP = 3.94 Total

BHP	kW	PwrFact	kVA	Annual	Annual $
3.94	2.94	0.9	3.26	28570	$ 1,314

ERV Cost	$ 13,300
Exhaust ductwork to ERV	$ 60,000
Total Additional ERV System Cost	$ 73,300

Fan Energy - MAU Supply-2.24 BHP; Exhaust Fan 1.19 BHP = 3.43 Total

BHP	kW	PwrFact	kVA	Annual	Annual $
3.43	2.56	0.9	2.84	24872	$ 1,144

Exhaust Fan and ductwork	$ 30,000
Packaged WSHP cost (200 MBH Htg)	$ 45,100
Additional 15 Wells and accessories	$ 87,000
Total Additional ERV System Cost	$ 162,100

ANNUAL OPERATING SAVINGS

Heating Energy	$ 1,658
Fan Energy Difference	$ (170)
	$ 1,488

CONCLUSION: ERV PROVIDES ANNUAL SAVINGS OF $1488 AND COSTS LESS TO INSTALL THAN A WSHP MAKEUP AIR UNIT.

MINOT AFB DUCT PRESSURE DROP CALCULATIONS (ERV-1)

DUCT SECTION	ITEM	DUCT WIDTH	DUCT HEIGHT	DUCT DIA	LENGTH (FT)	ACTUAL CFM @ ELEVATION	LOSS COEFF.	hydra DIA.	EQUIV DIA	AREA (sq. ft)	VELOCITY (FPM)	FRICTION /100 FT.	VELOCITY PRESS.	PRESS. LOSS ITEM	PRESS LOSS CUMULATIVE
INPUT								OUTPUT							
SUPPLY															
1	INTAKE LOUVER	48	48					48.00	52.47	16.00				0.030	0.030
2	PLENUM TAP	20	20			3,000	1	20.00	21.86	2.78	1,080		0.07	0.073	0.103
3	DUCT	20	20		10	3,000		20.00	21.86	2.78	1,080	0.074	0.07	0.007	0.110
4	90 L	20	20			3,000	0.24	20.00	21.86	2.78	1,080		0.07	0.017	0.128
5	DUCT	20	20		10	3,000		20.00	21.86	2.78	1,080	0.074	0.07	0.007	0.135
6	90 L	20	20			3,000	0.24	20.00	21.86	2.78	1,080		0.07	0.017	0.152
7	DUCT	20	20		9	3,000		20.00	21.86	2.78	1,080	0.074	0.07	0.007	0.159
8	90 L	20	20			3,000	0.24	20.00	21.86	2.78	1,080		0.07	0.017	0.176
9	PLENUM LOSS	20	20			3,000	1.00	20.00	21.86	2.78	1,080		0.07	0.073	0.249
10	ERV 1 DISCHARGE	26	26			3,000	1.00	26.00	28.42	4.69	639		0.03	0.025	0.275
11	DUCT	20	18		4	3,000		18.95	20.73	2.50	1,200	0.096	0.09	0.004	0.278
12	90 L	20	18			3,000	0.24	18.95	20.73	2.50	1,200		0.09	0.022	0.300
13	DUCT	20	18		5	3,000		18.95	20.73	2.50	1,200	0.096	0.09	0.005	0.305
14	90 L	20	18			3,000	0.24	18.95	20.73	2.50	1,200		0.09	0.022	0.326
15	DUCT	20	18		2	3,000		18.95	20.73	2.50	1,200	0.096	0.09	0.002	0.328
16	TRANSITION	20	18			3,000	0.33	18.95	20.73	2.50	1,200		0.09	0.030	0.358
17	DX COIL	28	20			3,000	15.00	23.33	25.78	3.89	771		0.04	0.557	0.914
18	90 L	20	18			3,000	0.24	18.95	20.73	2.50	1,200		0.09	0.022	0.936
19	DUCT	20	18		3	3,000		18.95	20.73	2.50	1,200	0.096	0.09	0.003	0.939
20	90 L	20	18			3,000	0.24	18.95	20.73	2.50	1,200		0.09	0.022	0.960
21	DUCT	20	18		6	3,000		18.95	20.73	2.50	1,200	0.096	0.09	0.006	0.966
22	90 L	18	16			1,990	0.24	16.94	18.54	2.00	995		0.06	0.015	0.981
23	DUCT	18	16		9	1,990		16.94	18.54	2.00	995	0.077	0.06	0.007	0.988
24	TRANSITION	28	6			995	0.33	9.88	13.24	1.17	853		0.05	0.015	1.003
25	DUCT	28	6		8	995		9.88	13.24	1.17	853	0.087	0.05	0.007	1.010
26	90 L	28	6			995	0.24	9.88	13.24	1.17	853		0.05	0.011	1.021
27	DUCT	28	6		4	995		9.88	13.24	1.17	853	0.087	0.05	0.003	1.024
28	90 L	14	6			480	0.24	8.40	9.80	0.58	823		0.04	0.010	1.034
29	TRANSITION	12	6			480	0.33	8.00	9.14	0.50	960		0.06	0.019	1.053
30	DUCT	12	6		68	480		8.00	9.14	0.50	960	0.170	0.06	0.116	1.169
31	TRANSITION	6	6			225	0.33	6.00	6.56	0.25	900		0.05	0.017	1.186
32	DUCT	6	6		38	225		6.00	6.56	0.25	900	0.226	0.05	0.086	1.272
33	90 L	6	4			110	0.24	4.80	5.33	0.17	660		0.03	0.007	1.278
34	DUCT	6	4		4	110		4.80	5.33	0.17	660	0.162	0.03	0.006	1.285
35	90 L	6	4			75	0.24	4.80	5.33	0.17	450		0.01	0.003	1.288
36	DUCT	6	4		14	75		4.80	5.33	0.17	450	0.078	0.01	0.011	1.299
37	90 L	6	4			37	0.24	4.80	5.33	0.17	222		0.00	0.001	1.299
38	DUCT	6	4		5	37		4.80	5.33	0.17	222	0.020	0.00	0.001	1.300
39	DIFFUSER	6	4			37		4.80	5.33	0.17	222	0.020	0.00	0.080	1.380

MINOT AFB DUCT PRESSURE DROP CALCULATIONS (ERV-1)

DUCT SECTION	ITEM	DUCT WIDTH	DUCT HEIGHT	DUCT DIA	LENGTH (FT)	ACTUAL CFM @ ELEVATION	LOSS COEFF.	hydra DIA.	EQUIV DIA	AREA (sq. ft)	VELOCITY (FPM)	FRICTION /100 FT.	VELOCITY PRESS.	PRESS. LOSS ITEM	PRESS LOSS CUMULATIVE
INPUT								OUTPUT							
40	DAMPER	6	4			37		4.80	5.33	0.17	222	0.020	0.00	0.030	1.410
													5 % SAFETY FACTOR		0.071
														TOTAL	1.481

MINOT AFB DUCT PRESSURE DROP CALCULATIONS (ERV-1)

DUCT SECTION	ITEM	DUCT WIDTH	DUCT HEIGHT	DUCT DIA	LENGTH (FT)	ACTUAL CFM @ ELEVATION	LOSS COEFF.	hydra DIA.	EQUIV DIA	AREA (sq. ft)	VELOCITY (FPM)	FRICTION /100 FT.	VELOCITY PRESS.	PRESS. LOSS ITEM	PRESS LOSS CUMULATIVE
INPUT								OUTPUT							
EXHAUST															
1	GRILLE	16	19					17.37	19.04	2.11	0	0.000	0.00	0.100	0.100
2	90 L			6		37	0.24	6.00	6.00	0.20	188	0.000	0.00	0.001	0.101
3	DUCT			6	3	37		6.00	6.00	0.20	188	0.013	0.00	0.000	0.101
4	90 L			6		37	0.24	6.00	6.00	0.20	188	0.000	0.00	0.001	0.101
5	DUCT			6	10	37		6.00	6.00	0.20	188	0.013	0.00	0.001	0.103
6	TRANSITION			6		37	0.33	6.00	6.00	0.20	188	0.000	0.00	0.001	0.103
7	DUCT			6	10	80		6.00	6.00	0.20	407	0.056	0.01	0.006	0.109
8	DUCT			8	10	110		8.00	8.00	0.35	315	0.024	0.01	0.002	0.111
9	90 L			8		110	0.24	8.00	8.00	0.35	315	0.000	0.01	0.001	0.113
10	DUCT			8	2	110		8.00	8.00	0.35	315	0.024	0.01	0.000	0.113
11	BRANCH LOSS			8		110	1.00	8.00	8.00	0.35	315	0.000	0.01	0.006	0.120
12	DUCT			8	18	225		8.00	8.00	0.35	645	0.094	0.03	0.017	0.137
13	TRANSITION			8	18	225	0.33	8.00	8.00	0.35	645	0.000	0.03	0.009	0.145
14	DUCT			10	10	450		10.00	10.00	0.55	825	0.115	0.04	0.011	0.157
15	TRANSITION			12		560	0.33	12.00	12.00	0.79	713	0.000	0.03	0.010	0.167
16	DUCT			12	10	560		12.00	12.00	0.79	713	0.070	0.03	0.007	0.174
17	DUCT			12	15	675		12.00	12.00	0.79	859	0.099	0.05	0.015	0.189
18	TRANSITION	12	16			1,020	0.33	13.71	15.11	1.33	765	0.000	0.04	0.012	0.201
19	DUCT	12	16		23	1,020		13.71	15.11	1.33	765	0.060	0.04	0.014	0.215
20	DUCT	12	16		25	1,100		13.71	15.11	1.33	825	0.069	0.04	0.017	0.232
21	DUCT	12	16		5	1,210		13.71	15.11	1.33	908	0.083	0.05	0.004	0.236
22	90 L	12	16			1,210	0.24	13.71	15.11	1.33	908	0.000	0.05	0.012	0.248
23	DUCT	12	16		2	1,210		13.71	15.11	1.33	908	0.083	0.05	0.002	0.250
24	90 L	12	16			1,210	0.24	13.71	15.11	1.33	908	0.000	0.05	0.012	0.262
25	DUCT	12	16		3	1,210		13.71	15.11	1.33	908	0.083	0.05	0.002	0.265
26	TAP LOSS	12	16			1,210	1.00	13.71	15.11	1.33	908	0.000	0.05	0.051	0.316
27	DUCT	12	28		10	2,105		16.80	19.61	2.33	902	0.060	0.05	0.006	0.322
28	90 L	12	28			2,105	0.33	16.80	19.61	2.33	902	0.000	0.05	0.017	0.339
29	TRANSITION	24	14			2,105	0.33	17.68	19.86	2.33	902	0.000	0.05	0.017	0.356
30	DUCT	24	14		4	2,105		17.68	19.86	2.33	902	0.059	0.05	0.002	0.358
31	90 L	24	14			2,105	0.24	17.68	19.86	2.33	902	0.000	0.05	0.012	0.370

32	DUCT	24	14		3	2,105		17.68	19.86	2.33	902	0.059	0.05	0.002	0.372
33	90 L	24	14			2,105	0.24	17.68	19.86	2.33	902	0.000	0.05	0.012	0.384
34	DUCT	24	14		4	2,385		17.68	19.86	2.33	1,022	0.075	0.07	0.003	0.387
35	90 L	24	14			2,385	0.24	17.68	19.86	2.33	1,022	0.000	0.07	0.016	0.403
36	INTAKE LOSS	24	14			2,385	1.00	17.68	19.86	2.33	1,022	0.000	0.07	0.065	0.468
37	EXHUAST LOUVER	30	30			2,385	8.00	30.00	32.79	6.25	382	0.000	0.01	0.073	0.541
38	ELEC. DUCT HEATER	24	14			2,385	2.50	17.68	19.86	2.33	1,022	0.000	0.07	0.163	0.703
													5 % SAFETY FACTOR		**0.035**
														TOTAL	**0.739**

GROUND SOURCE WELL FIELD NARRATIVE

CALCULATION SUMMARY

The GLHEPRO simulation that is in the calculations submitted was based on a 10 year simulation with a minimum desired temperature of 27.2 deg. F. The scheduled heat pumps reference ISO 13256-1 for which heating capacity of heat pumps for a ground loop heat pump system are based on 32 deg. F entering water. The peak heating load is 356 MBH and the peak cooling load is 231 MBH (19.25 Tons). The monthly heat extraction and heat sink injection in BTU's was derived from the Carrier HAP program.

The resultant well field configuration from the above input information resulted in a 6 x 6 well field spaced 15 feet apart requiring a minimum depth of 195 feet. These results are commensurate with other wells on the base.

BACKGROUND INFORMATION

The example dormitory project that the Base personnel provided Leidos has drawings that were dated in 2010. This 3-story dormitory building was roughly 78,000 sf and was provided with 80 205' deep wells spaced 15' on center with a 8 x 10 well field arrangement. On the mechanical site plan there is a note that designates a future space for 20 additional wells. Our project is approximately 31,000 sf and was provided with 36 205' deep wells spaced 15' on center with a 6 x 6 well field arrangement. Based on a well to building area comparison our project is very similar to the example project they provided to us.

GLHEPRO PROGRAM METHODOLOGY

GLHEPRO was developed as an aid in the design of vertical borehole-type ground loop heat exchangers used in geothermal heat pump systems. While GLHEPRO is aimed at commercial systems. The heat exchanger may be composed of any number of boreholes arranged in various configurations.

GLHEPRO performs three different tasks:

- Simulation (for up to 100 years) of ground loop heat exchangers to determine monthly average and peak heat pump entering and exiting fluid temperatures, as well as power consumption of the heat pump.
- Determination of the required borehole depth to meet user-specified minimum and maximum heat pump entering fluid temperatures.
- Sizing of hybrid ground source heat pump (HGSHP) systems by determination of the required borehole depth and necessary supplemental heat rejecter (cooling tower, fluid cooler) or heat extractor (boiler) size.

GLHEPRO requires four basic sets of input data:

- Monthly and monthly peak heating and cooling loads on the heat pumps.

- Ground thermal properties. GLHEPRO has a small database of ground thermal properties for a few different ground types. For larger jobs, an in situ test is recommended, using the in situ methodology developed at Oklahoma State University.
- Ground loop heat exchanger information. The user must select a borehole configuration and specify some related additional information - borehole diameter, borehole spacing, grout and piping properties, and fluid type and flow rate. Open and closed rectangle, line, U-shaped, L-shaped, and stacked L-shaped configurations are available; additionally, the Large Rectangle option can be purchased, which provides additional borehole configurations up to 900 boreholes.
- Heat pump information. GLHEPRO has a database of heat pump types from most manufacturers. Any models not available in the database may be added by the user using commonly available catalog data.

Project Name:
Default

Notes:
Default file.

File/Model Name: Minot AFB well field calculation
Simulated On: 1/21/2016 11:11:42 AM
Simulated By: James Chervek, Leidos

-------GLHE SYSTEM-------
System Parameters
Active borehole length, ft =194.710

Borehole Radius, in =2.25
Borehole spacing, ft =15
Borehole Geometry : RECTANGULAR CONFIGURATION
: 36 : 6 x 6, rectangle
Soil Type currently used : Heavy Soil (Damp)
Thermal conductivity of the ground, Btu/(hr·ft·°F) =1.17
Volumetric heat capacity of Ground, Btu/(°F·ft³) =40.7
Volumetric heat capacity of fluid, Btu/(°F·ft³) =60.1957
Undisturbed ground temperature, °F =45.5
Borehole thermal resistance, °F/(Btu/(hr·ft)) =0.2453
Fluid type currently entered : 20% Propylene Glycol / Water
Mass flow rate of the fluid, gal/min =200.016
Density of the fluid, lb/ft³ =63.8004
Heat Pump Selected : Trane : GET009@482CFM_2.25GPM

GLHE Monthly Loads

****

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	0.00
March	0.00	0.00	0.00	0.00
April	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.00
November	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00

;
;
Peak Heating Hours =0
Peak Cooling Hours =0
;
;

Heat Pump Monthly Loads

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Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	111305.00	0.00	356.00	0.00
February	93857.00	0.00	0.00	0.00
March	50087.00	27.00	0.00	0.00
April	22967.00	284.00	0.00	0.00
May	8483.00	10333.00	0.00	0.00
June	1080.00	32914.00	0.00	0.00
July	316.00	40541.00	0.00	231.00
August	1212.00	34154.00	0.00	0.00
September	7070.00	10173.00	0.00	0.00
October	14422.00	1220.00	0.00	0.00
November	55225.00	25.00	0.00	0.00
December	98789.00	0.00	0.00	0.00

;
;
Peak Heating Hours =0
Peak Cooling Hours =0
;
;

Simulation Results

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Borehole Information/Design

Each Borehole Design Depth, ft = 194.71
Total Borehole Depth, ft = 7009.56
Distance between borehole centers, ft = 15.00

Average Temperature:
the End of Month Temperature due to Average Monthly Loads

Maximum Average Temperature, °F = 50.09 at month 7
Minimum Average Temperature, °F = 27.20 at month 110

Peak temperature

Maximum Peak Temperature, °F = 50.09 at month 7
Minimum Peak Temperature, °F = 27.20 at month 110

Monthly Temperature Summary
Note: EWT = Entering water temperature to heat pump(s)
ExWT = Exiting water temperature from heat pump(s)
Average = End of Month temperature due to Average Monthly Loads
HP Energy = Electrical Energy requirements of Heat Pump(s)

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Time	Q	HP Energy	Tf	Average ExWT	Average EWT	Minimum EWT	Maximum EWT

(months)	(Btu/hr*ft)	(kW-hr)	(F)	(F)	(F)	(F)	(F)
1	15.24	9366.28	33.96	33.41	34.51	34.51	34.51
2	14.19	7961.00	33.30	32.78	33.81	33.81	33.81
3	6.95	4052.66	37.77	37.52	38.02	38.02	38.02
4	3.26	1818.59	40.37	40.25	40.49	40.49	40.49
5	-1.04	1043.13	43.35	43.39	43.32	43.32	43.32
6	-7.25	1383.60	48.28	48.54	48.02	48.02	48.02
7	-8.81	1662.51	50.41	50.73	50.09	50.09	50.09
8	-7.29	1464.78	50.12	50.39	49.86	49.86	49.86
9	-1.24	921.08	46.05	46.10	46.01	46.01	46.01
10	1.78	1141.15	43.81	43.75	43.88	43.88	43.88
11	7.96	4403.96	39.04	38.75	39.33	39.33	39.33
12	13.53	8304.27	34.10	33.60	34.59	34.59	34.59
13	15.10	9612.09	31.69	31.14	32.23	32.23	32.23
14	14.07	8138.53	31.37	30.86	31.88	31.88	31.88
15	6.90	4139.25	35.88	35.63	36.13	36.13	36.13
16	3.24	1859.50	38.34	38.23	38.46	38.46	38.46
17	-1.04	1052.24	41.54	41.57	41.50	41.50	41.50
18	-7.24	1366.58	46.59	46.85	46.33	46.33	46.33
19	-8.80	1636.50	48.74	49.06	48.42	48.42	48.42
20	-7.27	1444.61	48.48	48.75	48.22	48.22	48.22
21	-1.24	925.13	44.59	44.63	44.54	44.54	44.54
22	1.77	1156.93	42.46	42.40	42.53	42.53	42.53
23	7.92	4467.61	37.75	37.46	38.03	38.03	38.03
24	13.46	8427.37	32.82	32.33	33.31	33.31	33.31
25	15.01	9750.50	30.44	29.90	30.99	30.99	30.99
26	14.00	8255.34	30.13	29.62	30.63	30.63	30.63
27	6.86	4199.82	34.59	34.34	34.84	34.84	34.84
28	3.22	1885.48	37.09	36.97	37.21	37.21	37.21
29	-1.05	1058.84	40.36	40.40	40.32	40.32	40.32
30	-7.23	1356.92	45.49	45.76	45.23	45.23	45.23
31	-8.78	1621.61	47.69	48.01	47.37	47.37	47.37
32	-7.26	1433.30	47.44	47.70	47.18	47.18	47.18
33	-1.25	928.47	43.55	43.60	43.51	43.51	43.51
34	1.77	1169.12	41.43	41.36	41.49	41.49	41.49
35	7.89	4519.49	36.71	36.43	37.00	37.00	37.00
36	13.41	8520.94	31.85	31.37	32.34	32.34	32.34
37	14.95	9852.63	29.54	28.99	30.08	30.08	30.08
38	13.94	8337.12	29.27	28.76	29.78	29.78	29.78
39	6.84	4239.78	33.76	33.51	34.01	34.01	34.01
40	3.21	1902.78	36.27	36.15	36.39	36.39	36.39
41	-1.05	1063.76	39.55	39.59	39.51	39.51	39.51
42	-7.23	1350.36	44.67	44.93	44.41	44.41	44.41
43	-8.78	1610.97	46.86	47.18	46.55	46.55	46.55
44	-7.26	1425.28	46.64	46.90	46.38	46.38	46.38
45	-1.25	931.26	42.78	42.82	42.73	42.73	42.73
46	1.76	1178.28	40.67	40.61	40.74	40.74	40.74
47	7.87	4556.29	35.99	35.70	36.27	36.27	36.27
48	13.37	8588.58	31.16	30.68	31.65	31.65	31.65
49	14.91	9928.73	28.87	28.33	29.41	29.41	29.41
50	13.90	8400.00	28.62	28.12	29.12	29.12	29.12
51	6.82	4271.20	33.11	32.86	33.36	33.36	33.36
52	3.20	1916.50	35.63	35.51	35.75	35.75	35.75

53	-1.05	1067.76	38.91	38.95	38.88	38.88	38.88
54	-7.22	1345.80	44.04	44.31	43.78	43.78	43.78
55	-8.77	1603.51	46.25	46.57	45.93	45.93	45.93
56	-7.25	1419.64	46.04	46.30	45.77	45.77	45.77
57	-1.25	933.52	42.19	42.23	42.14	42.14	42.14
58	1.76	1185.35	40.10	40.03	40.16	40.16	40.16
59	7.85	4584.77	35.44	35.15	35.72	35.72	35.72
60	13.33	8641.16	30.63	30.15	31.12	31.12	31.12
61	14.87	9988.18	28.35	27.81	28.89	28.89	28.89
62	13.87	8450.34	28.10	27.60	28.61	28.61	28.61
63	6.81	4296.96	32.58	32.33	32.83	32.83	32.83
64	3.20	1927.91	35.10	34.98	35.22	35.22	35.22
65	-1.06	1071.22	38.39	38.43	38.35	38.35	38.35
66	-7.22	1342.27	43.52	43.78	43.26	43.26	43.26
67	-8.77	1597.63	45.74	46.06	45.42	45.42	45.42
68	-7.25	1415.26	45.54	45.80	45.28	45.28	45.28
69	-1.25	935.47	41.71	41.75	41.66	41.66	41.66
70	1.75	1191.20	39.63	39.56	39.69	39.69	39.69
71	7.83	4608.45	34.98	34.69	35.26	35.26	35.26
72	13.31	8685.53	30.19	29.70	30.67	30.67	30.67
73	14.84	10039.51	27.91	27.37	28.45	28.45	28.45
74	13.84	8493.11	27.67	27.17	28.17	28.17	28.17
75	6.79	4318.54	32.14	31.89	32.39	32.39	32.39
76	3.19	1937.42	34.66	34.55	34.78	34.78	34.78
77	-1.06	1074.16	37.95	37.99	37.91	37.91	37.91
78	-7.22	1339.53	43.09	43.35	42.83	42.83	42.83
79	-8.76	1592.92	45.31	45.63	44.99	44.99	44.99
80	-7.25	1411.71	45.12	45.38	44.85	44.85	44.85
81	-1.25	937.22	41.29	41.34	41.25	41.25	41.25
82	1.75	1196.32	39.22	39.15	39.28	39.28	39.28
83	7.82	4629.11	34.58	34.30	34.87	34.87	34.87
84	13.28	8723.84	29.80	29.32	30.29	30.29	30.29
85	14.82	10083.05	27.54	27.00	28.08	28.08	28.08
86	13.82	8529.47	27.30	26.80	27.80	27.80	27.80
87	6.78	4336.93	31.77	31.52	32.02	32.02	32.02
88	3.19	1945.54	34.29	34.17	34.41	34.41	34.41
89	-1.06	1076.72	37.58	37.62	37.54	37.54	37.54
90	-7.22	1337.33	42.72	42.98	42.46	42.46	42.46
91	-8.76	1589.05	44.95	45.26	44.63	44.63	44.63
92	-7.25	1408.80	44.76	45.02	44.49	44.49	44.49
93	-1.25	938.77	40.94	40.98	40.89	40.89	40.89
94	1.75	1200.76	38.87	38.80	38.93	38.93	38.93
95	7.81	4647.00	34.24	33.96	34.53	34.53	34.53
96	13.27	8757.05	29.47	28.99	29.96	29.96	29.96
97	14.80	10120.84	27.22	26.68	27.75	27.75	27.75
98	13.80	8561.08	26.98	26.48	27.48	27.48	27.48
99	6.77	4352.95	31.45	31.20	31.69	31.69	31.69
100	3.18	1952.63	33.97	33.85	34.08	34.08	34.08
101	-1.06	1079.00	37.26	37.30	37.22	37.22	37.22
102	-7.22	1335.51	42.40	42.66	42.14	42.14	42.14
103	-8.76	1585.79	44.63	44.94	44.31	44.31	44.31
104	-7.24	1406.36	44.44	44.70	44.18	44.18	44.18
105	-1.25	940.18	40.63	40.67	40.58	40.58	40.58
106	1.74	1204.66	38.56	38.50	38.62	38.62	38.62

107	7.80	4662.77	33.94	33.66	34.23	34.23	34.23
108	13.25	8786.37	29.19	28.70	29.67	29.67	29.67
109	14.78	10154.23	26.93	26.40	27.47	27.47	27.47
110	13.78	8589.04	26.70	26.20	27.20	27.20	27.20
111	6.76	4367.15	31.16	30.92	31.41	31.41	31.41
112	3.18	1958.93	33.68	33.57	33.80	33.80	33.80
113	-1.06	1080.91	36.98	37.02	36.94	36.94	36.94
114	-7.21	1333.97	42.12	42.38	41.85	41.85	41.85
115	-8.76	1583.00	44.34	44.66	44.03	44.03	44.03
116	-7.24	1404.27	44.16	44.42	43.90	43.90	43.90
117	-1.25	941.45	40.35	40.39	40.30	40.30	40.30
118	1.74	1208.16	38.29	38.22	38.35	38.35	38.35
119	7.79	4676.88	33.68	33.39	33.96	33.96	33.96
120	13.23	8812.60	28.93	28.45	29.41	29.41	29.41

GROUND SOURCE WELL FIELD NARRATIVE

CALCULATION SUMMARY

The GLHEPRO simulation that is in the calculations submitted was based on a 10 year simulation with a minimum desired temperature of 27.2 deg. F. The scheduled heat pumps reference ISO 13256-1 for which heating capacity of heat pumps for a ground loop heat pump system are based on 32 deg. F entering water. The peak heating load is 356 MBH and the peak cooling load is 231 MBH (19.25 Tons). The monthly heat extraction and heat sink injection in BTU's was derived from the Carrier HAP program.

The resultant well field configuration from the above input information resulted in a 6 x 6 well field spaced 15 feet apart requiring a minimum depth of 195 feet. These results are commensurate with other wells on the base.

BACKGROUND INFORMATION

The example dormitory project that the Base personnel provided Leidos has drawings that were dated in 2010. This 3-story dormitory building was roughly 78,000 sf and was provided with 80 205' deep wells spaced 15' on center with a 8 x 10 well field arrangement. On the mechanical site plan there is a note that designates a future space for 20 additional wells. Our project is approximately 31,000 sf and was provided with 36 205' deep wells spaced 15' on center with a 6 x 6 well field arrangement. Based on a well to building area comparison our project is very similar to the example project they provided to us.

GLHEPRO PROGRAM METHODOLOGY

GLHEPRO was developed as an aid in the design of vertical borehole-type ground loop heat exchangers used in geothermal heat pump systems. While GLHEPRO is aimed at commercial systems. The heat exchanger may be composed of any number of boreholes arranged in various configurations.

GLHEPRO performs three different tasks:

- Simulation (for up to 100 years) of ground loop heat exchangers to determine monthly average and peak heat pump entering and exiting fluid temperatures, as well as power consumption of the heat pump.
- Determination of the required borehole depth to meet user-specified minimum and maximum heat pump entering fluid temperatures.
- Sizing of hybrid ground source heat pump (HGSHP) systems by determination of the required borehole depth and necessary supplemental heat rejecter (cooling tower, fluid cooler) or heat extractor (boiler) size.

GLHEPRO requires four basic sets of input data:

- Monthly and monthly peak heating and cooling loads on the heat pumps.

- Ground thermal properties. GLHEPRO has a small database of ground thermal properties for a few different ground types. For larger jobs, an in situ test is recommended, using the in situ methodology developed at Oklahoma State University.
- Ground loop heat exchanger information. The user must select a borehole configuration and specify some related additional information - borehole diameter, borehole spacing, grout and piping properties, and fluid type and flow rate. Open and closed rectangle, line, U-shaped, L-shaped, and stacked L-shaped configurations are available; additionally, the Large Rectangle option can be purchased, which provides additional borehole configurations up to 900 boreholes.
- Heat pump information. GLHEPRO has a database of heat pump types from most manufacturers. Any models not available in the database may be added by the user using commonly available catalog data.

Project Name:
Default

Notes:
Default file.

File/Model Name: Minot AFB well field calculation
Simulated On: 1/21/2016 11:11:42 AM
Simulated By: James Chervek, Leidos

-------GLHE SYSTEM-------
System Parameters
Active borehole length, ft =194.710

Borehole Radius, in =2.25
Borehole spacing, ft =15
Borehole Geometry : RECTANGULAR CONFIGURATION
: 36 : 6 x 6, rectangle
Soil Type currently used : Heavy Soil (Damp)
Thermal conductivity of the ground, Btu/(hr·ft·°F) =1.17
Volumetric heat capacity of Ground, Btu/(°F·ft³) =40.7
Volumetric heat capacity of fluid, Btu/(°F·ft³) =60.1957
Undisturbed ground temperature, °F =45.5
Borehole thermal resistance, °F/(Btu/(hr·ft)) =0.2453
Fluid type currently entered : 20% Propylene Glycol / Water
Mass flow rate of the fluid, gal/min =200.016
Density of the fluid, lb/ft³ =63.8004
Heat Pump Selected : Trane : GET009@482CFM_2.25GPM

GLHE Monthly Loads
****

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	0.00
March	0.00	0.00	0.00	0.00
April	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.00
November	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00

;
;
Peak Heating Hours =0
Peak Cooling Hours =0
;
;

Heat Pump Monthly Loads

****

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	111305.00	0.00	356.00	0.00
February	93857.00	0.00	0.00	0.00
March	50087.00	27.00	0.00	0.00
April	22967.00	284.00	0.00	0.00
May	8483.00	10333.00	0.00	0.00
June	1080.00	32914.00	0.00	0.00
July	316.00	40541.00	0.00	231.00
August	1212.00	34154.00	0.00	0.00
September	7070.00	10173.00	0.00	0.00
October	14422.00	1220.00	0.00	0.00
November	55225.00	25.00	0.00	0.00
December	98789.00	0.00	0.00	0.00

;
;
Peak Heating Hours =0
Peak Cooling Hours =0
;
;

Simulation Results

****

Borehole Information/Design

Each Borehole Design Depth, ft = 194.71
Total Borehole Depth, ft = 7009.56
Distance between borehole centers, ft = 15.00

Average Temperature:
the End of Month Temperature due to Average Monthly Loads

Maximum Average Temperature, °F = 50.09 at month 7
Minimum Average Temperature, °F = 27.20 at month 110

Peak temperature

Maximum Peak Temperature, °F = 50.09 at month 7
Minimum Peak Temperature, °F = 27.20 at month 110

Monthly Temperature Summary

Note: EWT = Entering water temperature to heat pump(s)
ExWT = Exiting water temperature from heat pump(s)
Average = End of Month temperature due to Average Monthly Loads
HP Energy = Electrical Energy requirements of Heat Pump(s)

****

Time	Q	HP Energy	Tf	ExWT	Average EWT	Average EWT	Minimum EWT	Maximum EWT

(months)	(Btu/hr*ft)	(kW-hr)	(F)	(F)	(F)	(F)	(F)
1	15.24	9366.28	33.96	33.41	34.51	34.51	34.51
2	14.19	7961.00	33.30	32.78	33.81	33.81	33.81
3	6.95	4052.66	37.77	37.52	38.02	38.02	38.02
4	3.26	1818.59	40.37	40.25	40.49	40.49	40.49
5	-1.04	1043.13	43.35	43.39	43.32	43.32	43.32
6	-7.25	1383.60	48.28	48.54	48.02	48.02	48.02
7	-8.81	1662.51	50.41	50.73	50.09	50.09	50.09
8	-7.29	1464.78	50.12	50.39	49.86	49.86	49.86
9	-1.24	921.08	46.05	46.10	46.01	46.01	46.01
10	1.78	1141.15	43.81	43.75	43.88	43.88	43.88
11	7.96	4403.96	39.04	38.75	39.33	39.33	39.33
12	13.53	8304.27	34.10	33.60	34.59	34.59	34.59
13	15.10	9612.09	31.69	31.14	32.23	32.23	32.23
14	14.07	8138.53	31.37	30.86	31.88	31.88	31.88
15	6.90	4139.25	35.88	35.63	36.13	36.13	36.13
16	3.24	1859.50	38.34	38.23	38.46	38.46	38.46
17	-1.04	1052.24	41.54	41.57	41.50	41.50	41.50
18	-7.24	1366.58	46.59	46.85	46.33	46.33	46.33
19	-8.80	1636.50	48.74	49.06	48.42	48.42	48.42
20	-7.27	1444.61	48.48	48.75	48.22	48.22	48.22
21	-1.24	925.13	44.59	44.63	44.54	44.54	44.54
22	1.77	1156.93	42.46	42.40	42.53	42.53	42.53
23	7.92	4467.61	37.75	37.46	38.03	38.03	38.03
24	13.46	8427.37	32.82	32.33	33.31	33.31	33.31
25	15.01	9750.50	30.44	29.90	30.99	30.99	30.99
26	14.00	8255.34	30.13	29.62	30.63	30.63	30.63
27	6.86	4199.82	34.59	34.34	34.84	34.84	34.84
28	3.22	1885.48	37.09	36.97	37.21	37.21	37.21
29	-1.05	1058.84	40.36	40.40	40.32	40.32	40.32
30	-7.23	1356.92	45.49	45.76	45.23	45.23	45.23
31	-8.78	1621.61	47.69	48.01	47.37	47.37	47.37
32	-7.26	1433.30	47.44	47.70	47.18	47.18	47.18
33	-1.25	928.47	43.55	43.60	43.51	43.51	43.51
34	1.77	1169.12	41.43	41.36	41.49	41.49	41.49
35	7.89	4519.49	36.71	36.43	37.00	37.00	37.00
36	13.41	8520.94	31.85	31.37	32.34	32.34	32.34
37	14.95	9852.63	29.54	28.99	30.08	30.08	30.08
38	13.94	8337.12	29.27	28.76	29.78	29.78	29.78
39	6.84	4239.78	33.76	33.51	34.01	34.01	34.01
40	3.21	1902.78	36.27	36.15	36.39	36.39	36.39
41	-1.05	1063.76	39.55	39.59	39.51	39.51	39.51
42	-7.23	1350.36	44.67	44.93	44.41	44.41	44.41
43	-8.78	1610.97	46.86	47.18	46.55	46.55	46.55
44	-7.26	1425.28	46.64	46.90	46.38	46.38	46.38
45	-1.25	931.26	42.78	42.82	42.73	42.73	42.73
46	1.76	1178.28	40.67	40.61	40.74	40.74	40.74
47	7.87	4556.29	35.99	35.70	36.27	36.27	36.27
48	13.37	8588.58	31.16	30.68	31.65	31.65	31.65
49	14.91	9928.73	28.87	28.33	29.41	29.41	29.41
50	13.90	8400.00	28.62	28.12	29.12	29.12	29.12
51	6.82	4271.20	33.11	32.86	33.36	33.36	33.36
52	3.20	1916.50	35.63	35.51	35.75	35.75	35.75

53	-1.05	1067.76	38.91	38.95	38.88	38.88	38.88
54	-7.22	1345.80	44.04	44.31	43.78	43.78	43.78
55	-8.77	1603.51	46.25	46.57	45.93	45.93	45.93
56	-7.25	1419.64	46.04	46.30	45.77	45.77	45.77
57	-1.25	933.52	42.19	42.23	42.14	42.14	42.14
58	1.76	1185.35	40.10	40.03	40.16	40.16	40.16
59	7.85	4584.77	35.44	35.15	35.72	35.72	35.72
60	13.33	8641.16	30.63	30.15	31.12	31.12	31.12
61	14.87	9988.18	28.35	27.81	28.89	28.89	28.89
62	13.87	8450.34	28.10	27.60	28.61	28.61	28.61
63	6.81	4296.96	32.58	32.33	32.83	32.83	32.83
64	3.20	1927.91	35.10	34.98	35.22	35.22	35.22
65	-1.06	1071.22	38.39	38.43	38.35	38.35	38.35
66	-7.22	1342.27	43.52	43.78	43.26	43.26	43.26
67	-8.77	1597.63	45.74	46.06	45.42	45.42	45.42
68	-7.25	1415.26	45.54	45.80	45.28	45.28	45.28
69	-1.25	935.47	41.71	41.75	41.66	41.66	41.66
70	1.75	1191.20	39.63	39.56	39.69	39.69	39.69
71	7.83	4608.45	34.98	34.69	35.26	35.26	35.26
72	13.31	8685.53	30.19	29.70	30.67	30.67	30.67
73	14.84	10039.51	27.91	27.37	28.45	28.45	28.45
74	13.84	8493.11	27.67	27.17	28.17	28.17	28.17
75	6.79	4318.54	32.14	31.89	32.39	32.39	32.39
76	3.19	1937.42	34.66	34.55	34.78	34.78	34.78
77	-1.06	1074.16	37.95	37.99	37.91	37.91	37.91
78	-7.22	1339.53	43.09	43.35	42.83	42.83	42.83
79	-8.76	1592.92	45.31	45.63	44.99	44.99	44.99
80	-7.25	1411.71	45.12	45.38	44.85	44.85	44.85
81	-1.25	937.22	41.29	41.34	41.25	41.25	41.25
82	1.75	1196.32	39.22	39.15	39.28	39.28	39.28
83	7.82	4629.11	34.58	34.30	34.87	34.87	34.87
84	13.28	8723.84	29.80	29.32	30.29	30.29	30.29
85	14.82	10083.05	27.54	27.00	28.08	28.08	28.08
86	13.82	8529.47	27.30	26.80	27.80	27.80	27.80
87	6.78	4336.93	31.77	31.52	32.02	32.02	32.02
88	3.19	1945.54	34.29	34.17	34.41	34.41	34.41
89	-1.06	1076.72	37.58	37.62	37.54	37.54	37.54
90	-7.22	1337.33	42.72	42.98	42.46	42.46	42.46
91	-8.76	1589.05	44.95	45.26	44.63	44.63	44.63
92	-7.25	1408.80	44.76	45.02	44.49	44.49	44.49
93	-1.25	938.77	40.94	40.98	40.89	40.89	40.89
94	1.75	1200.76	38.87	38.80	38.93	38.93	38.93
95	7.81	4647.00	34.24	33.96	34.53	34.53	34.53
96	13.27	8757.05	29.47	28.99	29.96	29.96	29.96
97	14.80	10120.84	27.22	26.68	27.75	27.75	27.75
98	13.80	8561.08	26.98	26.48	27.48	27.48	27.48
99	6.77	4352.95	31.45	31.20	31.69	31.69	31.69
100	3.18	1952.63	33.97	33.85	34.08	34.08	34.08
101	-1.06	1079.00	37.26	37.30	37.22	37.22	37.22
102	-7.22	1335.51	42.40	42.66	42.14	42.14	42.14
103	-8.76	1585.79	44.63	44.94	44.31	44.31	44.31
104	-7.24	1406.36	44.44	44.70	44.18	44.18	44.18
105	-1.25	940.18	40.63	40.67	40.58	40.58	40.58
106	1.74	1204.66	38.56	38.50	38.62	38.62	38.62

107	7.80	4662.77	33.94	33.66	34.23	34.23	34.23
108	13.25	8786.37	29.19	28.70	29.67	29.67	29.67
109	14.78	10154.23	26.93	26.40	27.47	27.47	27.47
110	13.78	8589.04	26.70	26.20	27.20	27.20	27.20
111	6.76	4367.15	31.16	30.92	31.41	31.41	31.41
112	3.18	1958.93	33.68	33.57	33.80	33.80	33.80
113	-1.06	1080.91	36.98	37.02	36.94	36.94	36.94
114	-7.21	1333.97	42.12	42.38	41.85	41.85	41.85
115	-8.76	1583.00	44.34	44.66	44.03	44.03	44.03
116	-7.24	1404.27	44.16	44.42	43.90	43.90	43.90
117	-1.25	941.45	40.35	40.39	40.30	40.30	40.30
118	1.74	1208.16	38.29	38.22	38.35	38.35	38.35
119	7.79	4676.88	33.68	33.39	33.96	33.96	33.96
120	13.23	8812.60	28.93	28.45	29.41	29.41	29.41

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FORMATION THERMAL CONDUCTIVITY TEST AND DATA ANALYSIS

Analysis for: **Mowbray & Son Plumbing & Heating**
328 20th Ave SE
Minot, ND 58701
Phone: (701) 852-1492
Fax: (701) 839-5869

Test location: **Building 546**
Minot AFB, Minot, ND

Report Date: December 7, 2006

Test Performed by: **Mowbray & Son Plumbing & Heating**

Executive Summary

A formation thermal conductivity test was performed at the Building 546 site at Minot Air Force Base. The vertical bore was completed on November 22, 2006 by Iba Drilling Co. Inc. GRTI's test unit was attached to the vertical bore on the afternoon of November 27, 2006. Geothermal Resource Technologies, Inc. analyzed the collected data using the "line source" method.

This report provides a general overview of the test and procedures that were used to perform the thermal conductivity test along with a plot of the data in real time and in a form used to calculate the formation thermal conductivity. The following average formation thermal conductivity was found from the data analysis.

⇒ Formation Thermal Conductivity = 1.17 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an attempt was made to estimate the average thermal diffusivity for the encountered formation.

⇒ Formation Thermal Diffusivity ≈ 0.69 ft^2/day

An estimate of the undisturbed soil temperature value was unable to be determined from the initial temperature data at startup. However, from previous data collected in the area a recommended temperature range has been estimated.

⇒ Estimated Undisturbed Soil Temperature ≈ 45.5°F

A copy of the original collected data is available either in a hard copy or an electronic format upon request.

Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) recently adopted and published a set of recommended procedures for performing formation thermal conductivity tests for geothermal applications. GRTI is committed to adhering to ASHRAE recommendations. Some of these recommended procedures are listed below:

(1) Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours.

(2) Power Quality – The standard deviation of the power should be ≦ 1.5% of the average power, with maximum power variation of ≦ 10% of the average power. The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of borehole depth to best simulate the expected peak loads on the u-bend.

(3) Undisturbed Soil Temperature Measurement – The undisturbed soil temperature should be determined by recording the minimum loop temperature as the water returns from the u-bend at test startup.

(4) Installation Procedures for Test Loops – The bore diameter is to be no larger than 6 inches, with 4.5 inches being the target diameter. To ensure against bridging and voids, the bore annulus is to be uniformly grouted from the bottom to the top using a tremie pipe.

(5) Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended if the formation is expected to have a low thermal conductivity or if low conductivity grouts (< 0.75 Btu/hr·ft·°F) are used. A minimum delay of three days is recommended for all other conditions.

GRTI's testing procedures deviate slightly from those above with regard to item (5). While item (5) bases the delay between installation and testing on the expected formation conductivity, GRTI bases its delay on the type of drilling used in the installation. When air drilling is required, a five-day delay is recommended to allow the bore to return to its undisturbed temperature. For mud rotary drilling, a minimum waiting period of two days is sufficient.

For a complete list of recommended procedures, refer to ASHRAE's 2003 HVAC Applications handbook, page 32.14.

Data Analysis

Geothermal Resource Technologies, Inc. uses the "line source" method of data analysis. The line source equation used is not valid for early test times. Also, the line source method assumes an infinitely thin line source of heat in a continuous medium. If a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that the amount of time required to allow early test time error and finite borehole dimension effects to become insignificant is approximately ten hours.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of time. Using the Method of Least Squares, the linear equation coefficients are then calculated that produce a line that fits the data. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing erroneous results.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. A copy of this data can be obtained either in a hard copy or electronic copy format at any time. If desired, please contact Geothermal Resource Technologies, Inc. and provide a ship-to address or e-mail address at one of the following:

Phone: (605) 692-9069
Fax: (605) 692-2604
E-mail: gstreich@brookings.net

Formation Thermal Conductivity Test Report

Date	November 27-29, 2006
Location	Minot AFB

Borehole Data

Undisturbed Soil Temperature	NA
Borehole Diameter	4 1/2 inches

Drill Log

Clay	0'-60'
Sand	60'-95'
Clay	95'-140'
Sand	140'-165'
Clay	165'-250'

U-bend Size	1 inch HDPE
U-Bend Length	250 ft
Grout Type	GeoPro TG Lite 0.88
Grout Solids	63%
Grouted Portion	Entire bore

Test Data

Test Duration	47.4 hrs.
Average Voltage	204.4 V
Average Power	4,470 W
Total Heat Input Rate	15,255 Btu/hr
Calculated Circulator Flow Rate	6.3 gpm

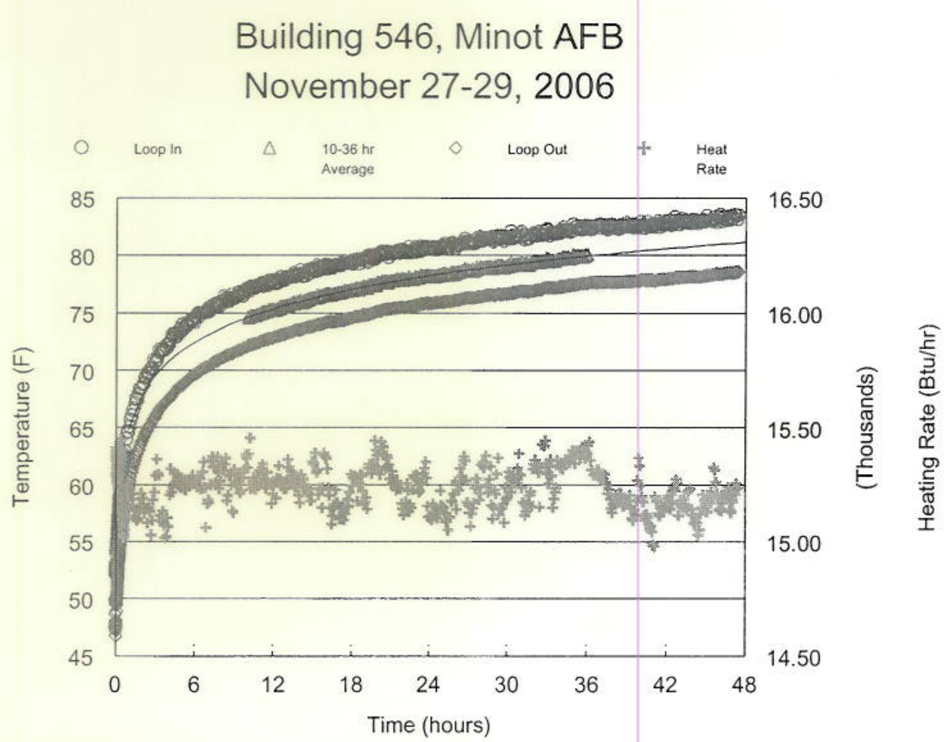


Figure 1: Temperature versus Time Data

Line Source Data Analysis

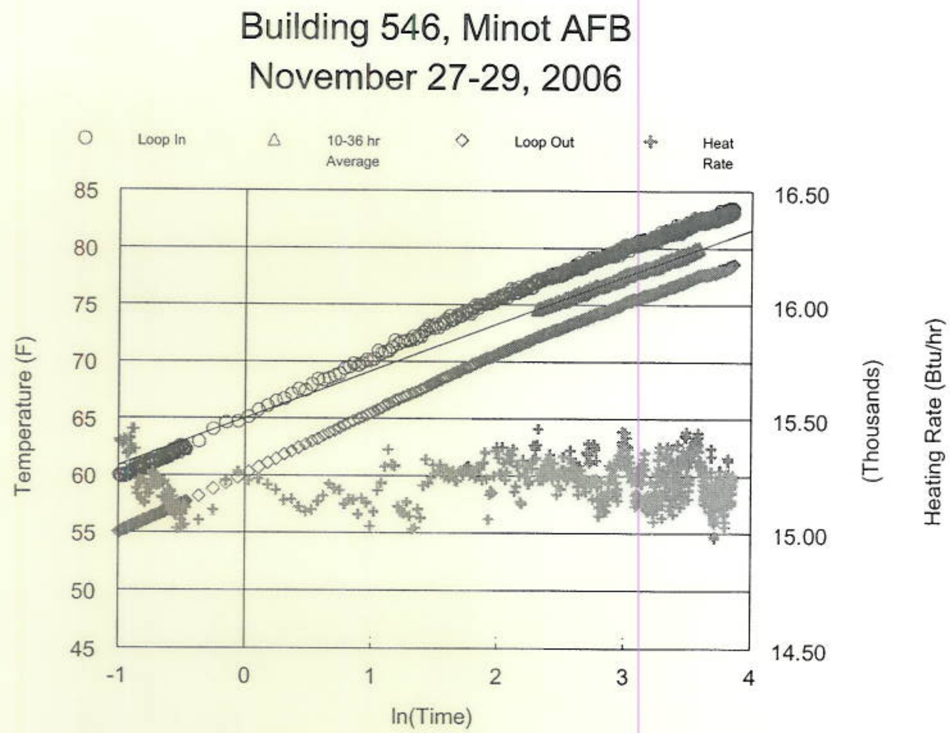


Figure 2: Temperature versus Natural Log of Time

Time Period	Slope: a_1	Average Heat Input (Btu/hr-ft)	(W/ft)	Thermal Conductivity (Btu/hr-ft-°F)
10 – 36 hrs	4.17	61.0	17.9	1.17

The temperature versus time data was analyzed using the line source analysis for the time period shown above. An average linear curve fit was applied to the data between 10 and 36 hours. The slope of the curve (a_1) was found to be 4.17. The resulting thermal conductivity was found to be 1.17 Btu/hr-ft-°F.

Estimated Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of sand and clay. Saturated moisture contents were assumed for sand and clay in order to calculate heat capacity values. A weighted average of these values based on the indicated formation was used to develop an average heat capacity for the formation. An estimated diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be approximately 0.69 ft^2/day.

Est. Average Heat Capacity (Btu/ft^3 °F)	Thermal Conductivity (Btu/hr-ft-°F)	Est. Thermal Diffusivity (ft^2/day)
40.7	1.17	0.69

Air System Design Load Summary for HEAT PUMP SPACE LOADS

Project Name: Building 276 Renovation-Minot AFB LEED calcs 01/07/2016
Prepared by: seeni 06:45AM

* Approx 80 units Provide Heat,

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500			HEATING DATA AT DES HTG		
	COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	1335 ft²	27224	-	1335 ft²	-	-
Wall Transmission	10987 ft²	5274	-	10987 ft²	42426	-
Roof Transmission	8697 ft²	14560	-	8697 ft²	18513	-
Window Transmission	1335 ft²	3363	-	1335 ft²	40043	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	7785 ft²	0	-	7785 ft²	16090	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	12832 W	43782	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	5325 W	18167	-	0	0	-
People	109	26705	22345	0	0	0
Infiltration	-	7064	-6225	-	53575	0
Miscellaneous	-	12000	8000	-	0	0
Safety Factor	0% / 0%	0	0	15%	25597	0
>> Total Zone Loads	-	**158139**	**24120**	-	**196245**	**0**
Zone Conditioning	-	153263	24120	-	189628	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	2018 CFM	1346	-	2018 CFM	-1346	-
Ventilation Load	2018 CFM	6857	-7400	2018 CFM	61081	0
Ventilation Fan Load	2018 CFM	2543	-	2018 CFM	-2543	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	-	**164009**	**16720**	-	**246821**	**0**
Terminal Unit Cooling	-	164056	17549	-	0	0
Terminal Unit Heating	-	0	-	-	246731	-
>> Total Conditioning	-	**164056**	**17549**	-	**246731**	**0**
Key:	**Positive values are clg loads**			**Positive values are htg loads**		
	Negative values are htg loads			**Negative values are clg loads**		

247 MBH
0.2 (INT. VAV 3 rms)
4.2 (EXT. VAV 3 rms)
252/80 HP* = 3.15 → 3.2 MBH average

Listed in schedule

THIS IS A ROUGH CALCULATION TO VERIFY THE WELL FIELD COOLING LOAD.

Cooling Total is ± 183,000/12 = 15.25T (For Heat Pump Space Loads)
ADD EXTERIOR ZONE VAV LOAD 0.1T
ADD INTERIOR ZONE VAV LOAD 1.3T
17.55 → 18T = 216,000/84 HP's = 2,571

Listed in Sched = 2.6 MBH Clg. Average

18T (Shown Here)
3T Computer Rm's, 1, 2, 3 FL
≈ 3T ERV HP 3-31 (See Sep. Calc)
< 24 Tons

MINOT BLDG 276 PUMP HEAD CALCULATIONS
GROUND LOOP PUMP P-1 (P-2)
(100 gpm maximum)

PIPE ELEMENT	FLOW GPM	VELOCITY FPS	WPD FT/100	LENGTH FT	LOSS FT	TOTAL FT
Well pipe 3/4"	2.77		0.55	411	2.26	2.26
Lateral 3/4"	2.77		0.55	30	0.17	2.43
Lateral 1"	5.5		0.52	60	0.31	2.74
Lateral 1 1/2"	13.9		1.4	60	0.84	3.58
Lateral 2"	22		0.97	90	0.87	4.45
Lateral 2"	25		1.21	60	0.73	5.18
(8)Elbow 2"	25		1.21	69	0.83	6.01
Header 3"	100		2.8	20	0.56	6.57
Pipe 3"	100		2.8	60	1.68	8.25
(9) Elbow 3"	100		2.8	100	2.80	11.05
Air Separator RL-3					2.50	13.55
Pump Trim					2.00	15.55
Pipe 3"	100		2.8	20	0.56	16.11
(4)Elbow 3"	100		2.8	35	0.98	17.09
(4) Tee 3"	70		1.3	48	0.62	17.72
Pipe 2 1/2"	50		1.66	160	2.66	20.37
(6) Tee 2 1/2"	50		1.66	40	0.66	21.04
Pipe 1 1/2"	20		2.5	90	2.25	23.29
(8) Tee 1 1/2"	20		2.5	22	0.55	23.84
(4)Elbow 1 1/2"	11		0.94	30	0.28	24.12
Pipe 1 1/2"	11		0.94	60	0.56	24.68
Pipe 1"	5.6		2.1	30	0.63	25.31
Flex hoses					2.00	27.31
Heat Pump Coil					8.00	35.31
Control Valve					2.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
					0.00	37.31
Safety Factor(15%)						5.60
TOTAL					128.06	**42.91**
						(200 kPa)

1. General Details:

Building Name .... **PTAC building**

2. Plants Included in this Building:

Plant Name
Service Hot Water

3. Air Systems Included in this Building:

System Name	Mult.
PTAC	1
Heating Only Spaces	1
PTAC Comm Rooms	1
PTAC Mech/elec rooms	1

4: Miscellaneous Energy

Name	Process Load	Energy/Fuel Type	Peak Use	Schedule
Exterior Lighting	No	Electric	0.5 kW	90.1 Hotel/Motel Lgt/Elec
Exhaust Fan	No	Electric	1.0 kW	90.1 Hotel/Motel Occupancy

5: Meters

Electric .... **Base utilities electric rate**
Natural Gas .... **Base natural gas rate**

6: Miscellaneous Data

Average Building Power Factor .... **100.00 %**
Source Electric Generating Efficiency .... **28.00 %**
Additional Floor Area .... **0.0 ft²**

1. General Details:

Air System Name	**Heating Only Spaces**	
Equipment Type	**Terminal Units**	
Air System Type	**Packaged DX Fan Coil**	
Number of zones	**1**	
Ventilation	**Direct Ventilation**	

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
east stair tower(1)	x1
first fl center stair	x1
first fl cordridor	x1
second fl center stair	x1
second fl cordridor	x1
second fl SW corner	x1
third fl center stair	x1
third fl cordridor	x1
first fl Mail Lobby	x1
west stair tower(1)	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F
Thermostat Schedule	**90.1 Office Thermostat(3)**	
Unoccupied Cooling is	**Not Available**	

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Electric Resistance**	
Schedule	**JFMAMJJASOND**	
Fan Control	**Cycled**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**

Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	1712.0	-	-	286.3

5. Equipment Data

No equipment data required for this system.

1. General Details:

Air System Name ... **PTAC**
Equipment Type ... **Terminal Units**
Air System Type ... **Packaged DX Fan Coil**
Number of zones ... **3**
Ventilation ... **Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
1st fl N DAY RM base	x1
1st fl NE corner base	x9
1st fl NW corner base	x1
1st fl S RM base	x10
1st fl SE corner base	x1
1st fl SW corner base	x1
Mail 1009 base	x1
Office 1005 base	x1
Zone 2: Zone 2	
2nd fl N DAY Rm base	x1
2nd fl N RM base	x9
2nd fl NE corner base	x1
2nd fl NW corner base	x1
2nd fl S RM base	x13
2nd fl SE corner base	x1
2nd fl SW corner base	x1
Zone 3: Zone 3	
3rd fl N DAY RM base	x1
3rd fl N RM base	x9
3rd fl NE corner base	x1
3rd fl NW corner base	x1
3rd fl S RM base	x13
3rd fl SE corner base	x1
3rd fl SW corner base	x1

Thermostats and Zone Data:

Zone ... **All**
Cooling T-stat: Occ. ... **78.0** °F
Cooling T-stat: Unocc. ... **80.0** °F
Heating T-stat: Occ. ... **68.0** °F
Heating T-stat: Unocc. ... **55.0** °F
T-stat Throttling Range ... **1.50** °F

Thermostat Schedule ... **90.1 Hotel/Motel Thermostat(1)**
Unoccupied Cooling is ... **Available**

Common Terminal Unit Data:

Cooling Coil:

Design Supply Temperature ... **58.0** °F
Coil Bypass Factor ... **0.100**
Cooling Source ... **Air-Cooled DX**
Schedule ... **JFMAMJJASOND**

Heating Coil:

Design Supply Temperature ... **95.0** °F
Heating Source ... **Air Source Heat Pump**
Schedule ... **JFMAMJJASOND**

Fan Control ... **Fan On**
Ventilation Sizing Method ... **Sum of Space OA Airflows**

Terminal Units Data:

Zone ... **All**

Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.06** CFM/ft²
Fan Performance .... **0.50** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **58.0** °F
Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	4151.0	-	-	543.1
2	3246.4	-	-	620.2
3	3680.6	-	-	620.2

5. Equipment Data

Terminal Cooling Units - Air-Cooled DX

Zone	Estimated Maximum Load (MBH)	Design OAT (°F)	Equipment Sizing	Gross Cooling Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor + OD Fan Power (kW)	ARI Performance Rating	Units	Conventional Cutoff OAT (°F)
1	65.9	89.3	Auto-Sized	65.9	0	-	Auto-Calculated (9.105)	EER	0.0
2	68.9	89.3	Auto-Sized	68.9	0	-	Auto-Calculated (9.105)	EER	0.0
3	75.8	89.3	Auto-Sized	75.8	0	-	Auto-Calculated (9.105)	EER	0.0

*Auto-Calculated = Calculated per ASHRAE 90.1 Minimum Equipment Efficiency.

Terminal Heating Units - ASHP

Zone	Estimated Maximum Load (MBH)	Design OAT (°F)	Equipment Sizing	Gross Heating Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor + OD Fan Power (kW)	ARI Performance Rating	Units	Cutoff OAT (°F)
1	147.0	47.0	Auto-Sized	147.0	0	-	3.200	COP	-15.0
2	120.1	47.0	Auto-Sized	120.1	0	-	3.200	COP	-15.0
3	135.4	47.0	Auto-Sized	135.4	0	-	3.200	COP	-15.0

Auxiliary Heating Type .... **Electric Resistance**
Auxiliary Heating Upper Cutoff .... **40.0** °F

1. General Details:

Air System Name .... **PTAC Comm Rooms**
Equipment Type .... **Terminal Units**
Air System Type .... **Packaged DX Fan Coil**
Number of zones **1**
Ventilation .... **Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Comm 1003 base	x1
Comm 2002 base	x1
Comm 3002 base	x1

Thermostats and Zone Data:

Zone .... **All**
Cooling T-stat: Occ. .... **75.0** °F
Cooling T-stat: Unocc. .... **80.0** °F
Heating T-stat: Occ. .... **70.0** °F
Heating T-stat: Unocc. .... **65.0** °F
T-stat Throttling Range .... **1.50** °F

Thermostat Schedule .... **90.1 Office Thermostat(2)**
Unoccupied Cooling is .... **Available**

Common Terminal Unit Data:

Cooling Coil:

Design Supply Temperature .... **58.0** °F
Coil Bypass Factor **0.100**
Cooling Source .... **Air-Cooled DX**
Schedule .... **JFMAMJJASOND**

Heating Coil:

Design Supply Temperature .... **95.0** °F
Heating Source .... **Air Source Heat Pump**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Cycled**
Ventilation Sizing Method .... **Sum of Space OA Airflows**

Terminal Units Data:

Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.00** CFM/person
Fan Performance .... **0.00** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **58.0** °F
Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	587.4	-	-	17.3

5. Equipment Data

Terminal Cooling Units - Air-Cooled DX

Zone	Estimated Maximum Load (MBH)	Design OAT (°F)	Equipment Sizing	Gross Cooling Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor + OD Fan Power (kW)	ARI Performance Rating	Units	Conventional Cutoff OAT (°F)
1	16.8	95.0	Auto-Sized	16.8	0	-	Auto-Calculated (9.105)	EER	0.0

*Auto-Calculated = Calculated per ASHRAE 90.1 Minimum Equipment Efficiency.

Terminal Heating Units - ASHP

Zone	Estimated Maximum Load (MBH)	Design OAT (°F)	Equipment Sizing	Gross Heating Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor + OD Fan Power (kW)	ARI Performance Rating	Units	Cutoff OAT (°F)
1	0.3	47.0	Auto-Sized	0.3	0	-	3.200	COP	-15.0

Auxiliary Heating Type .... **Electric Resistance**
Auxiliary Heating Upper Cutoff .... **40.0** °F

1. General Details:

Air System Name	**PTAC Mech/elec rooms**
Equipment Type	**Terminal Units**
Air System Type	**Packaged DX Fan Coil**
Number of zones	**1**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Elec 1011 base	x1
Elec 2003 base	x1
Elec 3003 base	x1
Mech 1010 base	x1
Mech 2006 base	x1
Mech 3006 base	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F

Thermostat Schedule	**90.1 Office Thermostat(2)**
Unoccupied Cooling is	**Not Available**

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Electric Resistance**	
Schedule	**JFMAMJJASOND**	

Fan Control	**Cycled**
Ventilation Sizing Method	**Sum of Space OA Airflows**

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow	Zone Htg Unit	Reheat Coil	Ventilation

	(CFM)	(MBH)	(MBH)	(CFM)
1	451.6	-	-	60.2

5. Equipment Data

No equipment data required for this system.

Air System Information

Air System Name	Heating Only Spaces	Number of zones	1	
Equipment Class	TERM	Floor Area	4272.0	ft^2
Air System Type	PKG-FC	Location	Minot IAP, North Dakota	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Air System Information

Air System Name ..... **Heating Only Spaces**
Equipment Class ..... **TERM**
Air System Type ..... **PKG-FC**

Number of zones **1**
Floor Area ..... **4272.0** ft²
Location ..... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone CFM Sizing ..... **Sum of space airflow rates**
Space CFM Sizing ..... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	22.2	1712	1577	Jul 1500	40.0	4272.0	0.40

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	60.7	54.2 / 95.0	-	1712	0.000	0.000	286

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
east stair tower(1)	1	0.3	Jul 1500	490	12.4	136.0	3.61
first fl center stair	1	0.3	Jul 1500	48	1.2	171.0	0.28
first fl cordridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
second fl center stair	1	0.3	Jul 1500	28	0.7	171.0	0.17
second fl cordridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
second fl SW corner	1	1.3	Aug 1400	130	3.3	252.0	0.52
third fl center stair	1	0.8	Jul 1400	60	1.5	189.0	0.32
third fl cordridor	1	6.4	Jul 1400	226	5.7	1042.0	0.22
first fl Mail Lobby	1	0.5	Jul 1500	103	2.6	91.0	1.14
west stair tower(1)	1	0.8	Jul 1700	490	12.4	136.0	3.61

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	135 ft²	-	-	135 ft²	-	-
Wall Transmission	2423 ft²	-	-	2423 ft²	9575	-
Roof Transmission	1821 ft²	-	-	1821 ft²	7685	-
Window Transmission	135 ft²	-	-	135 ft²	6512	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	42 ft²	-	-	42 ft²	2578	-
Floor Transmission	1576 ft²	-	-	1576 ft²	2085	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	11568	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**40004**	**0**
Zone Conditioning	-	-	-	-	39261	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	245 CFM	21476	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**60737**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	60737	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**60737**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	135 ft²	3594	-	135 ft²	-	-
Wall Transmission	2423 ft²	-1136	-	2423 ft²	9575	-
Roof Transmission	1821 ft²	634	-	1821 ft²	7685	-
Window Transmission	135 ft²	-1099	-	135 ft²	6512	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	42 ft²	-435	-	42 ft²	2578	-
Floor Transmission	1576 ft²	0	-	1576 ft²	2085	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3204 W	10932	-	0	0	-
Task Lighting	201 W	686	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	6	1470	1230	0	0	0
Infiltration	-	-1411	5979	-	11568	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**22235**	**13209**	**-**	**40004**	**0**

Air System Information

Air System Name	**PTAC**	Number of zones	**3**
Equipment Class	**TERM**	Floor Area	**20976.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **PTAC**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **3**
Floor Area .... **20976.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	59.8	4151	4151	Aug 1500	103.2	6302.0	0.66
Zone 2	60.6	3246	3246	Aug 1500	69.3	7337.0	0.44
Zone 3	68.7	3681	3681	Jul 1600	87.4	7337.0	0.50

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	65.9	65.9	80.6 / 67.2	65.0 / 62.2	-	Aug 1500
Zone 2	68.9	66.5	81.5 / 66.8	61.3 / 59.9	-	Aug 1500
Zone 3	75.8	73.4	81.1 / 66.7	61.5 / 60.1	-	Aug 1600

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	147.0	56.1 / 91.0	-	4151	0.614	0.487	543
Zone 2	120.1	51.1 / 87.6	-	3246	0.480	0.381	620
Zone 3	135.4	52.8 / 89.1	-	3681	0.544	0.432	620

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
1st fl N DAY RM base	1	5.5	Jul 1500	271	6.7	348.0	0.78
1st fl NE corner base	9	2.3	Jul 1600	198	5.4	252.0	0.79
1st fl NW corner base	1	2.1	Jul 1900	198	5.4	252.0	0.79
1st fl S RM base	10	2.4	Sep 1500	117	2.7	273.0	0.43
1st fl SE corner base	1	2.7	Aug 1500	198	5.4	252.0	0.79
1st fl SW corner base	1	2.5	Aug 1500	198	5.4	252.0	0.79
Mail 1009 base	1	1.2	Jul 1500	148	4.1	119.0	1.24
Office 1005 base	1	3.6	Jan 2300	178	0.0	81.0	2.20
Zone 2							
2nd fl N DAY Rm base	1	4.9	Jul 1500	241	4.0	323.0	0.75
2nd fl N RM base	9	1.8	Jul 1600	91	2.1	273.0	0.33
2nd fl NE corner base	1	2.3	Jul 1600	165	4.5	252.0	0.66
2nd fl NW corner base	1	2.1	Jul 1900	165	4.5	252.0	0.66
2nd fl S RM base	13	2.4	Sep 1500	117	2.1	273.0	0.43
2nd fl SE corner base	1	2.7	Aug 1500	165	4.5	252.0	0.66

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
2nd fl SW corner base	1	2.5	Aug 1500	165	4.5	252.0	0.66
Zone 3							
3rd fl N DAY RM base	1	5.3	Jul 1600	262	4.8	323.0	0.81
3rd fl N RM base	9	2.2	Jul 1800	109	2.8	273.0	0.40
3rd fl NE corner base	1	2.6	Jul 1700	188	5.2	252.0	0.75
3rd fl NW corner base	1	2.4	Jul 1800	188	5.2	252.0	0.75
3rd fl S RM base	13	2.6	Aug 1600	130	2.8	273.0	0.47
3rd fl SE corner base	1	3.0	Aug 1600	188	5.2	252.0	0.75
3rd fl SW corner base	1	2.8	Aug 1600	188	5.2	252.0	0.75

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	1320 ft²	30417	-	1320 ft²	-	-
Wall Transmission	12398 ft²	11943	-	12398 ft²	102003	-
Roof Transmission	7337 ft²	7377	-	7337 ft²	18068	-
Window Transmission	1320 ft²	5226	-	1320 ft²	62218	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6302 ft²	0	-	6302 ft²	17972	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	23161 W	79024	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	5214 W	17791	-	0	0	-
People	105	25725	21525	0	0	0
Infiltration	-	7865	-5482	-	59645	0
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**188366**	**18043**	**-**	**259906**	**0**
Zone Conditioning	-	181778	18043	-	254152	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	0 CFM	0	-	0 CFM	0	-
Ventilation Load	1784 CFM	18508	-13943	1784 CFM	152829	0
Ventilation Fan Load	0 CFM	0	-	0 CFM	0	-
Space Fan Coil Fans	-	4435	-	-	-4435	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**204721**	**4100**	**-**	**402547**	**0**
Terminal Unit Cooling	-	204721	4111	-	0	0
Terminal Unit Heating	-	0	-	-	402547	-
>> Total Conditioning	**-**	**204721**	**4111**	**-**	**402547**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone Design Load Summary for PTAC

Project Name: Building 276 Reno-Minot AFB LEED 24Feb16 | 02/25/2016
Prepared by: SEENI | 02:17PM

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	450 ft²	9351	-	450 ft²	-	-
Wall Transmission	4938 ft²	5448	-	4938 ft²	40627	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	450 ft²	1781	-	450 ft²	21211	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6302 ft²	0	-	6302 ft²	17972	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	6955 W	23730	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1546 W	5274	-	0	0	-
People	33	8085	6765	0	0	0
Infiltration	-	3089	-2478	-	23427	0
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**59758**	**6287**	**-**	**103236**	**0**

Zone 2	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	435 ft²	10533	-	435 ft²	-	-
Wall Transmission	3730 ft²	3248	-	3730 ft²	30688	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	435 ft²	1722	-	435 ft²	20504	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	8103 W	27647	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2388	-1406	-	18109	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**60616**	**5974**	**-**	**69301**	**0**

Zone 3	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1600 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	435 ft²	8540	-	435 ft²	-	-
Wall Transmission	3730 ft²	3838	-	3730 ft²	30688	-
Roof Transmission	7337 ft²	9654	-	7337 ft²	18068	-
Window Transmission	435 ft²	1675	-	435 ft²	20504	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	8103 W	27647	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2243	-1696	-	18109	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**68674**	**5684**	**-**	**87369**	**0**

Air System Information

Air System Name	**PTAC Comm Rooms**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**288.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name	**PTAC Comm Rooms**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**288.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	10.1	587	587	Jul 1800	0.2	288.0	2.04

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	16.8	10.9	76.3 / 66.6	58.0 / 57.1	-	Jul 0500

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	0.3	67.4 / 95.0	-	587	0.000	0.000	17

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Comm 1003 base	1	3.3	Jan 2300	192	0.0	90.0	2.13
Comm 2002 base	1	3.3	Jan 2200	193	0.0	99.0	1.95
Comm 3002 base	1	3.5	Jul 1800	202	0.2	99.0	2.04

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 0500 COOLING OA DB / WB 66.4 °F / 60.1 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	25	-	99 ft²	249	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	288 W	983	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**10008**	**6000**	**-**	**249**	**0**
Zone Conditioning	-	11116	6000	-	249	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	0 CFM	0	-	0 CFM	0	-
Ventilation Load	17 CFM	-180	-181	0 CFM	26	0
Ventilation Fan Load	0 CFM	0	-	0 CFM	0	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**10936**	**5819**	**-**	**275**	**0**
Terminal Unit Cooling	-	10936	5846	-	0	0
Terminal Unit Heating	-	0	-	-	275	-
>> Total Conditioning	**-**	**10936**	**5846**	**-**	**275**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1800 COOLING OA DB / WB 84.5 °F / 66.0 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 75.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	150	-	99 ft²	249	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	288 W	983	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**10132**	**6000**	**-**	**249**	**0**

Air System Information

Air System Name	**PTAC Mech/elec rooms**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**1003.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Zone Sizing Summary for PTAC Mech/elec rooms

Project Name: Building 276 Reno-Minot AFB LEED 24Feb16 02/25/2016
Prepared by: SEENI 02:17PM

Air System Information

Air System Name ..... **PTAC Mech/elec rooms**
Equipment Class ..... **TERM**
Air System Type ..... **PKG-FC**

Number of zones **1**
Floor Area ..... **1003.0** ft²
Location ..... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone CFM Sizing ..... **Sum of space airflow rates**
Space CFM Sizing ..... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	4.3	452	452	Jul 1700	11.5	1003.0	0.45

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	16.2	57.1 / 95.0	-	452	0.000	0.000	60

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Elec 1011 base	1	0.6	Aug 1900	80	2.0	130.0	0.61
Elec 2003 base	1	0.2	Jul 1600	39	1.0	80.0	0.48
Elec 3003 base	1	0.3	Jul 1700	47	1.2	80.0	0.58
Mech 1010 base	1	1.2	Sep 1500	106	2.7	169.0	0.62
Mech 2006 base	1	1.0	Jul 1600	77	2.0	272.0	0.28
Mech 3006 base	1	1.3	Jul 1800	104	2.6	272.0	0.38

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	15 ft²	-	-	15 ft²	-	-
Wall Transmission	689 ft²	-	-	689 ft²	5801	-
Roof Transmission	352 ft²	-	-	352 ft²	887	-
Window Transmission	15 ft²	-	-	15 ft²	724	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	0 ft²	-	-	0 ft²	0	-
Floor Transmission	299 ft²	-	-	299 ft²	911	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	3132	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**11455**	**0**
Zone Conditioning	-	-	-	-	11258	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	56 CFM	4907	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**16165**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	16165	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**16165**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1700 COOLING OA DB / WB 87.0 °F / 66.8 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	15 ft²	369	-	15 ft²	-	-
Wall Transmission	689 ft²	-878	-	689 ft²	5801	-
Roof Transmission	352 ft²	271	-	352 ft²	887	-
Window Transmission	15 ft²	-131	-	15 ft²	724	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	299 ft²	0	-	299 ft²	911	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	1505 W	5133	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	-464	1619	-	3132	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**4300**	**1619**	**-**	**11455**	**0**

1. General Details:

Building Name ..... **FAN COIL building**

2. Plants Included in this Building:

Plant Name
FAN COIL CHILLED WATER PLANT
hot water plant
Service Hot Water

3. Air Systems Included in this Building:

System Name	Mult.
FAN COIL w HW HEAT	1

4: Miscellaneous Energy

(no items defined)

5: Meters

Electric ..... **Base utilities electric rate**
Natural Gas ..... **Base natural gas rate**

6: Miscellaneous Data

Average Building Power Factor ..... **100.00 %**
Source Electric Generating Efficiency ..... **28.00 %**
Additional Floor Area ..... **0.0 ft²**

1. General Details:

Air System Name	**FAN COIL w HW HEAT**
Equipment Type	**Terminal Units**
Air System Type	**4-Pipe Fan Coil**
Number of zones	**3**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
first fl NE corner	x1
first fl North DAY RM	x1
first fl North RM	x1
first fl North RM(1)	x1
first fl NW corner	x1
first fl SE corner	x1
first fl SW corner	x1
first fl South RM(10)	x1
first fl South RM(2)	x1
first fl South RM(3)	x1
first fl South RM(4)	x1
first fl South RM(5)	x1
first fl South RM(6)	x1
first fl South RM(7)	x1
first fl South RM(8)	x1
first fl South RM(9)	x1
first fl North RM(2)	x1
first fl North RM(3)	x1
first fl North RM(4)	x1
first fl North RM(5)	x1
first fl North RM(6)	x1
first fl North RM(7)	x1
first fl North RM(8)	x1
first fl North RM(9)	x1
Zone 2: Zone 2	
second fl NE corner	x1
second fl North DAY RM	x1
second fl North RM	x1
second fl North RM(1)	x1
second fl NW corner	x1
second fl SE corner	x1
second fl South RM	x1
second fl SW corner	x1
second fl North RM(2)	x1
second fl North RM(3)	x1
second fl North RM(4)	x1
second fl North RM(5)	x1
second fl North RM(6)	x1
second fl North RM(7)	x1
second fl North RM(8)	x1
second fl North RM(9)	x1
second fl South RM(1)	x1
second fl South RM(10)	x1
second fl South RM(11)	x1
second fl South RM(12)	x1
second fl South RM(13)	x1
second fl South RM(2)	x1

second fl South RM(3)	x1
second fl South RM(4)	x1
second fl South RM(5)	x1
second fl South RM(6)	x1
second fl South RM(7)	x1
second fl South RM(8)	x1
second fl South RM(9)	x1
Zone 3: Zone 3	
third fl NE corner	x1
third fl North DAY RM	x1
third fl North RM	x1
third fl NW corner	x1
third fl SE corner	x1
third fl South RM	x1
third fl SW corner	x1
third fl North RM(1)	x1
third fl North RM(2)	x1
third fl North RM(3)	x1
third fl North RM(4)	x1
third fl North RM(5)	x1
third fl North RM(6)	x1
third fl North RM(7)	x1
third fl North RM(8)	x1
third fl North RM(9)	x1
third fl South RM(11)	x1
third fl South RM(12)	x1
third fl South RM(13)	x1
third fl South RM(1)	x1
third fl South RM(10)	x1
third fl South RM(2)	x1
third fl South RM(3)	x1
third fl South RM(4)	x1
third fl South RM(5)	x1
third fl South RM(6)	x1
third fl South RM(7)	x1
third fl South RM(8)	x1
third fl South RM(9)	x1

Thermostats and Zone Data:

Zone	Cooling T-Stat Occ. (°F)	Cooling T-Stat Unocc. (°F)	Heating T-Stat Occ. (°F)	Heating T-Stat Unocc. (°F)	T-Stat Throttling Range (°F)
1	75.0	80.0	70.0	65.0	1.50
2	75.0	80.0	70.0	65.0	1.50
3	75.0	80.0	70.0	65.0	1.50

Thermostat Schedule .... **90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is .... **Not Available**

Common Terminal Unit Data:

Cooling Coil:

Design Supply Temperature .... **58.0** °F
Coil Bypass Factor **0.100**
Cooling Source .... **Chilled Water**
Schedule .... **JFMAMJJASOND**

Heating Coil:

Design Supply Temperature .... **95.0** °F
Heating Source .... **Hot Water**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Fan On**

Ventilation Sizing Method .... **Sum of Space OA Airflows**

Terminal Units Data:

Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.06** CFM/person
Fan Performance .... **0.50** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **58.0** °F
Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	2954.2	-	-	557.6
2	3367.1	-	-	663.0
3	4092.5	-	-	663.0

5. Equipment Data

Changeover Controller:

Used .... **Yes**
Trigger .... **OAT Threshold**
Threshold Value .... **57.2** °F
Deadband .... **7.0** °F
Minimum Cycle Time .... **4** hours

1. General Details:

Air System Name	**Heating Only Spaces**
Equipment Type	**Terminal Units**
Air System Type	**2-Pipe Fan Coil**
Number of zones	**1**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
east stair tower	x1
first fl center stair	x1
first fl cordridor	x1
first fl Mail Lobby	x1
second fl center stair	x1
second fl cordridor	x1
west stair tower	x1
third fl center stair	x1
third fl cordridor	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F

Thermostat Schedule	**90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is	**Available**

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Hot Water**	
Schedule	**JFMAMJJASOND**	

Fan Control	**Fan On**
Ventilation Sizing Method	**Sum of Space OA Airflows**

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	1581.9	-	-	266.2

5. Equipment Data

No equipment data required for this system.

Air System Information

Air System Name	**FAN COIL w HW HEAT**	Number of zones	**3**
Equipment Class	**TERM**	Floor Area	**22309.0** ft²
Air System Type	**4P-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name	FAN COIL w HW HEAT	Number of zones	3
Equipment Class	TERM	Floor Area	22309.0 ft²
Air System Type	4P-FC	Location	Minot IAP, North Dakota

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	46.1	2954	2954	Aug 1500	66.9	6543.0	0.45
Zone 2	55.7	3367	3367	Aug 1500	57.7	7883.0	0.43
Zone 3	67.0	4093	4093	Aug 1400	90.9	7883.0	0.52

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	55.6	55.4	76.5 / 63.2	58.0 / 56.7	11.12	Oct 1500
Zone 2	66.7	63.7	79.1 / 65.7	60.5 / 59.2	13.34	Aug 1500
Zone 3	77.9	74.8	78.6 / 65.6	60.6 / 59.3	15.59	Jul 1500

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	113.5	52.8 / 90.7	11.35	2954	0.437	0.347	558
Zone 2	114.7	52.4 / 86.0	11.48	3367	0.498	0.395	663
Zone 3	145.5	55.2 / 90.2	14.56	4093	0.605	0.480	663

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
first fl NE corner	1	1.8	Jul 1500	166	4.2	252.0	0.66
first fl North DAY RM	1	5.1	Jul 1500	297	6.2	348.0	0.85
first fl North RM	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(1)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl NW corner	1	1.8	Jul 1500	166	4.2	252.0	0.66
first fl SE corner	1	2.2	Aug 1500	166	4.2	252.0	0.66
first fl SW corner	1	2.2	Aug 1400	166	4.2	252.0	0.66
first fl South RM(10)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(2)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(3)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(4)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(5)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(6)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(7)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl South RM(8)	1	2.1	Sep 1400	120	2.3	273.0	0.44

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
first fl South RM(9)	1	2.1	Sep 1400	120	2.3	273.0	0.44
first fl North RM(2)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(3)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(4)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(5)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(6)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(7)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(8)	1	1.6	Jul 1500	91	2.3	273.0	0.33
first fl North RM(9)	1	1.6	Jul 1500	91	2.3	273.0	0.33
Zone 2							
second fl NE corner	1	1.8	Jul 1500	130	3.3	252.0	0.52
second fl North DAY RM	1	4.5	Jul 1500	261	3.5	323.0	0.81
second fl North RM	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(1)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl NW corner	1	1.8	Jul 1500	130	3.3	252.0	0.52
second fl SE corner	1	2.2	Aug 1500	130	3.3	252.0	0.52
second fl South RM	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl SW corner	1	2.2	Aug 1400	130	3.3	252.0	0.52
second fl North RM(2)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(3)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(4)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(5)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(6)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(7)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(8)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl North RM(9)	1	1.6	Jul 1500	90	1.7	273.0	0.33
second fl South RM(1)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(10)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(11)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(12)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(13)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(2)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(3)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(4)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(5)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(6)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(7)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(8)	1	2.1	Sep 1400	120	1.7	273.0	0.44
second fl South RM(9)	1	2.1	Sep 1400	120	1.7	273.0	0.44
Zone 3							
third fl NE corner	1	2.2	Jul 1500	172	4.4	252.0	0.68
third fl North DAY RM	1	5.0	Jul 1500	290	4.9	323.0	0.90
third fl North RM	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl NW corner	1	2.2	Jul 1500	172	4.4	252.0	0.68
third fl SE corner	1	2.6	Aug 1400	172	4.4	252.0	0.68
third fl South RM	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl SW corner	1	2.6	Aug 1400	172	4.4	252.0	0.68
third fl North RM(1)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(2)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(3)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(4)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(5)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(6)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(7)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(8)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl North RM(9)	1	2.0	Jul 1500	115	2.9	273.0	0.42
third fl South RM(11)	1	2.4	Aug 1400	140	2.9	273.0	0.51

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
third fl South RM(12)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(13)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(1)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(10)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(2)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(3)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(4)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(5)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(6)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(7)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(8)	1	2.4	Aug 1400	140	2.9	273.0	0.51
third fl South RM(9)	1	2.4	Aug 1400	140	2.9	273.0	0.51

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	1350 ft²	27682	-	1350 ft²	-	-
Wall Transmission	11316 ft²	6916	-	11316 ft²	44716	-
Roof Transmission	7883 ft²	12231	-	7883 ft²	33269	-
Window Transmission	1350 ft²	7572	-	1350 ft²	65117	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6543 ft²	0	-	6543 ft²	16060	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	16732 W	57088	-	0	0	-
Task Lighting	5577 W	19029	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	109	26705	22345	0	0	0
Infiltration	-	9189	-4279	-	56356	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**166411**	**18066**	**-**	**215519**	**0**
Zone Conditioning	-	158330	18066	-	212397	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	0 CFM	0	-	0 CFM	0	-
Ventilation Load	1884 CFM	25101	-12691	1884 CFM	165478	0
Ventilation Fan Load	0 CFM	0	-	0 CFM	0	-
Space Fan Coil Fans	-	4169	-	-	-4169	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**187600**	**5375**	**-**	**373706**	**0**
Terminal Unit Cooling	-	187600	5413	-	0	0
Terminal Unit Heating	-	0	-	-	373706	-
>> Total Conditioning	**-**	**187600**	**5413**	**-**	**373706**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 75.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	420 ft²	8640	-	420 ft²	-	-
Wall Transmission	3420 ft²	1945	-	3420 ft²	13514	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	420 ft²	2356	-	420 ft²	20259	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6543 ft²	0	-	6543 ft²	16060	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	4907 W	16743	-	0	0	-
Task Lighting	1636 W	5581	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	33	8085	6765	0	0	0
Infiltration	-	2786	-1658	-	17086	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**46136**	**5107**	**-**	**66919**	**0**

Zone 2	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 75.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	465 ft²	11244	-	465 ft²	-	-
Wall Transmission	3948 ft²	2396	-	3948 ft²	15601	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	465 ft²	2608	-	465 ft²	22429	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	5912 W	20172	-	0	0	-
Task Lighting	1971 W	6724	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	38	9310	7790	0	0	0
Infiltration	-	3202	-1218	-	19635	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**55656**	**6572**	**-**	**57665**	**0**

Zone 3	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1400 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 75.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	465 ft²	11575	-	465 ft²	-	-
Wall Transmission	3948 ft²	2369	-	3948 ft²	15601	-
Roof Transmission	7883 ft²	11366	-	7883 ft²	33269	-
Window Transmission	465 ft²	2419	-	465 ft²	22429	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	5912 W	20172	-	0	0	-
Task Lighting	1971 W	6724	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	38	9310	7790	0	0	0
Infiltration	-	3048	-1412	-	19635	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**66983**	**6378**	**-**	**90935**	**0**

Air System Information

Air System Name	Heating Only Spaces	Number of zones	1
Equipment Class	TERM	Floor Area	4020.0 ft²
Air System Type	2P-FC	Location	Minot IAP, North Dakota

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Air System Information

Air System Name .... **Heating Only Spaces**
Equipment Class .... **TERM**
Air System Type **2P-FC**

Number of zones **1**
Floor Area .... **4020.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	21.1	1582	1447	Jul 1500	36.7	4020.0	0.39

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	63.1	54.1 / 93.5	6.32	1582	0.000	0.000	266

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
east stair tower	1	0.3	Jul 1500	490	12.4	136.0	3.61
first fl center stair	1	0.3	Jul 1500	48	1.2	171.0	0.28
first fl cordridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
first fl Mail Lobby	1	0.5	Jul 1500	103	2.6	91.0	1.14
second fl center stair	1	0.3	Jul 1500	28	0.7	171.0	0.17
second fl cordridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
west stair tower	1	0.8	Jul 1700	490	12.4	136.0	3.61
third fl center stair	1	0.8	Jul 1400	60	1.5	189.0	0.32
third fl cordridor	1	6.4	Jul 1400	226	5.7	1042.0	0.22

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	120 ft²	-	-	120 ft²	-	-
Wall Transmission	2124 ft²	-	-	2124 ft²	8393	-
Roof Transmission	1821 ft²	-	-	1821 ft²	7685	-
Window Transmission	120 ft²	-	-	120 ft²	5788	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	42 ft²	-	-	42 ft²	2578	-
Floor Transmission	1576 ft²	-	-	1576 ft²	2085	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	10171	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**36701**	**0**
Zone Conditioning	-	-	-	-	36403	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	266 CFM	23330	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**59733**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	63130	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**63130**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	120 ft²	3137	-	120 ft²	-	-
Wall Transmission	2124 ft²	-1034	-	2124 ft²	8393	-
Roof Transmission	1821 ft²	634	-	1821 ft²	7685	-
Window Transmission	120 ft²	-977	-	120 ft²	5788	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	42 ft²	-435	-	42 ft²	2578	-
Floor Transmission	1576 ft²	0	-	1576 ft²	2085	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3015 W	10287	-	0	0	-
Task Lighting	138 W	471	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	5	1225	1025	0	0	0
Infiltration	-	-1241	-2110	-	10171	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**21067**	**4915**	**-**	**36701**	**0**

Minot GSHP building Input Data

1. General Details:

Building Name .... **Minot GSHP building**

2. Plants Included in this Building:

Plant Name
Service hot water plant

3. Air Systems Included in this Building:

System Name	Mult.
GSHP Space Loads	1
GSHP Vestibule	1
GSHP Comm Rooms	1
GSHP Mech/elec room zones	1
GSHP Stair towers zones	1

4: Miscellaneous Energy

Name	Process Load	Energy/Fuel Type	Peak Use	Schedule
ERV 1 SUPPLY FAN	No	Electric	1.9 kW	90.1 Hotel/Motel Occupancy
ERV 1 EXHAUST FAN	No	Electric	1.0 kW	90.1 Hotel/Motel Occupancy
Exterior lighting	No	Electric	0.5 kW	90.1 Hotel/Motel Lgt/Elec

5: Meters

Electric .... **Base utilities electric rate**
Natural Gas .... **Base natural gas rate**

6: Miscellaneous Data

Average Building Power Factor .... **100.00 %**
Source Electric Generating Efficiency .... **28.00 %**
Additional Floor Area .... **0.0 ft²**

1. General Details:

Air System Name	**GSHP Comm Rooms**
Equipment Type	**Terminal Units**
Air System Type	**Ground Source Heat Pump**
Number of zones	**1**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Comm 1003	x1
Comm 2002	x1
Comm 3002	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**75.0**	°F
Cooling T-stat: Unocc.	**80.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F
Thermostat Schedule	**90.1 Office Thermostat(2)**	
Unoccupied Cooling is	**Available**	

Common Terminal Unit Data:

Cooling Coil:

Design Supply Temperature	**58.0**	°F
Coil Bypass Factor	**0.100**	
Cooling Source	**Water-Cooled DX**	
Schedule	**JFMAMJJASOND**	

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Water Source Heat Pump**	
Schedule	**JFMAMJJASOND**	
Fan Control	**Fan On**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature	**58.0**	°F
Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	555.2	-	-	17.3

5. Equipment Data

Terminal Cooling Units - WSHP

Zone	Estimated Maximum Load (MBH)	Design EWT (°F)	Equipment Sizing	Gross Cooling Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor Power (kW)	ISO / ARI Performance Rating	Units
1	16.2	80.0	Auto-Sized	16.2	0	-	14.900	EER

Terminal Heating Units - WSHP

Zone	Estimated Maximum Load (MBH)	Design EWT (°F)	Equipment Sizing	Gross Heating Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor Power (kW)	ISO / ARI Performance Rating	Units
1	1.8	32.0	Auto-Sized	1.8	0	-	3.200	COP

Misc. Components - GSHP

Souce Water .... **vertical bore well field**
Auxiliary Heat .... **Electric Resistance**

Pump Data:

Circulation Pump Performance .... **19.0** W/gpm
Circulation Pump Mechanical Efficiency .... **80.0** %
Circulation Pump Motor Electrical Efficiency .... **94.0** %

1. General Details:

Air System Name .... **GSHP Mech/elec room zones**
Equipment Type .... **Terminal Units**
Air System Type .... **Packaged DX Fan Coil**
Number of zones **1**
Ventilation .... **Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Elec 1011	x1
Elec 2003	x1
Mech 1010	x1
Mech 2006	x1
Mech 3006	x1
Elec 3003	x1

Thermostats and Zone Data:

Zone .... **All**
Cooling T-stat: Occ. .... **100.0** °F
Cooling T-stat: Unocc. .... **100.0** °F
Heating T-stat: Occ. .... **50.0** °F
Heating T-stat: Unocc. .... **50.0** °F
T-stat Throttling Range .... **1.50** °F

Thermostat Schedule .... **90.1 Office Thermostat(2)**
Unoccupied Cooling is .... **Not Available**

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature .... **95.0** °F
Heating Source .... **Electric Resistance**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Cycled**
Ventilation Sizing Method .... **Sum of Space OA Airflows**

Terminal Units Data:

Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.00** CFM/person
Fan Performance .... **0.00** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow	Zone Htg Unit	Reheat Coil	Ventilation

	(CFM)	(MBH)	(MBH)	(CFM)
1	135.1	-	-	60.2

5. Equipment Data

No equipment data required for this system.

1. General Details:

Air System Name	**GSHP Space Loads**	
Equipment Type	**Terminal Units**	
Air System Type	**Ground Source Heat Pump**	
Number of zones	**3**	
Ventilation	**Common Ventilation System**	

2. Ventilation System Components:

Ventilation Air Data:

Airflow Control	**Constant Ventilation Airflow**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	
Unocc. Damper Position	**Closed**	
Damper Leak Rate	**0**	%
Outdoor Air CO2 Level	**400**	ppm

Ventilation Reclaim Data:

Reclaim Type	**Sensible and Latent Heat**	
Thermal Efficiency	**65**	%
Input kW	**0.800**	kW
Schedule	**JFMAMJJASOND**	

Cooling Coil Data:

Setpoint	**75.0**	°F
Coil Bypass Factor	**0.100**	
Cooling Source	**Air-Cooled DX**	
Schedule	**JFMAMJJASOND**	

Heating Coil Data:

Setpoint	**70.0**	°F
Heating Source	**Electric Resistance**	
Schedule	**JFMAMJJASOND**	

Humidification Data:

Minimum RH Setpoint	**30**	%
Humidifier Type	**Self-Contained Steam - Electric**	
Input Power	**0.000**	kWh/lb

Ventilation Fan Data:

Fan Type	**Forward Curved**	
Configuration	**Draw-thru**	
Fan Performance	**1.70**	in wg
Overall Efficiency	**54**	%

% Airflow	100	90	80	70	60	50
% kW	100	91	81	72	61	54

% Airflow	40	30	20	10	0
% kW	46	40	33	27	21

Duct System Data:

Return Duct or Plenum Data:

Return Air Via	**Ducted Return**

Exhaust Fan Data:

Fan Type	**Forward Curved**	
Fan Performance	**0.90**	in wg
Overall Efficiency	**54**	%

% Airflow	100	90	80	70	60	50
% kW	100	91	81	72	61	54

% Airflow	40	30	20	10	0
% kW	46	40	33	27	21

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	

1st fl NE corner	x1
1st fl N DAY RM	x1
1st fl N RM	x9
1st fl NW corner	x1
1st fl SE corner	x1
1st fl S RM	x10
1st fl SW corner	x1
Office 1005	x1
Mail 1009	x1
Zone 2: Zone 2	
2nd fl NE corner	x1
2nd fl N DAY Rm	x1
2nd fl N RM	x9
2nd fl NW corner	x1
2nd fl SE corner	x1
2nd fl SW corner	x1
2nd fl S RM	x13
Zone 3: Zone 3	
3rd fl NE corner	x1
3rd fl N DAY RM	x1
3rd fl NW corner	x1
3rd fl SE corner	x1
3rd fl S RM	x13
3rd fl SW corner	x1
3rd fl N RM	x9

Thermostats and Zone Data:

Zone .... **All**
Cooling T-stat: Occ. .... **78.0** °F
Cooling T-stat: Unocc. .... **80.0** °F
Heating T-stat: Occ. .... **68.0** °F
Heating T-stat: Unocc. .... **55.0** °F
T-stat Throttling Range .... **1.50** °F

Thermostat Schedule .... **90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is .... **Available**

Common Terminal Unit Data:

Cooling Coil:

Design Supply Temperature .... **58.0** °F
Coil Bypass Factor **0.100**
Cooling Source .... **Water-Cooled DX**
Schedule .... **JFMAMJJASOND**

Heating Coil:

Design Supply Temperature .... **95.0** °F
Heating Source .... **Water Source Heat Pump**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Fan On**

Terminal Units Data:

Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.00** CFM/person
Fan Performance .... **0.00** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (User-Modified):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **58.0** °F
Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F

Hot Water Delta-T .... **20.0** °F

Safety Factors:
Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **15** %

Zone Sizing Data:
Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	3090.4	-	-	642.1
2	2660.2	-	-	687.7
3	3329.9	-	-	687.7

5. Equipment Data

Vent. Cooling Unit - Air-Cooled DX
Estimated Maximum Load .... **31.8** MBH
Design OAT .... **95.0** °F
Equipment Sizing .... **(Auto-Sized) 31.8** MBH
Capacity Oversizing Factor .... **0** %
ARI Performance Rating .... **11.000** EER
Conventional Cutoff OAT .... **55.0** °F
Low Temperature Operation .... **Used**
Low Temperature Cutoff OAT .... **0.0** °F

Terminal Cooling Units - WSHP

Zone	Estimated Maximum Load (MBH)	Design EWT (°F)	Equipment Sizing	Gross Cooling Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor Power (kW)	ISO / ARI Performance Rating	Units
1	38.4	77.0	User-Defined	55.3	-	-	14.900	EER
2	39.4	77.0	User-Defined	55.3	-	-	14.900	EER
3	48.6	77.0	User-Defined	55.3	-	-	14.900	EER

Terminal Heating Units - WSHP

Zone	Estimated Maximum Load (MBH)	Design EWT (°F)	Equipment Sizing	Gross Heating Capacity (MBH)	Capacity Oversizing Factor (%)	Compressor Power (kW)	ISO / ARI Performance Rating	Units
1	68.9	32.0	Auto-Sized	68.9	0	-	3.200	COP
2	49.5	32.0	Auto-Sized	49.5	0	-	3.200	COP
3	68.8	32.0	Auto-Sized	68.8	0	-	3.200	COP

Misc. Components - GSHP
Souce Water .... **spaces vertical bore well field**
Auxiliary Heat .... **Electric Resistance**

Pump Data:
Circulation Pump Performance .... **19.0** W/gpm
Circulation Pump Mechanical Efficiency .... **80.0** %
Circulation Pump Motor Electrical Efficiency .... **94.0** %

1. General Details:

Air System Name	**GSHP Stair towers zones**
Equipment Type	**Terminal Units**
Air System Type	**Packaged DX Fan Coil**
Number of zones	**1**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
east stair tower	x1
west stair tower	x1
1st fl ctr stair	x1
2nd fl ctr stair	x1
3rd fl ctr stair	x1
1st fl corridor	x1
2nd fl corridor	x1
3rd fl corridor	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F
Thermostat Schedule	**90.1 Hotel/Motel Thermostat**	
Unoccupied Cooling is	**Not Available**	

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Electric Resistance**	
Schedule	**JFMAMJJASOND**	
Fan Control	**Cycled**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	1269.6	-	-	255.7

5. Equipment Data

No equipment data required for this system.

1. General Details:
Air System Name .... **GSHP Vestibule**
Equipment Type .... **Terminal Units**
Air System Type .... **Packaged DX Fan Coil**
Number of zones **1**
Ventilation .... **Direct Ventilation**

2. Ventilation System Components:
(Common Ventilation System not used: no inputs)

3. Zone Components:
Space Assignments:

Zone 1: Zone 1	
Vestibule 1000	x1

Thermostats and Zone Data:
Zone .... **All**
Cooling T-stat: Occ. .... **100.0** °F
Cooling T-stat: Unocc. .... **100.0** °F
Heating T-stat: Occ. .... **70.0** °F
Heating T-stat: Unocc. .... **65.0** °F
T-stat Throttling Range .... **1.50** °F

Thermostat Schedule .... **90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is .... **Not Available**

Common Terminal Unit Data:
Heating Coil:
Design Supply Temperature .... **95.0** °F
Heating Source .... **Electric Resistance**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Cycled**
Ventilation Sizing Method .... **Sum of Space OA Airflows**

Terminal Units Data:
Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.00** CFM/person
Fan Performance .... **0.00** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):
System Sizing Data:
Sizing Data:
Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:
Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:
Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:
Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	171.2	-	-	6.7

5. Equipment Data

No equipment data required for this system.

Air System Information

Air System Name	**GSHP Comm Rooms**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**288.0** ft²
Air System Type	**GSHP**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **GSHP Comm Rooms**
Equipment Class .... **TERM**
Air System Type .... **GSHP**

Number of zones **1**
Floor Area .... **288.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	9.6	555	555	Jul 1800	0.2	288.0	1.93

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	16.2	10.4	76.4 / 66.8	58.0 / 57.2	-	Jul 0500

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	1.8	67.0 / 70.1	-	555	0.000	0.000	17

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Comm 1003	1	3.1	Jan 2200	182	0.0	90.0	2.03
Comm 2002	1	3.1	Jan 2200	182	0.0	99.0	1.84
Comm 3002	1	3.3	Jul 1800	191	0.2	99.0	1.93

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 0500 COOLING OA DB / WB 66.4 °F / 60.1 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	25	-	99 ft²	249	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	125 W	428	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**9453**	**6000**	**-**	**249**	**0**
Zone Conditioning	-	10550	6000	-	237	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	0 CFM	0	-	0 CFM	0	-
Ventilation Load	17 CFM	-181	-192	17 CFM	1533	0
Ventilation Fan Load	0 CFM	0	-	0 CFM	0	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**10369**	**5808**	**-**	**1770**	**0**
Terminal Unit Cooling	-	10369	5836	-	0	0
Terminal Unit Heating	-	0	-	-	1770	-
>> Total Conditioning	**-**	**10369**	**5836**	**-**	**1770**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1800 COOLING OA DB / WB 84.5 °F / 66.0 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 75.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	150	-	99 ft²	249	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	125 W	428	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**9578**	**6000**	**-**	**249**	**0**

Air System Information

Air System Name	**GSHP Mech/elec room zones**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**1003.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **GSHP Mech/elec room zones**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **1003.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	1.6	135	135	Aug 1500	6.2	1003.0	0.13

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	9.8	19.1 / 95.0	-	135	0.000	0.000	60

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Elec 1011	1	0.0	Aug 1500	25	1.1	130.0	0.19
Elec 2003	1	0.0	Jul 1500	11	0.5	80.0	0.13
Mech 1010	1	0.8	Sep 1400	33	1.5	169.0	0.19
Mech 2006	1	0.2	Jul 1500	22	1.0	272.0	0.08
Mech 3006	1	0.5	Jul 1500	32	1.4	272.0	0.12
Elec 3003	1	0.1	Jul 1500	14	0.6	80.0	0.17

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	15 ft²	-	-	15 ft²	-	-
Wall Transmission	689 ft²	-	-	689 ft²	2102	-
Roof Transmission	352 ft²	-	-	352 ft²	592	-
Window Transmission	15 ft²	-	-	15 ft²	355	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	0 ft²	-	-	0 ft²	0	-
Floor Transmission	299 ft²	-	-	299 ft²	703	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	2418	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**6170**	**0**
Zone Conditioning	-	-	-	-	6009	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	57 CFM	3822	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**9831**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	9831	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**9831**	**0**
Key:	**Positive values are clg loads** **Negative values are htg loads**			**Positive values are htg loads** **Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 50.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	15 ft²	575	-	15 ft²	-	-
Wall Transmission	689 ft²	-470	-	689 ft²	2102	-
Roof Transmission	352 ft²	335	-	352 ft²	592	-
Window Transmission	15 ft²	-78	-	15 ft²	355	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	299 ft²	0	-	299 ft²	703	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	468 W	1596	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	-382	1619	-	2418	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**1577**	**1619**	**-**	**6170**	**0**

Air System Information

Air System Name	GSHP Space Loads		Number of zones	3	
Equipment Class	TERM		Floor Area	21417.0	ft²
Air System Type	GSHP		Location	Minot IAP, North Dakota	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	User-Modified	Space CFM Sizing	Individual peak space loads

Cooling Coil Sizing Data

Total coil load	2.7	Tons	Load occurs at	Jul 1500	
Total coil load	31.8	MBH	OA DB / WB	89.3 / 67.5	°F
Sensible coil load	31.8	MBH	Entering DB / WB	89.3 / 67.5	°F
Coil CFM at Jul 1500	2018	CFM	Leaving DB / WB	73.8 / 62.6	°F
Max coil CFM	2018	CFM	Bypass Factor	0.100	
Sensible heat ratio	1.000				
Water flow @ 10.0 °F rise	N/A				

Heating Coil Sizing Data

Max coil load	63.4	MBH	Load occurs at	Des Htg	
Coil CFM at Des Htg	2018	CFM	Ent. DB / Lvg DB	37.8 / 68.8	°F
Max coil CFM	2018	CFM			
Water flow @ 20.0 °F drop	N/A				

Humidifier Sizing Data

Max steam flow at Des Htg	20.55	lb/hr	Air mass flow	8530.05	lb/hr
Airflow Rate	2018	CFM	Moisture gain	.00241	lb/lb

Ventilation Fan Sizing Data

Actual max CFM	2018	CFM	Fan motor BHP	0.94	BHP
Standard CFM	1896	CFM	Fan motor kW	0.75	kW
Actual max CFM/ft²	0.09	CFM/ft²	Fan static	1.70	in wg

Exhaust Fan Sizing Data

Actual max CFM	2018	CFM	Fan motor BHP	0.50	BHP
Standard CFM	1896	CFM	Fan motor kW	0.39	kW
Actual max CFM/ft²	0.09	CFM/ft²	Fan static	0.90	in wg

Outdoor Ventilation Air Data

Design airflow CFM	2018	CFM	CFM/person	19.03	CFM/person
CFM/ft²	0.09	CFM/ft²			

Air System Information

Air System Name ..... **GSHP Space Loads**
Equipment Class ..... **TERM**
Air System Type ..... **GSHP**

Number of zones **3**
Floor Area ..... **21417.0** ft²
Location ..... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months ..... **Jan to Dec**
Sizing Data ..... **User-Modified**

Zone CFM Sizing ..... **Sum of space airflow rates**
Space CFM Sizing ..... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	42.9	3090	3090	Aug 1500	70.2	6743.0	0.46
Zone 2	42.9	2660	2660	Aug 1400	52.4	7337.0	0.36
Zone 3	54.2	3330	3330	Jul 1500	70.4	7337.0	0.45

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	38.4	38.4	78.0 / 66.2	65.8 / 62.2	-	Aug 1300
Zone 2	39.4	39.4	77.9 / 66.0	63.3 / 61.3	-	Aug 1400
Zone 3	48.6	48.6	78.1 / 66.2	63.7 / 61.6	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	68.9	67.6 / 89.6	-	3090	0.000	0.000	642
Zone 2	49.5	67.8 / 86.1	-	2660	0.000	0.000	688
Zone 3	68.8	67.6 / 88.0	-	3330	0.000	0.000	688

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
1st fl NE corner	1	1.4	Jul 1500	162	4.4	252.0	0.64
1st fl N DAY RM	1	4.8	Jul 1500	239	5.4	348.0	0.69
1st fl N RM	9	1.2	Jul 1500	84	2.3	273.0	0.31
1st fl NW corner	1	1.4	Jul 1500	162	4.4	252.0	0.64
1st fl SE corner	1	1.9	Aug 1400	162	4.4	252.0	0.64
1st fl S RM	10	1.8	Sep 1400	87	2.3	273.0	0.32
1st fl SW corner	1	1.9	Aug 1400	162	4.4	252.0	0.64
Office 1005	1	3.4	Jan 2300	170	0.0	81.0	2.10
Mail 1009	1	1.0	Jul 1500	118	3.2	119.0	0.99
Zone 2							
2nd fl NE corner	1	1.4	Jul 1500	125	3.4	252.0	0.49
2nd fl N DAY Rm	1	4.0	Jul 1500	198	3.1	323.0	0.61
2nd fl N RM	9	1.2	Jul 1500	61	1.6	273.0	0.22
2nd fl NW corner	1	1.4	Jul 1500	125	3.4	252.0	0.49
2nd fl SE corner	1	1.9	Aug 1400	125	3.4	252.0	0.49

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
2nd fl SW corner	1	1.9	Aug 1400	125	3.4	252.0	0.49
2nd fl S RM	13	1.8	Sep 1400	87	1.6	273.0	0.32
Zone 3							
3rd fl NE corner	1	1.9	Jul 1500	147	4.0	252.0	0.58
3rd fl N DAY RM	1	4.9	Jul 1500	239	3.9	323.0	0.74
3rd fl NW corner	1	1.8	Jul 1500	147	4.0	252.0	0.58
3rd fl SE corner	1	2.2	Aug 1500	147	4.0	252.0	0.58
3rd fl S RM	13	2.1	Aug 1400	104	2.3	273.0	0.38
3rd fl SW corner	1	2.2	Aug 1400	147	4.0	252.0	0.58
3rd fl N RM	9	1.7	Jul 1500	84	2.3	273.0	0.31

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1400 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	1335 ft²	31413	-	1335 ft²	-	-
Wall Transmission	10987 ft²	5034	-	10987 ft²	42426	-
Roof Transmission	7337 ft²	10865	-	7337 ft²	15618	-
Window Transmission	1335 ft²	3017	-	1335 ft²	40043	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6743 ft²	0	-	6743 ft²	16090	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	10488 W	35783	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	5325 W	18167	-	0	0	-
People	106	25970	21730	0	0	0
Infiltration	-	6635	-5565	-	53575	9547
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	15%	25163	1432
>> Total Zone Loads	**-**	**139883**	**18165**	**-**	**192916**	**10978**
Zone Conditioning	-	133652	18165	-	193353	10978
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Exhaust Fan Load	2018 CFM	1346	-	2018 CFM	-1346	-
Ventilation Load	2018 CFM	18474	-18239	2018 CFM	61148	10692
Ventilation Fan Load	2018 CFM	2543	-	2018 CFM	-2543	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**156015**	**-73**	**-**	**250612**	**21670**
Cooling Coil	-	30411	0	-	0	0
Heating Coil	-	0	-	-	63437	-
Terminal Unit Cooling	-	125604	0	-	0	0
Terminal Unit Heating	-	0	-	-	187175	-
Humidification Load	-	-	0	-	-	21674
>> Total Conditioning	**-**	**156015**	**0**	**-**	**250612**	**21674**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	465 ft²	9487	-	465 ft²	-	-
Wall Transmission	3527 ft²	1559	-	3527 ft²	13619	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	465 ft²	1171	-	465 ft²	13948	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6743 ft²	0	-	6743 ft²	16090	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3357 W	11453	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1656 W	5650	-	0	0	-
People	34	8330	6970	0	0	0
Infiltration	-	2289	-1812	-	17357	3095
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	15%	9152	464
>> Total Zone Loads	**-**	**42939**	**7158**	**-**	**70166**	**3559**

Zone 2	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1400 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	435 ft²	10843	-	435 ft²	-	-
Wall Transmission	3730 ft²	1748	-	3730 ft²	14403	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	435 ft²	983	-	435 ft²	13048	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3522 W	12016	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2243	-1883	-	18109	3226
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	15%	6834	484
>> Total Zone Loads	**-**	**42912**	**5497**	**-**	**52394**	**3709**

Zone 3	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	435 ft²	9248	-	435 ft²	-	-
Wall Transmission	3730 ft²	1812	-	3730 ft²	14403	-
Roof Transmission	7337 ft²	12283	-	7337 ft²	15618	-
Window Transmission	435 ft²	1096	-	435 ft²	13048	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3609 W	12314	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2388	-1915	-	18109	3226
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	15%	9177	484
>> Total Zone Loads	**-**	**54219**	**5465**	**-**	**70355**	**3710**

Air System Information

Air System Name	GSHP Stair towers zones	Number of zones	1
Equipment Class	TERM	Floor Area	3929.0 ft²
Air System Type	PKG-FC	Location	Minot IAP, North Dakota

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Air System Information

Air System Name .... **GSHP Stair towers zones**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **3929.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	21.9	1270	1135	Jul 1600	28.8	3929.0	0.32

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	46.8	51.2 / 95.0	-	1270	0.000	0.000	256

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
east stair tower	1	0.8	Jul 1500	448	11.4	136.0	3.30
west stair tower	1	1.3	Jul 1700	448	11.4	136.0	3.30
1st fl ctr stair	1	0.1	Jul 1500	48	1.2	171.0	0.28
2nd fl ctr stair	1	0.1	Jul 1500	28	0.7	171.0	0.17
3rd fl ctr stair	1	0.6	Jul 1500	45	1.1	189.0	0.24
1st fl corridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
2nd fl corridor	1	5.9	Jan 2300	68	0.0	1042.0	0.06
3rd fl corridor	1	7.4	Jul 1500	117	3.0	1042.0	0.11

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	90 ft²	-	-	90 ft²	-	-
Wall Transmission	2040 ft²	-	-	2040 ft²	8061	-
Roof Transmission	1821 ft²	-	-	1821 ft²	3967	-
Window Transmission	90 ft²	-	-	90 ft²	2763	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	42 ft²	-	-	42 ft²	2578	-
Floor Transmission	1485 ft²	-	-	1485 ft²	1748	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	9664	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**28781**	**0**
Zone Conditioning	-	-	-	-	28198	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	212 CFM	18580	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**46778**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	46778	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**46778**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1600 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	90 ft²	3029	-	90 ft²	-	-
Wall Transmission	2040 ft²	-951	-	2040 ft²	8061	-
Roof Transmission	1821 ft²	1932	-	1821 ft²	3967	-
Window Transmission	90 ft²	-472	-	90 ft²	2763	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	42 ft²	-441	-	42 ft²	2578	-
Floor Transmission	1485 ft²	0	-	1485 ft²	1748	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	2957 W	10088	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	4	980	820	0	0	0
Infiltration	-	-1255	4995	-	9664	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**21910**	**11815**	**-**	**28781**	**0**

Air System Information

Air System Name	**GSHP Vestibule**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**112.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **GSHP Vestibule**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **112.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	0.0	171	171	Des Htg	4.3	112.0	1.53

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	4.8	65.2 / 95.0	-	171	0.000	0.000	7

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Vestibule 1000	1	0.0	Jan 0000	171	4.3	112.0	1.53

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	19 ft²	-	-	19 ft²	75	-
Roof Transmission	0 ft²	-	-	0 ft²	0	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	48 ft²	-	-	48 ft²	3578	-
Floor Transmission	112 ft²	-	-	112 ft²	393	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	298	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**4344**	**0**
Zone Conditioning	-	-	-	-	4281	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	6 CFM	549	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**4830**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	4830	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**4830**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	19 ft²	-	-	19 ft²	75	-
Roof Transmission	0 ft²	-	-	0 ft²	0	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	48 ft²	-	-	48 ft²	3578	-
Floor Transmission	112 ft²	-	-	112 ft²	393	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	298	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**4344**	**0**

1. General Details:

Building Name .... **baseline building**

2. Plants Included in this Building:

Plant Name
Baseline hot water plant
Service hot water plant

3. Air Systems Included in this Building:

System Name	Mult.
Base VAV HW reheat space loads	1
Base Comm Rooms vav	1
Base Mech/elec room zones vav	1
Base Stair towers zones vav	1
Base Vestibule vav	1

4: Miscellaneous Energy

Name	Process Load	Energy/Fuel Type	Peak Use	Schedule
Exterior lighting	No	Electric	0.5 kW	90.1 Hotel/Motel Lgt/Elec

5: Meters

Electric .... **Base utilities electric rate**
Natural Gas .... **Base natural gas rate**

6: Miscellaneous Data

Average Building Power Factor .... **100.00 %**
Source Electric Generating Efficiency .... **28.00 %**
Additional Floor Area .... **0.0 ft²**

1. General Details:

Air System Name	**Comm Rooms vav**	
Equipment Type	**Packaged Rooftop Units**	
Air System Type	**VAV**	
Number of zones	**1**	

2. Ventilation System Components:

Ventilation Air Data:

Airflow Control	**Constant Ventilation Airflow**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	
Unocc. Damper Position	**Closed**	
Damper Leak Rate	**0**	%
Outdoor Air CO2 Level	**400**	ppm

Economizer Data:

Control	**Integrated enthalpy control**	
Upper Cutoff	**75.0**	°F
Lower Cutoff	**-60.0**	°F

Central Cooling Data:

Supply Air Temperature	**55.0**	°F
Coil Bypass Factor	**0.100**	
Cooling Source	**Air-Cooled DX**	
Schedule	**JFMAMJJASOND**	
Capacity Control	**Constant Temperature - Fan On**	

Supply Fan Data:

Fan Type	**ASHRAE 90.1 App G Fan Curve**	
Configuration	**Draw-thru**	
Fan Performance	**1.00**	in wg
Overall Efficiency	**54**	%

% Airflow	100	90	80	70	60	50
% kW	100	83	68	54	41	30

% Airflow	40	30	20	10	0
% kW	21	13	7	3	0

Duct System Data:

Supply Duct Data:

Duct Heat Gain	**0**	%
Duct Leakage	**0**	%

Return Duct or Plenum Data:

Return Air Via	**Ducted Return**

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Comm 1003 base	x1
Comm 2002 base	x1
Comm 3002 base	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**78.0**	°F
Cooling T-stat: Unocc.	**80.0**	°F
Heating T-stat: Occ.	**68.0**	°F
Heating T-stat: Unocc.	**55.0**	°F
T-stat Throttling Range	**1.50**	°F
Diversity Factor	**100**	%
Direct Exhaust Airflow	**0.0**	CFM
Direct Exhaust Fan kW	**0.0**	kW

Thermostat Schedule	**90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is	**Available**

Supply Terminals Data:

Zone	**All**

Terminal Type .... **VAV box with RH**
Minimum Airflow .... **0.40** CFM/ft²

Reheat Coil Source .... **Hot Water**
Reheat Coil Schedule .... **JFMAMJJASOND**

Zone Heating Units:
Zone .... **All**
Zone Heating Unit Type .... **None**

Zone Unit Heat Source .... **Hot Water**
Zone Heating Unit Schedule .... **JFMAMJJASOND**

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **55.0** °F
Supply Fan Airflow .... **433.8** CFM
Ventilation Airflow .... **17.3** CFM

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Peak zone sensible load**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	- (CFM)
1	433.8	-	1.8	

5. Equipment Data

Central Cooling Unit - Air-Cooled DX

Estimated Maximum Load .... **16.4** MBH
Design OAT .... **95.0** °F
Equipment Sizing .... **(Auto-Sized) 16.4** MBH
Capacity Oversizing Factor .... **0** %
ASHRAE 90.1 Minimum Equipment Efficiency .... **(Auto-Calculated) 13.000** SEER
Conventional Cutoff OAT .... **55.0** °F
Low Temperature Operation .... **Used**
Low Temperature Cutoff OAT .... **0.0** °F

1. General Details:

Air System Name .... **Mech/elec room zones vav**
Equipment Type .... **Terminal Units**
Air System Type .... **Packaged DX Fan Coil**
Number of zones **1**
Ventilation .... **Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Elec 1011 base	x1
Elec 2003 base	x1
Elec 3003 base	x1
Mech 1010 base	x1
Mech 2006 base	x1
Mech 3006 base	x1

Thermostats and Zone Data:

Zone .... **All**
Cooling T-stat: Occ. .... **100.0** °F
Cooling T-stat: Unocc. .... **100.0** °F
Heating T-stat: Occ. .... **50.0** °F
Heating T-stat: Unocc. .... **50.0** °F
T-stat Throttling Range .... **1.50** °F

Thermostat Schedule .... **90.1 Office Thermostat(2)**
Unoccupied Cooling is .... **Not Available**

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature .... **95.0** °F
Heating Source .... **Hot Water**
Schedule .... **JFMAMJJASOND**

Fan Control .... **Cycled**
Ventilation Sizing Method .... **Sum of Space OA Airflows**

Terminal Units Data:

Zone .... **All**
Terminal Type .... **Fan Coil**
Minimum Airflow .... **0.00** CFM/person
Fan Performance .... **0.00** in wg
Fan Overall Efficiency .... **50** %

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature .... **95.0** °F

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Sum of space airflow rates**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow	Zone Htg Unit	Reheat Coil	Ventilation

	(CFM)	(MBH)	(MBH)	(CFM)
1	193.7	-	-	60.2

5. Equipment Data

No equipment data required for this system.

1. General Details:

Air System Name	**Stair towers zones vav**
Equipment Type	**Terminal Units**
Air System Type	**Packaged DX Fan Coil**
Number of zones	**1**
Ventilation	**Direct Ventilation**

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
east stair tower base	x1
west stair tower base	x1
1st fl ctr stair base	x1
2nd fl ctr stair base	x1
3rd fl ctr stair base	x1
1st fl corridor base	x1
2nd fl corridor base	x1
3rd fl corridor base	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F

Thermostat Schedule	**90.1 Office Thermostat(2)**
Unoccupied Cooling is	**Not Available**

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Hot Water**	
Schedule	**JFMAMJJASOND**	

Fan Control	**Cycled**
Ventilation Sizing Method	**Sum of Space OA Airflows**

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	1648.1	-	-	188.2

5. Equipment Data

No equipment data required for this system.

1. General Details:

Air System Name .... **VAV HW reheat space loads**
Equipment Type .... **Packaged Rooftop Units**
Air System Type .... **VAV**
Number of zones **3**

2. Ventilation System Components:

Ventilation Air Data:

Airflow Control .... **Constant Ventilation Airflow**
Ventilation Sizing Method .... **Sum of Space OA Airflows**
Unocc. Damper Position .... **Closed**
Damper Leak Rate .... **0** %
Outdoor Air CO2 Level .... **400** ppm

Economizer Data:

Control .... **Integrated enthalpy control**
Upper Cutoff .... **75.0** °F
Lower Cutoff .... **-60.0** °F

Central Cooling Data:

Supply Air Temperature .... **55.0** °F
Coil Bypass Factor **0.100**
Cooling Source .... **Air-Cooled DX**
Schedule .... **JFMAMJJASOND**
Capacity Control .... **Constant Temperature - Fan On**

Supply Fan Data:

Fan Type .... **ASHRAE 90.1 App G Fan Curve**
Configuration .... **Draw-thru**
Fan Performance .... **1.00** in wg
Overall Efficiency .... **54** %

% Airflow	100	90	80	70	60	50
% kW	100	83	68	54	41	30

% Airflow	40	30	20	10	0
% kW	21	13	7	3	0

Duct System Data:

Supply Duct Data:

Duct Heat Gain .... **0** %
Duct Leakage .... **0** %

Return Duct or Plenum Data:

Return Air Via .... **Ducted Return**

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
1st fl N DAY RM base	x1
1st fl N RM base	x9
1st fl NE corner base	x1
1st fl NW corner base	x1
1st fl S RM base	x10
1st fl SE corner base	x1
1st fl SW corner base	x1
Mail 1009 base	x1
Office 1005 base	x1
Zone 2: Zone 2	
2nd fl N DAY Rm base	x1
2nd fl N RM base	x9
2nd fl NE corner base	x1
2nd fl NW corner base	x1
2nd fl S RM base	x13
2nd fl SE corner base	x1
2nd fl SW corner base	x1

Zone 3: Zone 3	
3rd fl N DAY RM base	x1
3rd fl N RM base	x9
3rd fl NE corner base	x1
3rd fl NW corner base	x1
3rd fl S RM base	x13
3rd fl SE corner base	x1
3rd fl SW corner base	x1

Thermostats and Zone Data:

Zone .... **All**
Cooling T-stat: Occ. .... **78.0** °F
Cooling T-stat: Unocc. .... **80.0** °F
Heating T-stat: Occ. .... **68.0** °F
Heating T-stat: Unocc. .... **55.0** °F
T-stat Throttling Range .... **1.50** °F
Diversity Factor .... **100** %
Direct Exhaust Airflow .... **0.0** CFM
Direct Exhaust Fan kW .... **0.0** kW

Thermostat Schedule .... **90.1 Hotel/Motel Thermostat**
Unoccupied Cooling is .... **Available**

Supply Terminals Data:

Zone .... **All**
Terminal Type .... **VAV box with RH**
Minimum Airflow .... **0.40** CFM/ft²

Reheat Coil Source .... **Hot Water**
Reheat Coil Schedule .... **JFMAMJJASOND**

Zone Heating Units:

Zone .... **All**
Zone Heating Unit Type .... **None**

Zone Unit Heat Source .... **Hot Water**
Zone Heating Unit Schedule .... **JFMAMJJASOND**

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Cooling Supply Temperature .... **55.0** °F
Supply Fan Airflow .... **8574.6** CFM
Ventilation Airflow .... **1815.0** CFM

Hydronic Sizing Specifications:

Chilled Water Delta-T .... **10.0** °F
Hot Water Delta-T .... **20.0** °F

Safety Factors:

Cooling Sensible .... **0** %
Cooling Latent .... **0** %
Heating .... **0** %

Zone Sizing Data:

Zone Airflow Sizing Method .... **Peak zone sensible load**
Space Airflow Sizing Method .... **Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	- -
1	2697.2	-	120.0	-
2	2934.8	-	108.0	
3	2942.6	-	126.1	

5. Equipment Data

Central Cooling Unit - Air-Cooled DX

Estimated Maximum Load		**242.8**	MBH
Design OAT		**95.0**	°F
Equipment Sizing	**(Auto-Sized)**	**242.8**	MBH
Capacity Oversizing Factor		**0**	%
ASHRAE 90.1 Minimum Equipment Efficiency	**(Auto-Calculated)**	**10.000**	EER
Conventional Cutoff OAT		**55.0**	°F
Low Temperature Operation		**Used**	
Low Temperature Cutoff OAT		**0.0**	°F

1. General Details:

Air System Name	**Vestibule vav**	
Equipment Type	**Terminal Units**	
Air System Type	**Packaged DX Fan Coil**	
Number of zones	**1**	
Ventilation	**Direct Ventilation**	

2. Ventilation System Components:

(Common Ventilation System not used: no inputs)

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
Vestibule 1000 base	x1

Thermostats and Zone Data:

Zone	**All**	
Cooling T-stat: Occ.	**100.0**	°F
Cooling T-stat: Unocc.	**100.0**	°F
Heating T-stat: Occ.	**70.0**	°F
Heating T-stat: Unocc.	**65.0**	°F
T-stat Throttling Range	**1.50**	°F
Thermostat Schedule	**90.1 Hotel/Motel Thermostat**	
Unoccupied Cooling is	**Not Available**	

Common Terminal Unit Data:

Heating Coil:

Design Supply Temperature	**95.0**	°F
Heating Source	**Hot Water**	
Schedule	**JFMAMJJASOND**	
Fan Control	**Cycled**	
Ventilation Sizing Method	**Sum of Space OA Airflows**	

Terminal Units Data:

Zone	**All**	
Terminal Type	**Fan Coil**	
Minimum Airflow	**0.00**	CFM/person
Fan Performance	**0.00**	in wg
Fan Overall Efficiency	**50**	%
Reheat Coil Source	**Any**	
Reheat Coil Schedule	**JFMAMJJASOND**	

4. Sizing Data (Computer-Generated):

System Sizing Data:

Sizing Data:

Heating Supply Temperature	**95.0**	°F

Hydronic Sizing Specifications:

Chilled Water Delta-T	**10.0**	°F
Hot Water Delta-T	**20.0**	°F

Safety Factors:

Cooling Sensible	**0**	%
Cooling Latent	**0**	%
Heating	**0**	%

Zone Sizing Data:

Zone Airflow Sizing Method	**Sum of space airflow rates**
Space Airflow Sizing Method	**Individual peak space loads**

Zone	Supply Airflow (CFM)	Zone Htg Unit (MBH)	Reheat Coil (MBH)	Ventilation (CFM)
1	174.6	-	0.0	6.7

5. Equipment Data

No equipment data required for this system.

Air System Information

Air System Name	Comm Rooms vav		Number of zones	1	
Equipment Class	PKG ROOF		Floor Area	288.0	ft²
Air System Type	VAV		Location	Minot IAP, North Dakota	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Peak zone sensible load
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Central Cooling Coil Sizing Data

Total coil load	1.4	Tons	Load occurs at	Jul 1600	
Total coil load	16.4	MBH	OA DB / WB	88.6 / 67.3	°F
Sensible coil load	10.6	MBH	Entering DB / WB	79.8 / 67.0	°F
Coil CFM at Jul 1600	409	CFM	Leaving DB / WB	54.3 / 53.3	°F
Max block CFM at Jul 1800	434	CFM	Coil ADP	51.5	°F
Sum of peak zone CFM	434	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.643		Resulting RH	54	%
ft²/Ton	210.6		Design supply temp.	55.0	°F
BTU/(hr-ft²)	57.0		Zone T-stat Check	1 of 1	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	0.0	°F

Supply Fan Sizing Data

Actual max CFM at Jul 1800	434	CFM	Fan motor BHP	0.12	BHP
Standard CFM	408	CFM	Fan motor kW	0.09	kW
Actual max CFM/ft²	1.51	CFM/ft²	Fan static	1.00	in wg

Outdoor Ventilation Air Data

Design airflow CFM	17	CFM	CFM/person	0.00	CFM/person
CFM/ft²	0.06	CFM/ft²			

Air System Information

Air System Name .... **Comm Rooms vav**
Equipment Class .... **PKG ROOF**
Air System Type .... **VAV**

Number of zones **1**
Floor Area .... **288.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Peak zone sensible load**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	10.1	434	115	Jul 1800	0.2	288.0	1.51

Zone Terminal Sizing Data

Zone Name	Reheat Coil Load (MBH)	Reheat Coil Water gpm @ 20.0 °F	Zone Htg Coil Load (MBH)	Zone Htg Water gpm @ 20.0 °F	Mixing Box Fan Airflow (CFM)
Zone 1	1.8	0.18	0.0	0.00	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Comm 1003 base	1	3.3	Jan 2300	142	0.0	90.0	1.57
Comm 2002 base	1	3.3	Jan 2200	143	0.0	99.0	1.44
Comm 3002 base	1	3.5	Jul 1800	149	0.2	99.0	1.51

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1600 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	130	-	99 ft²	244	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	288 W	983	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**10113**	**6000**	**-**	**244**	**0**
Zone Conditioning	-	10103	6000	-	226	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	409 CFM	0	-	115 CFM	0	-
Ventilation Load	17 CFM	162	-147	17 CFM	1478	0
Supply Fan Load	409 CFM	290	-	115 CFM	-35	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**10555**	**5853**	**-**	**1669**	**0**
Central Cooling Coil	-	10555	5854	-	0	0
Terminal Reheat Coils	-	0	-	-	1664	-
>> Total Conditioning	**-**	**10555**	**5854**	**-**	**1664**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1800 COOLING OA DB / WB 84.5 °F / 66.0 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	0 ft²	0	-	0 ft²	0	-
Roof Transmission	99 ft²	141	-	99 ft²	244	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	81 ft²	0	-	81 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	288 W	983	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**10124**	**6000**	**-**	**244**	**0**

Air System Information

Air System Name	**Mech/elec room zones vav**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**1003.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **Mech/elec room zones vav**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **1003.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	4.3	194	194	Jul 1700	8.8	1003.0	0.19

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	12.5	28.0 / 95.0	1.25	194	0.000	0.000	60

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Elec 1011 base	1	0.6	Aug 1900	34	1.6	130.0	0.26
Elec 2003 base	1	0.2	Jul 1600	17	0.8	80.0	0.21
Elec 3003 base	1	0.3	Jul 1700	20	0.9	80.0	0.25
Mech 1010 base	1	1.2	Sep 1500	45	2.1	169.0	0.27
Mech 2006 base	1	1.0	Jul 1600	33	1.5	272.0	0.12
Mech 3006 base	1	1.3	Jul 1800	45	2.0	272.0	0.16

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	15 ft²	-	-	15 ft²	-	-
Wall Transmission	689 ft²	-	-	689 ft²	4478	-
Roof Transmission	352 ft²	-	-	352 ft²	685	-
Window Transmission	15 ft²	-	-	15 ft²	559	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	0 ft²	-	-	0 ft²	0	-
Floor Transmission	299 ft²	-	-	299 ft²	703	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	2418	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**8842**	**0**
Zone Conditioning	-	-	-	-	8636	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	57 CFM	3832	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**12468**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	12468	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**12468**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1700 COOLING OA DB / WB 87.0 °F / 66.8 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 50.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	15 ft²	369	-	15 ft²	-	-
Wall Transmission	689 ft²	-878	-	689 ft²	4478	-
Roof Transmission	352 ft²	271	-	352 ft²	685	-
Window Transmission	15 ft²	-131	-	15 ft²	559	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	299 ft²	0	-	299 ft²	703	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	1505 W	5133	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	-464	1619	-	2418	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**4300**	**1619**	**-**	**8842**	**0**

Air System Information

Air System Name	Stair towers zones vav	Number of zones	1
Equipment Class	TERM	Floor Area	3929.0 ft²
Air System Type	PKG-FC	Location	Minot IAP, North Dakota

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Zone Sizing Summary for Stair towers zones vav

Project Name: Building 276 Reno-Minot AFB RTU VAV1 02/25/2016
Prepared by: SEENI 02:43PM

Air System Information

Air System Name .... **Stair towers zones vav**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **3929.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	19.1	1648	1581	Jul 1700	40.1	3929.0	0.42

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	54.1	58.8 / 95.0	5.41	1648	0.000	0.000	188

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
east stair tower base	1	0.0	Jan 0000	638	16.2	136.0	4.69
west stair tower base	1	0.2	Jul 1800	638	16.2	136.0	4.69
1st fl ctr stair base	1	0.2	Jul 1600	63	1.6	171.0	0.37
2nd fl ctr stair base	1	0.2	Jul 1600	44	1.1	171.0	0.26
3rd fl ctr stair base	1	0.6	Jul 1800	62	1.6	189.0	0.33
1st fl corridor base	1	5.0	Jan 2300	0	0.0	1042.0	0.00
2nd fl corridor base	1	5.0	Jan 2300	68	0.0	1042.0	0.06
3rd fl corridor base	1	8.2	Jul 1800	135	3.4	1042.0	0.13

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	90 ft²	-	-	90 ft²	-	-
Wall Transmission	2040 ft²	-	-	2040 ft²	17176	-
Roof Transmission	1821 ft²	-	-	1821 ft²	4589	-
Window Transmission	90 ft²	-	-	90 ft²	4341	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	42 ft²	-	-	42 ft²	2578	-
Floor Transmission	1485 ft²	-	-	1485 ft²	1748	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	9664	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**40096**	**0**
Zone Conditioning	-	-	-	-	39365	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	168 CFM	14703	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**54068**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	54068	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**54068**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1700 COOLING OA DB / WB 87.0 °F / 66.8 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	90 ft²	3158	-	90 ft²	-	-
Wall Transmission	2040 ft²	-1849	-	2040 ft²	17176	-
Roof Transmission	1821 ft²	1400	-	1821 ft²	4589	-
Window Transmission	90 ft²	-785	-	90 ft²	4341	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	42 ft²	-466	-	42 ft²	2578	-
Floor Transmission	1485 ft²	0	-	1485 ft²	1748	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	2670 W	9110	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	4	980	820	0	0	0
Infiltration	-	-1431	4995	-	9664	0
Miscellaneous	-	9000	6000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**19117**	**11815**	**-**	**40096**	**0**

Air System Information

Air System Name	VAV HW reheat space loads		Number of zones	3	
Equipment Class	PKG ROOF		Floor Area	21417.0	ft²
Air System Type	VAV		Location	Minot IAP, North Dakota	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Peak zone sensible load
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Central Cooling Coil Sizing Data

Total coil load	20.2	Tons	Load occurs at	Aug 1500	
Total coil load	242.8	MBH	OA DB / WB	89.3 / 67.5	°F
Sensible coil load	209.0	MBH	Entering DB / WB	78.3 / 63.1	°F
Coil CFM at Aug 1500	8567	CFM	Leaving DB / WB	54.3 / 52.9	°F
Max block CFM at Jul 1600	8575	CFM	Coil ADP	51.6	°F
Sum of peak zone CFM	8575	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.861		Resulting RH	47	%
ft²/Ton	1058.7		Design supply temp.	55.0	°F
BTU/(hr-ft²)	11.3		Zone T-stat Check	3 of 3	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	0.0	°F

Supply Fan Sizing Data

Actual max CFM at Jul 1600	8575	CFM	Fan motor BHP	2.35	BHP
Standard CFM	8056	CFM	Fan motor kW	1.86	kW
Actual max CFM/ft²	0.40	CFM/ft²	Fan static	1.00	in wg

Outdoor Ventilation Air Data

Design airflow CFM	1815	CFM	CFM/person	17.12	CFM/person
CFM/ft²	0.08	CFM/ft²			

Air System Information

Air System Name .... **VAV HW reheat space loads**
Equipment Class .... **PKG ROOF**
Air System Type .... **VAV**

Number of zones **3**
Floor Area .... **21417.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Peak zone sensible load**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	58.8	2697	2697	Aug 1500	84.4	6743.0	0.40
Zone 2	60.6	2935	2935	Aug 1500	69.3	7337.0	0.40
Zone 3	68.7	2943	2935	Jul 1600	87.4	7337.0	0.40

Zone Terminal Sizing Data

Zone Name	Reheat Coil Load (MBH)	Reheat Coil Water gpm @ 20.0 °F	Zone Htg Coil Load (MBH)	Zone Htg Water gpm @ 20.0 °F	Mixing Box Fan Airflow (CFM)
Zone 1	120.0	12.00	0.0	0.00	0
Zone 2	108.0	10.81	0.0	0.00	0
Zone 3	126.1	12.61	0.0	0.00	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
1st fl N DAY RM base	1	5.5	Jul 1500	246	6.7	348.0	0.71
1st fl N RM base	9	1.8	Jul 1600	109	2.7	273.0	0.40
1st fl NE corner base	1	2.3	Jul 1600	101	5.4	252.0	0.40
1st fl NW corner base	1	2.1	Jul 1900	101	5.4	252.0	0.40
1st fl S RM base	10	2.4	Sep 1500	109	2.7	273.0	0.40
1st fl SE corner base	1	2.7	Aug 1500	120	5.4	252.0	0.48
1st fl SW corner base	1	2.5	Aug 1500	112	5.4	252.0	0.44
Mail 1009 base	1	1.2	Jul 1500	55	4.1	119.0	0.46
Office 1005 base	1	3.6	Jan 2300	162	0.0	81.0	2.00
Zone 2							
2nd fl N DAY Rm base	1	4.9	Jul 1500	232	4.0	323.0	0.72
2nd fl N RM base	9	1.8	Jul 1600	109	2.1	273.0	0.40
2nd fl NE corner base	1	2.3	Jul 1600	107	4.5	252.0	0.42
2nd fl NW corner base	1	2.1	Jul 1900	101	4.5	252.0	0.40
2nd fl S RM base	13	2.4	Sep 1500	113	2.1	273.0	0.41
2nd fl SE corner base	1	2.7	Aug 1500	127	4.5	252.0	0.50
2nd fl SW corner base	1	2.5	Aug 1500	119	4.5	252.0	0.47
Zone 3							
3rd fl N DAY RM base	1	5.3	Jul 1600	227	4.8	323.0	0.70
3rd fl N RM base	9	2.2	Jul 1800	109	2.8	273.0	0.40
3rd fl NE corner base	1	2.6	Jul 1700	111	5.2	252.0	0.44
3rd fl NW corner base	1	2.4	Jul 1800	103	5.2	252.0	0.41
3rd fl S RM base	13	2.6	Aug 1600	113	2.8	273.0	0.41
3rd fl SE corner base	1	3.0	Aug 1600	126	5.2	252.0	0.50
3rd fl SW corner base	1	2.8	Aug 1600	118	5.2	252.0	0.47

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	1335 ft²	30553	-	1335 ft²	-	-
Wall Transmission	10987 ft²	9321	-	10987 ft²	90394	-
Roof Transmission	7337 ft²	7377	-	7337 ft²	18068	-
Window Transmission	1335 ft²	5285	-	1335 ft²	62925	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6743 ft²	0	-	6743 ft²	16090	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	23646 W	80679	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	5325 W	18167	-	0	0	-
People	106	25970	21730	0	0	0
Infiltration	-	7064	2520	-	53575	0
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**187416**	**26250**	**-**	**241053**	**0**
Zone Conditioning	-	177034	26250	-	210369	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	8567 CFM	0	-	8567 CFM	0	-
Ventilation Load	1815 CFM	25662	7435	1815 CFM	150176	0
Supply Fan Load	8567 CFM	6347	-	8567 CFM	-6347	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	**-**	**209043**	**33686**	**-**	**354198**	**0**
Central Cooling Coil	-	209043	33708	-	0	0
Terminal Reheat Coils	-	0	-	-	354057	-
>> Total Conditioning	**-**	**209043**	**33708**	**-**	**354057**	**0**
Key:	**Positive values are clg loads** **Negative values are htg loads**			**Positive values are htg loads** **Negative values are clg loads**		

Zone 1	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	465 ft²	9487	-	465 ft²	-	-
Wall Transmission	3527 ft²	2825	-	3527 ft²	29018	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	465 ft²	1841	-	465 ft²	21918	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	6743 ft²	0	-	6743 ft²	16090	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	7440 W	25385	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1656 W	5650	-	0	0	-
People	34	8330	6970	0	0	0
Infiltration	-	2289	784	-	17357	0
Miscellaneous	-	3000	2000	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**58808**	**9754**	**-**	**84383**	**0**

Zone 2	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1500 COOLING OA DB / WB 89.3 °F / 67.5 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	435 ft²	10533	-	435 ft²	-	-
Wall Transmission	3730 ft²	3248	-	3730 ft²	30688	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	435 ft²	1722	-	435 ft²	20504	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	8103 W	27647	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2388	1049	-	18109	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**60616**	**8429**	**-**	**69301**	**0**

Zone 3	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1600 COOLING OA DB / WB 88.6 °F / 67.3 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 78.0 °F			OCCUPIED T-STAT 68.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	435 ft²	8540	-	435 ft²	-	-
Wall Transmission	3730 ft²	3838	-	3730 ft²	30688	-
Roof Transmission	7337 ft²	9654	-	7337 ft²	18068	-
Window Transmission	435 ft²	1675	-	435 ft²	20504	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	8103 W	27647	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1834 W	6258	-	0	0	-
People	36	8820	7380	0	0	0
Infiltration	-	2243	629	-	18109	1
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	**-**	**68674**	**8009**	**-**	**87369**	**1**

Air System Information

Air System Name	**Vestibule vav**	Number of zones	**1**
Equipment Class	**TERM**	Floor Area	**112.0** ft²
Air System Type	**PKG-FC**	Location	**Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months	**Jan to Dec**	Zone CFM Sizing	**Sum of space airflow rates**
Sizing Data	**Calculated**	Space CFM Sizing	**Individual peak space loads**

Air System Information

Air System Name .... **Vestibule vav**
Equipment Class .... **TERM**
Air System Type .... **PKG-FC**

Number of zones **1**
Floor Area .... **112.0** ft²
Location .... **Minot IAP, North Dakota**

Sizing Calculation Information

Calculation Months .... **Jan to Dec**
Sizing Data .... **Calculated**

Zone CFM Sizing .... **Sum of space airflow rates**
Space CFM Sizing .... **Individual peak space loads**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Airflow (CFM)	Minimum Airflow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	0.0	175	175	Des Htg	4.4	112.0	1.56

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	0.0	0.0	-1.0 / -1.0	-1.0 / -1.0	0.00	Des 0000

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	4.9	65.3 / 95.0	0.49	175	0.000	0.000	7

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
Vestibule 1000 base	1	0.0	Jan 0000	175	4.4	112.0	1.56

	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	19 ft²	-	-	19 ft²	160	-
Roof Transmission	0 ft²	-	-	0 ft²	0	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	48 ft²	-	-	48 ft²	3578	-
Floor Transmission	112 ft²	-	-	112 ft²	393	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	298	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**4429**	**0**
Zone Conditioning	-	-	-	-	4365	0
Plenum Wall Load	0%	-	-	0	0	-
Plenum Roof Load	0%	-	-	0	0	-
Plenum Lighting Load	0%	-	-	0	0	-
Exhaust Fan Load	-	-	-	0 CFM	0	-
Ventilation Load	-	-	-	6 CFM	549	0
Ventilation Fan Load	-	-	-	0 CFM	0	-
Space Fan Coil Fans	-	-	-	-	0	-
Duct Heat Gain / Loss	0%	-	-	0%	0	-
>> Total System Loads	**-**	**-**	**-**	**-**	**4914**	**0**
Terminal Unit Cooling	-	-	-	-	0	0
Terminal Unit Heating	-	-	-	-	4914	-
Terminal Reheat Coils	-	-	-	-	4914	-
>> Total Conditioning	**-**	**-**	**-**	**-**	**4914**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

Zone Design Load Summary for Vestibule vav

Project Name: Building 276 Reno-Minot AFB RTU VAV1 02/25/2016
Prepared by: SEENI 02:43PM

Zone 1	DESIGN COOLING			DESIGN HEATING		
	NO COOLING DATA NO COOLING OA DB / WB			HEATING DATA AT DES HTG HEATING OA DB / WB -17.7 °F / -18.0 °F		
	OCCUPIED T-STAT 100.0 °F			OCCUPIED T-STAT 70.0 °F		
ZONE LOADS	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**	**Details**	**Sensible (BTU/hr)**	**Latent (BTU/hr)**
Window & Skylight Solar Loads	0 ft²	-	-	0 ft²	-	-
Wall Transmission	19 ft²	-	-	19 ft²	160	-
Roof Transmission	0 ft²	-	-	0 ft²	0	-
Window Transmission	0 ft²	-	-	0 ft²	0	-
Skylight Transmission	0 ft²	-	-	0 ft²	0	-
Door Loads	48 ft²	-	-	48 ft²	3578	-
Floor Transmission	112 ft²	-	-	112 ft²	393	-
Partitions	0 ft²	-	-	0 ft²	0	-
Ceiling	0 ft²	-	-	0 ft²	0	-
Overhead Lighting	-	-	-	0	0	-
Task Lighting	-	-	-	0	0	-
Electric Equipment	-	-	-	0	0	-
People	-	-	-	0	0	0
Infiltration	-	-	-	-	298	0
Miscellaneous	-	-	-	-	0	0
Safety Factor	0% / 0%	-	-	0%	0	0
>> Total Zone Loads	**-**	**-**	**-**	**-**	**4429**	**0**

Table 1. Annual Costs

Component	[B090] PTAC building ($)	[B180] PTAC building ($)	[B270] PTAC building ($)	Minot GSHP building ($)	PTAC building ($)
Air System Fans	556	519	554	721	524
Cooling	655	562	646	419	565
Heating	11,879	11,780	11,919	9,945	11,811
Pumps	394	394	394	739	394
Heat Rejection Fans	0	0	0	0	0
HVAC Sub-Total	**13,484**	**13,256**	**13,513**	**11,824**	**13,294**
Lights	3,993	3,993	3,993	1,994	3,993
Electric Equipment	734	734	734	750	734
Misc. Electric	302	302	302	741	302
Misc. Fuel Use	0	0	0	0	0
Non-HVAC Sub-Total	**5,029**	**5,029**	**5,029**	**3,485**	**5,029**
Grand Total	**18,513**	**18,284**	**18,542**	**15,309**	**18,322**

Table 2. Annual Cost per Unit Floor Area

Component	[B090] PTAC building ($/ft²)	[B180] PTAC building ($/ft²)	[B270] PTAC building ($/ft²)	Minot GSHP building ($/ft²)	PTAC building ($/ft²)
Air System Fans	0.021	0.020	0.021	0.027	0.020
Cooling	0.025	0.021	0.024	0.016	0.021
Heating	0.448	0.444	0.449	0.372	0.445
Pumps	0.015	0.015	0.015	0.028	0.015
Heat Rejection Fans	0.000	0.000	0.000	0.000	0.000
HVAC Sub-Total	**0.508**	**0.500**	**0.509**	**0.442**	**0.501**
Lights	0.151	0.151	0.151	0.075	0.151
Electric Equipment	0.028	0.028	0.028	0.028	0.028
Misc. Electric	0.011	0.011	0.011	0.028	0.011
Misc. Fuel Use	0.000	0.000	0.000	0.000	0.000
Non-HVAC Sub-Total	**0.190**	**0.190**	**0.190**	**0.130**	**0.190**
Grand Total	**0.698**	**0.689**	**0.699**	**0.572**	**0.691**
Gross Floor Area (ft²)	26539.0	26539.0	26539.0	26749.0	26539.0
Conditioned Floor Area (ft²)	26539.0	26539.0	26539.0	26749.0	26539.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 3. Component Cost as a Percentage of Total Cost

Component	[B090] PTAC building (%)	[B180] PTAC building (%)	[B270] PTAC building (%)	Minot GSHP building (%)	PTAC building (%)
Air System Fans	3.0	2.8	3.0	4.7	2.9
Cooling	3.5	3.1	3.5	2.7	3.1
Heating	64.2	64.4	64.3	65.0	64.5
Pumps	2.1	2.2	2.1	4.8	2.2
Heat Rejection Fans	0.0	0.0	0.0	0.0	0.0
HVAC Sub-Total	**72.8**	**72.5**	**72.9**	**77.2**	**72.6**
Lights	21.6	21.8	21.5	13.0	21.8
Electric Equipment	4.0	4.0	4.0	4.9	4.0
Misc. Electric	1.6	1.6	1.6	4.8	1.6
Misc. Fuel Use	0.0	0.0	0.0	0.0	0.0
Non-HVAC Sub-Total	**27.2**	**27.5**	**27.1**	**22.8**	**27.4**
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 1. Annual Costs

Component	[B090] PTAC building ($)	[B180] PTAC building ($)	[B270] PTAC building ($)	Minot GSHP building ($)	PTAC building ($)
HVAC Components					
Electric	5,897	5,669	5,926	4,237	5,707
Natural Gas	7,587	7,587	7,587	7,587	7,587
Fuel Oil	0	0	0	0	0
Propane	0	0	0	0	0
Remote HW	0	0	0	0	0
Remote Steam	0	0	0	0	0
Remote CW	0	0	0	0	0
HVAC Sub-Total	**13,484**	**13,256**	**13,513**	**11,824**	**13,294**
Non-HVAC Components					
Electric	5,029	5,029	5,029	3,485	5,029
Natural Gas	0	0	0	0	0
Fuel Oil	0	0	0	0	0
Propane	0	0	0	0	0
Remote HW	0	0	0	0	0
Remote Steam	0	0	0	0	0
Non-HVAC Sub-Total	**5,029**	**5,029**	**5,029**	**3,485**	**5,029**
Grand Total	**18,513**	**18,284**	**18,542**	**15,309**	**18,322**

Table 2. Annual Energy Consumption

Component	[B090] PTAC building	[B180] PTAC building	[B270] PTAC building	Minot GSHP building	PTAC building
HVAC Components					
Electric (kWh)	128,199	123,234	128,834	92,116	124,057
Natural Gas (Therm)	16,142	16,142	16,142	16,142	16,142
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Remote CW (na)	0	0	0	0	0
Non-HVAC Components					
Electric (kWh)	109,321	109,321	109,321	75,751	109,321
Natural Gas (Therm)	0	0	0	0	0
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Totals					
Electric (kWh)	237,519	232,555	238,155	167,867	233,378
Natural Gas (Therm)	16,142	16,142	16,142	16,142	16,142
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Remote CW (na)	0	0	0	0	0

Table 3. Annual Emissions

Component	[B090] PTAC building	[B180] PTAC building	[B270] PTAC building	Minot GSHP building	PTAC building
CO2 Equivalent (lb)	0	0	0	0	0

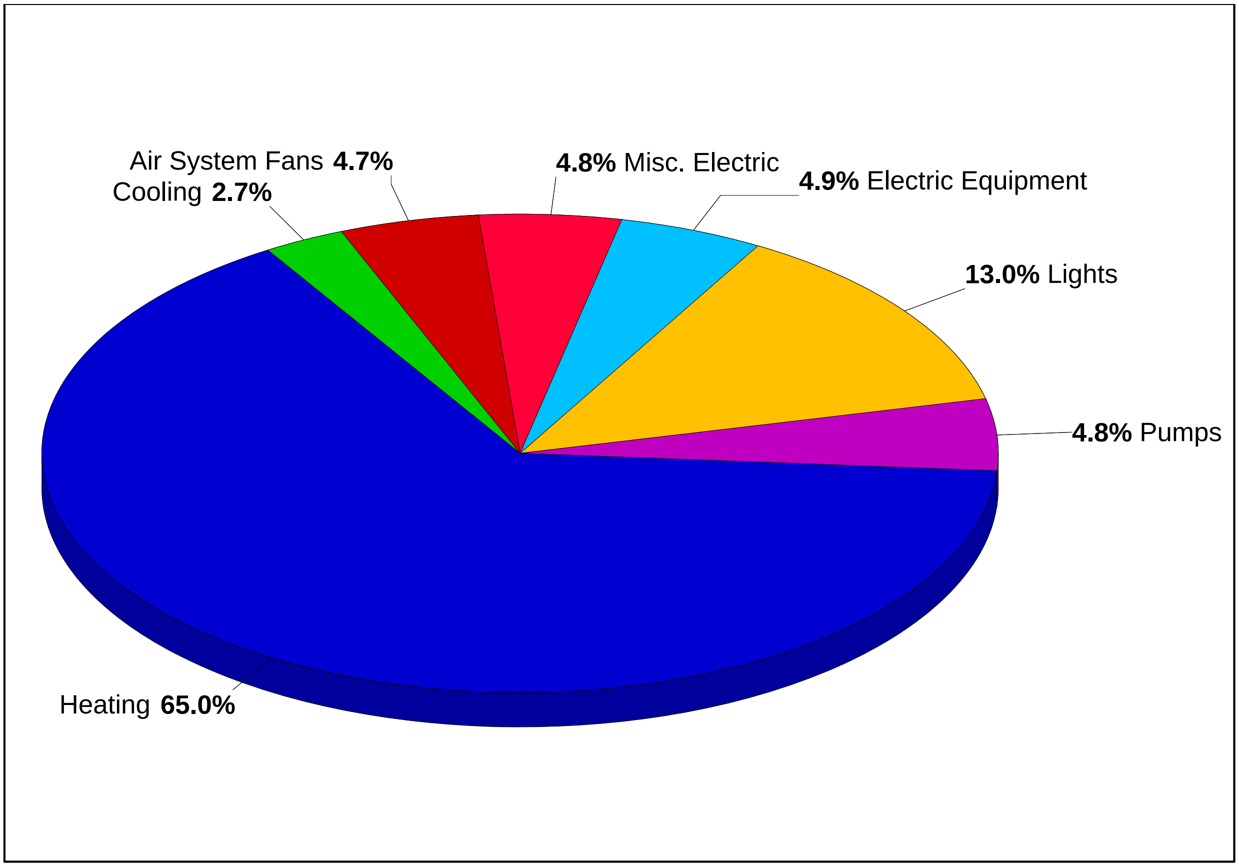
Table 4. Annual Cost per Unit Floor Area

Component	[B090] PTAC building ($/ft²)	[B180] PTAC building ($/ft²)	[B270] PTAC building ($/ft²)	Minot GSHP building ($/ft²)	PTAC building ($/ft²)
HVAC Components					
Electric	0.222	0.214	0.223	0.158	0.215
Natural Gas	0.286	0.286	0.286	0.284	0.286
Fuel Oil	0.000	0.000	0.000	0.000	0.000
Propane	0.000	0.000	0.000	0.000	0.000
Remote HW	0.000	0.000	0.000	0.000	0.000
Remote Steam	0.000	0.000	0.000	0.000	0.000
Remote CW	0.000	0.000	0.000	0.000	0.000
HVAC Sub-Total	**0.508**	**0.500**	**0.509**	**0.442**	**0.501**
Non-HVAC Components					
Electric	0.190	0.190	0.190	0.130	0.190
Natural Gas	0.000	0.000	0.000	0.000	0.000
Fuel Oil	0.000	0.000	0.000	0.000	0.000
Propane	0.000	0.000	0.000	0.000	0.000
Remote HW	0.000	0.000	0.000	0.000	0.000
Remote Steam	0.000	0.000	0.000	0.000	0.000
Non-HVAC Sub-Total	**0.190**	**0.190**	**0.190**	**0.130**	**0.190**
Grand Total	**0.698**	**0.689**	**0.699**	**0.572**	**0.690**
Gross Floor Area (ft²)	26539.0	26539.0	26539.0	26749.0	26539.0
Conditioned Floor Area (ft²)	26539.0	26539.0	26539.0	26749.0	26539.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 5. Component Cost as a Percentage of Total Cost

Component	[B090] PTAC building (%)	[B180] PTAC building (%)	[B270] PTAC building (%)	Minot GSHP building (%)	PTAC building (%)
HVAC Components					
Electric	31.9	31.0	32.0	27.7	31.1
Natural Gas	41.0	41.5	40.9	49.6	41.4
Fuel Oil	0.0	0.0	0.0	0.0	0.0
Propane	0.0	0.0	0.0	0.0	0.0
Remote HW	0.0	0.0	0.0	0.0	0.0
Remote Steam	0.0	0.0	0.0	0.0	0.0
Remote CW	0.0	0.0	0.0	0.0	0.0
HVAC Sub-Total	**72.8**	**72.5**	**72.9**	**77.2**	**72.6**
Non-HVAC Components					
Electric	27.2	27.5	27.1	22.8	27.4
Natural Gas	0.0	0.0	0.0	0.0	0.0
Fuel Oil	0.0	0.0	0.0	0.0	0.0
Propane	0.0	0.0	0.0	0.0	0.0
Remote HW	0.0	0.0	0.0	0.0	0.0
Remote Steam	0.0	0.0	0.0	0.0	0.0
Non-HVAC Sub-Total	**27.2**	**27.5**	**27.1**	**22.8**	**27.4**
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

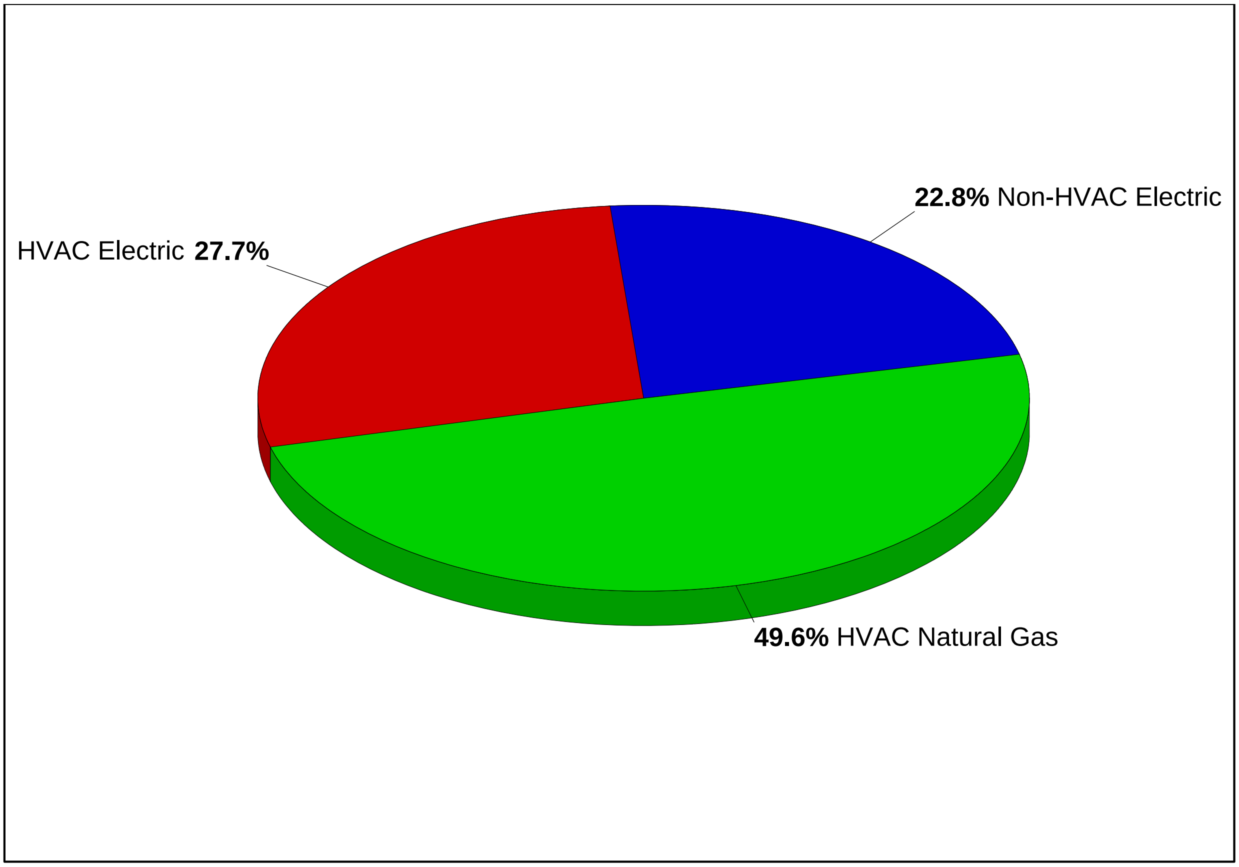


1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	721	0.027	4.7
Cooling	419	0.016	2.7
Heating	9,945	0.372	65.0
Pumps	739	0.028	4.8
Heat Rejection Fans	0	0.000	0.0
HVAC Sub-Total	**11,824**	**0.442**	**77.2**
Lights	1,994	0.075	13.0
Electric Equipment	750	0.028	4.9
Misc. Electric	741	0.028	4.8
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**3,485**	**0.130**	**22.8**
Grand Total	**15,309**	**0.572**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26749.0** ft²
Conditioned Floor Area .... **26749.0** ft²

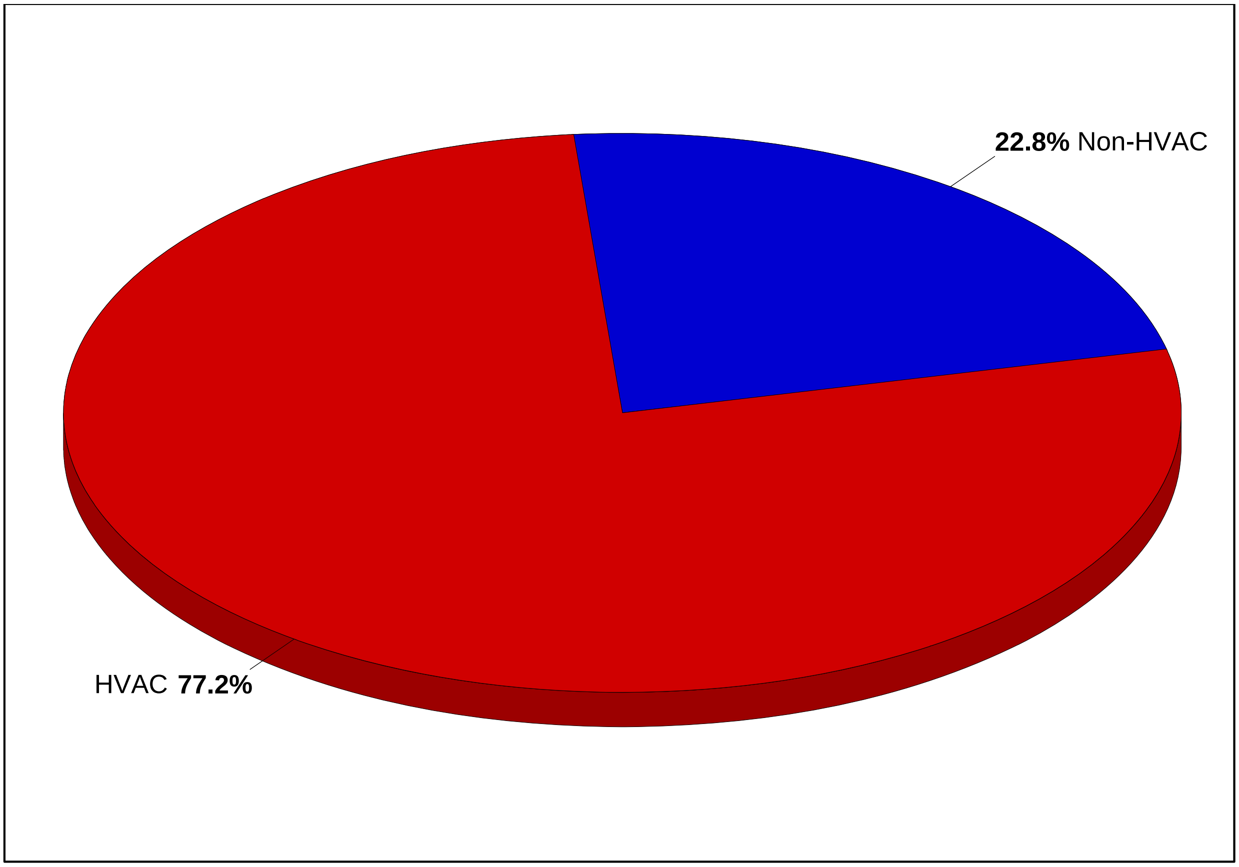


1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	4,237	0.158	27.7
Natural Gas	7,587	0.284	49.6
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**11,824**	**0.442**	**77.2**
Non-HVAC Components			
Electric	3,485	0.130	22.8
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**3,485**	**0.130**	**22.8**
Grand Total	**15,309**	**0.572**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26749.0** ft²
Conditioned Floor Area .... **26749.0** ft²



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	11,824	0.442	77.2
Non-HVAC	3,485	0.130	22.8
Grand Total	**15,309**	**0.572**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26749.0** ft²
Conditioned Floor Area .... **26749.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	140,042	5.235
Heating Coil Loads	228,740	8.551
Grand Total	**368,782**	**13.787**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	53,453	1.998	190,902	7.137
Cooling	31,107	1.163	111,098	4.153
Heating	1,789,168	66.887	2,239,002	83.704
Pumps	54,805	2.049	195,733	7.317
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**1,928,533**	**72.097**	**2,736,734**	**102.312**
Lights	147,893	5.529	528,188	19.746
Electric Equipment	55,609	2.079	198,603	7.425
Misc. Electric	54,960	2.055	196,287	7.338
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**258,462**	**9.663**	**923,079**	**34.509**
Grand Total	**2,186,995**	**81.760**	**3,659,813**	**136.821**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

Energy Budget by Energy Source - Minot GSHP building

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	140,042	5.235
Heating Coil Loads	228,740	8.551
Grand Total	**368,782**	**13.787**

2. Energy Consumption by Energy Source

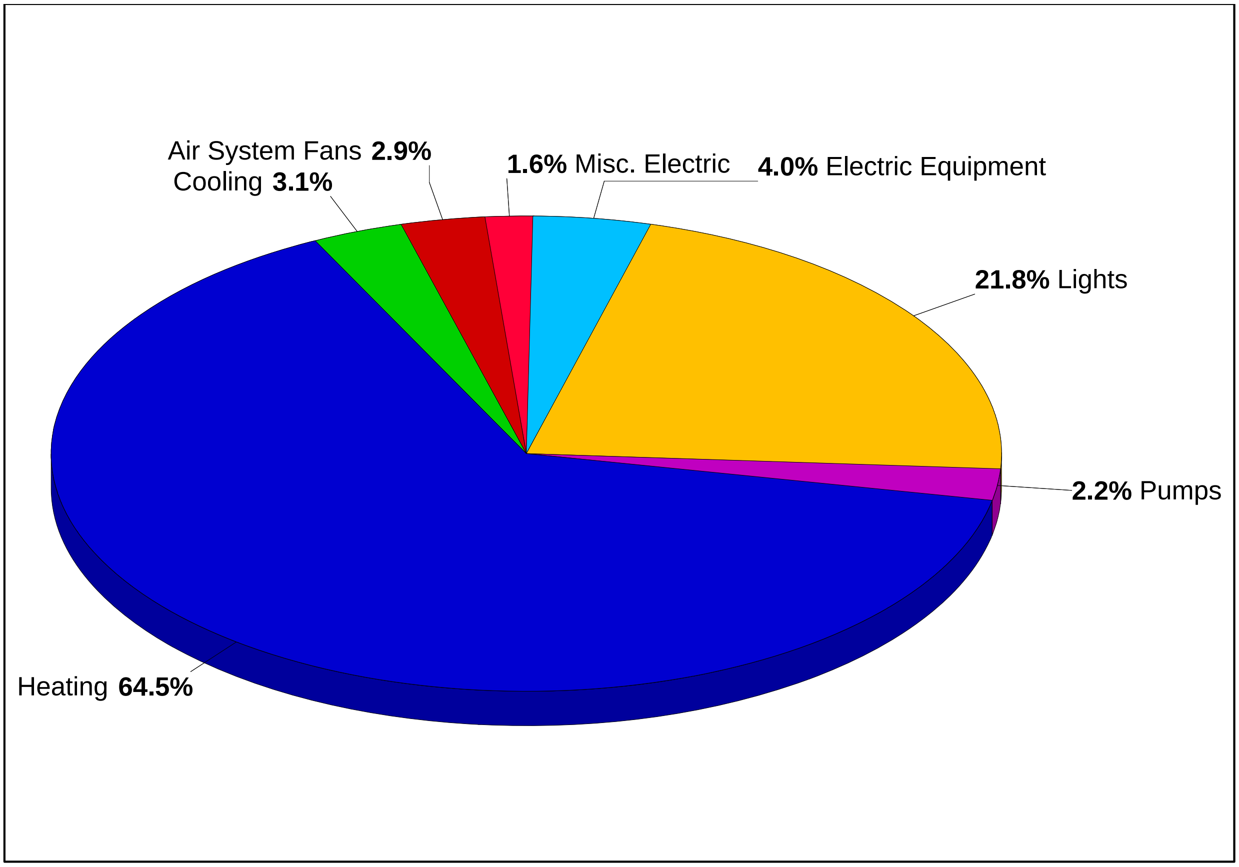
Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	314,299	11.750	1,122,497	41.964
Natural Gas	1,614,232	60.347	1,614,232	60.347
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**1,928,531**	**72.097**	**2,736,729**	**102.312**
Non-HVAC Components				
Electric	258,464	9.663	923,084	34.509
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**258,464**	**9.663**	**923,084**	**34.509**
Grand Total	**2,186,995**	**81.760**	**3,659,814**	**136.821**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

Monthly Energy Use by Component - Minot GSHP building

1. Monthly Energy Use by System Component

Component	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air System Fans (kWh)	1443	1303	1442	1363	1299	1096	1079	1138	1270	1395	1395	1443
Cooling												
Electric (kWh)	158	164	209	357	976	1779	2086	1830	863	360	171	164
Natural Gas (Therm)	0	0	0	0	0	0	0	0	0	0	0	0
Fuel Oil (na)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote CW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Heating												
Electric (kWh)	11657	10643	5951	2997	678	71	15	63	519	2072	5921	10685
Natural Gas (Therm)	1372	1238	1371	1326	1372	1326	1371	1372	1326	1372	1326	1371
Fuel Oil (na)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0
Pumps (kWh)	1363	1232	1362	1320	1365	1322	1365	1365	1321	1363	1320	1364
Heat Rej. Fans (kWh)	0	0	0	0	0	0	0	0	0	0	0	0
Lighting (kWh)	3688	3325	3672	3567	3678	3561	3688	3672	3567	3688	3551	3688
Electric Eqpt. (kWh)	1387	1250	1381	1341	1383	1339	1387	1381	1341	1387	1335	1387
Misc. Electric (kWh)	1369	1236	1366	1325	1369	1322	1369	1366	1325	1369	1322	1369
Misc. Fuel												
Natural Gas (Therm)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0

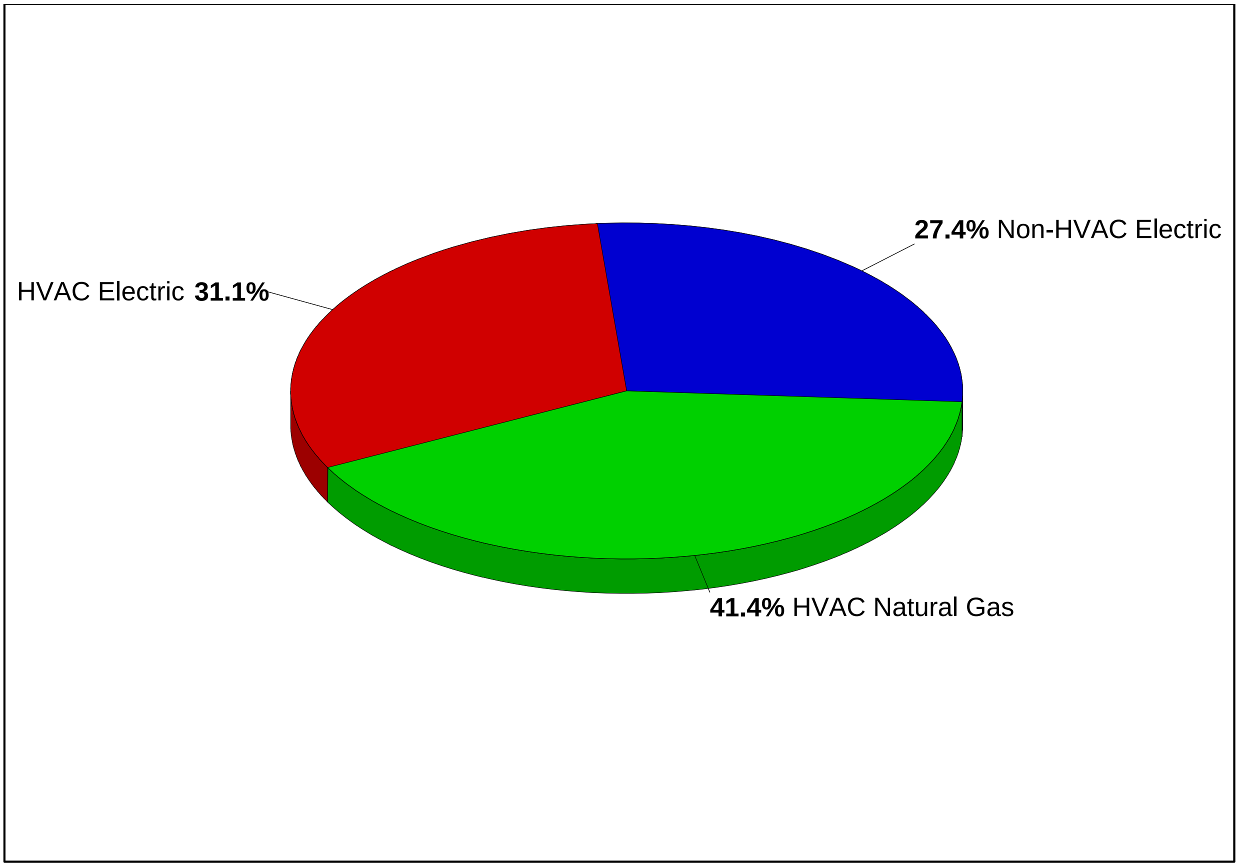


1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	524	0.020	2.9
Cooling	565	0.021	3.1
Heating	11,811	0.445	64.5
Pumps	394	0.015	2.2
Heat Rejection Fans	0	0.000	0.0
HVAC Sub-Total	**13,294**	**0.501**	**72.6**
Lights	3,993	0.151	21.8
Electric Equipment	734	0.028	4.0
Misc. Electric	302	0.011	1.6
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**5,029**	**0.190**	**27.4**
Grand Total	**18,322**	**0.691**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26539.0** ft²
Conditioned Floor Area .... **26539.0** ft²

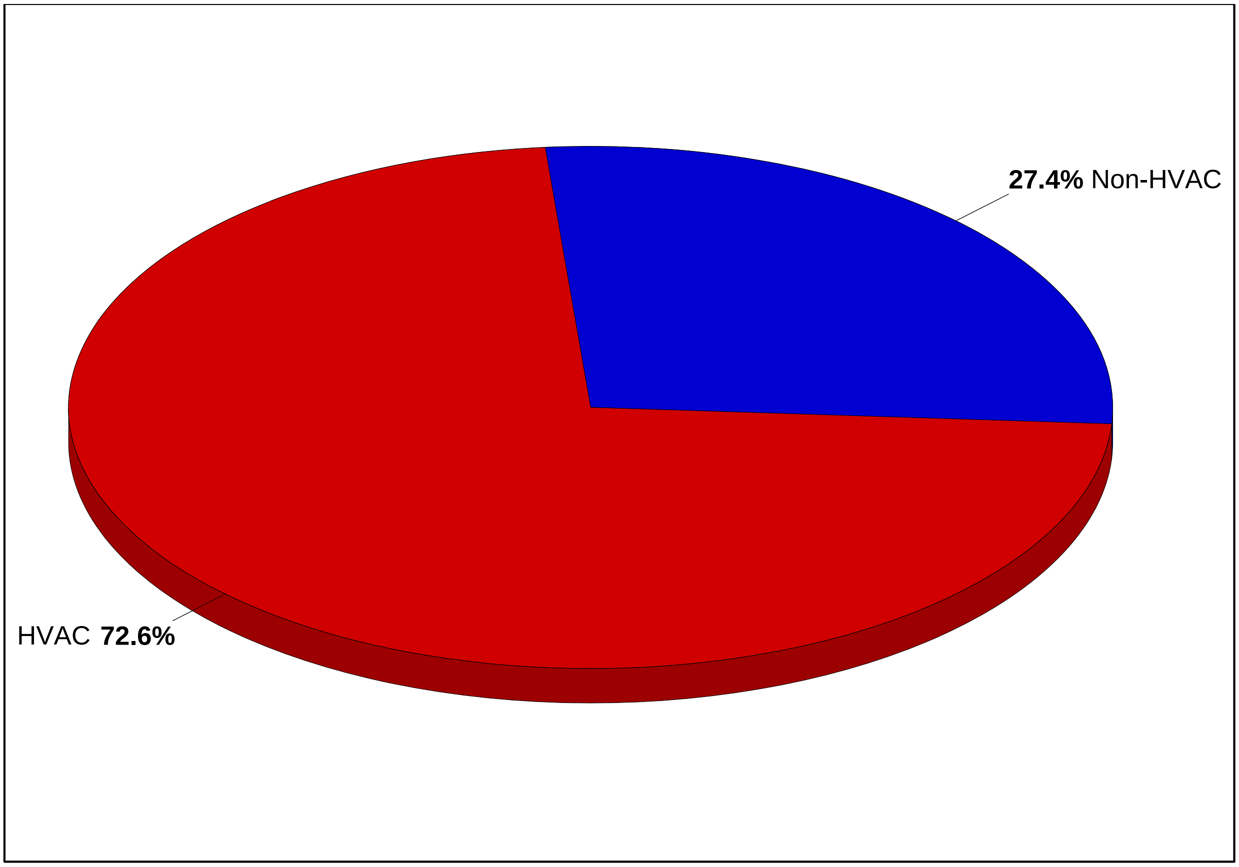


1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	5,707	0.215	31.1
Natural Gas	7,587	0.286	41.4
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**13,294**	**0.501**	**72.6**
Non-HVAC Components			
Electric	5,029	0.190	27.4
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**5,029**	**0.190**	**27.4**
Grand Total	**18,322**	**0.690**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26539.0** ft²
Conditioned Floor Area .... **26539.0** ft²



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	13,294	0.501	72.6
Non-HVAC	5,029	0.189	27.4
Grand Total	**18,322**	**0.690**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **26539.0** ft²
Conditioned Floor Area .... **26539.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	155,931	5.876
Heating Coil Loads	581,694	21.918
Grand Total	**737,625**	**27.794**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	38,846	1.464	138,737	5.228
Cooling	41,882	1.578	149,580	5.636
Heating	1,927,532	72.630	2,733,160	102.987
Pumps	29,260	1.103	104,500	3.938
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**2,037,520**	**76.775**	**3,125,976**	**117.788**
Lights	296,170	11.160	1,057,748	39.856
Electric Equipment	54,458	2.052	194,491	7.329
Misc. Electric	22,373	0.843	79,904	3.011
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**373,000**	**14.055**	**1,332,144**	**50.196**
Grand Total	**2,410,520**	**90.829**	**4,458,119**	**167.984**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26539.0** ft²
   Conditioned Floor Area .... **26539.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	155,931	5.876
Heating Coil Loads	581,694	21.918
Grand Total	**737,625**	**27.794**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	423,282	15.949	1,511,722	56.962
Natural Gas	1,614,232	60.825	1,614,232	60.825
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**2,037,514**	**76.774**	**3,125,954**	**117.787**
Non-HVAC Components				
Electric	373,002	14.055	1,332,150	50.196
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**373,002**	**14.055**	**1,332,150**	**50.196**
Grand Total	**2,410,516**	**90.829**	**4,458,104**	**167.983**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26539.0** ft²
   Conditioned Floor Area .... **26539.0** ft²

1. Monthly Energy Use by System Component

Component	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air System Fans (kWh)	967	873	967	936	967	936	967	967	936	967	936	967
Cooling												
Electric (kWh)	136	130	210	309	1060	2708	3304	2784	913	360	199	163
Natural Gas (Therm)	0	0	0	0	0	0	0	0	0	0	0	0
Fuel Oil (na)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote CW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Heating												
Electric (kWh)	23084	20987	8162	4487	1400	95	16	108	1186	3704	8933	19661
Natural Gas (Therm)	1372	1238	1371	1326	1372	1326	1371	1372	1326	1372	1326	1371
Fuel Oil (na)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0
Pumps (kWh)	728	658	728	705	728	705	728	728	705	728	705	728
Heat Rej. Fans (kWh)	0	0	0	0	0	0	0	0	0	0	0	0
Lighting (kWh)	7386	6658	7353	7143	7366	7131	7386	7353	7143	7386	7111	7386
Electric Eqpt. (kWh)	1358	1224	1352	1313	1354	1311	1358	1352	1313	1358	1307	1358
Misc. Electric (kWh)	558	503	556	539	557	538	558	556	539	558	538	558
Misc. Fuel												
Natural Gas (Therm)	0	0	0	0	0	0	0	0	0	0	0	0
Propane (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote HW (na)	0	0	0	0	0	0	0	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0	0	0	0	0	0	0	0

General Information

Simulation Program Name and Version .... **Hourly Analysis Program v4.80**
Simulation Weather File Name .... **Minot IAP, North Dakota (TM2)**

Building Designations

Proposed Building .... **Minot GSHP building**
Baseline - 0 degrees .... **PTAC building**
Baseline - 90 degrees .... **[B090] PTAC building**
Baseline - 180 degrees .... **[B180] PTAC building**
Baseline - 270 degrees .... **[B270] PTAC building**

Floor Areas and Window-to-Wall Ratios

	Proposed Design	Baseline
Total Conditioned Floor Area (ft²)	26,749	26,539
Total Floor Area (ft²)	26,749	26,539
Window to Wall Ratio	9 %	9 %
Gross Wall Area (ft²)	15,265	17,022
Vertical Window Area (ft²)	1,440	1,470

Advisory Messages

	Proposed Building	Baseline Building (0 deg. rotation)	Difference
Number of hours heating loads not met	0	0	0
Number of hours cooling loads not met	0	455	-455

Energy Type Summary

Energy Type	Utility Rate Description	Units of Energy	Units of Demand
Electric	Base utilities electric rate	kWh	kW
Natural Gas	Base natural gas rate	Therm	MBH

Energy Units:
1 kBTU = 1,000 BTU
1 kWh = 3.412 kBTU
1 Therm = 100.000 kBTU

Demand Units:
1 MBH = 1,000 BTU/h
1 kW = 3.412 MBH

Baseline Performance - Performance Rating Method Compliance

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand	Baseline (0 deg rotation)	Baseline (90 deg rotation)	Baseline (180 deg rotation)	Baseline (270 deg rotation)	Baseline Design
Interior Lighting	No	Electric	Energy kWh	86,804	86,804	86,804	86,804	86,804
			Demand kW	25.5	25.5	25.5	25.5	25.5
Space Heating	No	Electric	Energy kWh	91,823	93,304	91,151	94,169	92,612
			Demand kW	99.3	99.8	98.8	101.0	99.7
Space Cooling	No	Electric	Energy kWh	12,275	14,237	12,222	14,041	13,194
			Demand kW	13.3	14.3	13.2	14.5	13.8
Pumps	No	Electric	Energy kWh	8,576	8,576	8,576	8,576	8,576
			Demand kW	1.0	1.0	1.0	1.0	1.0
Heat Rejection	No	Electric	Energy kWh	0	0	0	0	0
			Demand kW	0.0	0.0	0.0	0.0	0.0
Fans - Interior	No	Electric	Energy kWh	11,385	12,083	11,284	12,050	11,701
			Demand kW	1.3	1.4	1.3	1.4	1.3
Receptacle Equipment	Yes	Electric	Energy kWh	15,961	15,961	15,961	15,961	15,961

			Demand kW	4.7	4.7	4.7	4.7	4.7
Service Water Heating	No	Natural Gas	Energy Therm	16,142	16,142	16,142	16,142	16,142
			Demand MBH	261.7	261.7	261.7	261.7	261.7
Exterior Lighting	No	Electric	Energy kWh	1,530	1,530	1,530	1,530	1,530
			Demand kW	0.5	0.5	0.5	0.5	0.5
Exhaust Fan	No	Electric	Energy kWh	5,027	5,027	5,027	5,027	5,027
			Demand kW	0.9	0.9	0.9	0.9	0.9
ERV 1 SUPPLY FAN	No	Electric	Energy kWh	0	0	0	0	0
			Demand kW	0.0	0.0	0.0	0.0	0.0
ERV 1 EXHAUST FAN	No	Electric	Energy kWh	0	0	0	0	0
			Demand kW	0.0	0.0	0.0	0.0	0.0
Baseline Energy Totals	Total Annual Energy Use kBTU			2,410,528	2,424,659	2,407,708	2,426,826	2,417,430
	Annual Process Energy kBTU							54,457
	Process Energy Modeling Compliance							N

(1) This form determines compliance using cost calculations from Section 1.9. Process Energy Costs should be modeled to accurately reflect the proposed building. Process Energy must be the same in the baseline and proposed cases, unless an exceptional calculation is used. Process energy costs must be at least 25% of the total baseline energy costs. Any exceptions must be supported by a narrative and/or other supporting doucmentation.
(2) In this project Process Energy is 4% of total baseline energy cost.

Baseline Energy Costs

Energy Type	Baseline Cost (0 deg rotation) ($)	Baseline Cost (90 deg rotation) ($)	Baseline Cost (180 deg rotation) ($)	Baseline Cost (270 deg rotation) ($)	Baseline Building Performance ($)
Electric	10,736	10,926	10,697	10,955	10,829
Natural Gas	7,587	7,587	7,587	7,587	7,587
Total Baseline Costs	**18,322**	**18,513**	**18,284**	**18,542**	**18,415**

Performance Rating Table - Performance Rating Method Compliance

End Use	Process ?	Baseline Building Units	Baseline Building Results	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Percent Savings
Interior Lighting	No	Energy kWh	86,804	Electric	Energy kWh	43,345	50 %
		Demand kW	25.5		Demand kW	12.7	50 %
Space Heating	No	Energy kWh	92,612	Electric	Energy kWh	51,271	45 %
		Demand kW	99.7		Demand kW	30.2	70 %
Space Cooling	No	Energy kWh	13,194	Electric	Energy kWh	9,117	31 %
		Demand kW	13.8		Demand kW	6.7	52 %
Pumps	No	Energy kWh	8,576	Electric	Energy kWh	16,062	-87 %
		Demand kW	1.0		Demand kW	1.8	-88 %
Heat Rejection	No	Energy kWh	0	Electric	Energy kWh	0	n/a
		Demand kW	0.0		Demand kW	0.0	n/a
Fans - Interior	No	Energy kWh	11,701	Electric	Energy kWh	15,666	-34 %
		Demand kW	1.3		Demand kW	1.9	-45 %
Receptacle Equipment	Yes	Energy kWh	15,961	Electric	Energy kWh	16,298	-2 %
		Demand kW	4.7		Demand kW	4.8	-2 %
Service Water Heating	No	Energy Therm	16,142	Natural Gas	Energy Therm	16,142	0 %
		Demand MBH	261.7		Demand MBH	261.7	0 %
Exterior Lighting	No	Energy kWh	1,530	Electric	Energy kWh	1,530	0 %
		Demand kW	0.5		Demand kW	0.5	0 %
Exhaust Fan	No	Energy kWh	5,027	Electric	Energy kWh	0	100 %
		Demand kW	0.9		Demand kW	0.0	100 %
ERV 1 SUPPLY FAN	No	Energy kWh	0	Electric	Energy kWh	9,551	n/a

		Demand kW	0.0		Demand kW	1.7	n/a
ERV 1 EXHAUST FAN	No	Energy kWh	0	Electric	Energy kWh	5,027	n/a
		Demand kW	0.0		Demand kW	0.9	n/a
Energy Totals	Baseline Total Energy Use (kBTU)		2,417,430	Proposed Total Energy Use (kBTU)		2,186,994	10 %
	Baseline Annual Process Energy (kBTU)		54,457	Proposed Annual Process Energy (kBTU)		55,609	-2 %

Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		**Baseline Design**	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	167,867 kWh	7,722	235,404 kWh	10,829
Natural Gas	16,142 Therm	7,587	16,142 Therm	7,587
Subtotal (Model Outputs)	**2,186,994 kBTU**	**15,309**	**2,417,430 kBTU**	**18,415**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**2,186,994 kBTU**	**15,309**		
	Percent Savings		**Energy Use Intensity**	
	Energy	**Cost**	**Proposed Design ($kBTU/ft^2$)**	**Baseline Design ($kBTU/ft^2$)**
Summary Data	**9.5 %**	**16.9 %**	**81.76**	**91.09**

LEED 2009 EA Credit 1 Points Reference Table

New Construction % Cost Savings	**Existing Building Renovations % Cost Savings**	**LEED 2009 Points Awarded**
12%	8%	1 pt
14%	10%	2 pt
16%	12%	**3 pts**
18%	14%	4 pts
20%	**16%**	**5 pts**
22%	18%	6 pts
24%	20%	7 pts
26%	22%	8 pts
28%	24%	9 pts
30%	26%	10 pts
32%	28%	11 pts
34%	30%	12 pts
36%	32%	13 pts
38%	34%	14 pts
40%	36%	15 pts
42%	38%	16 pts
44%	40%	17 pts
46%	42%	18 pts
48%	44%	19 pts

LIFE CYCLE COST ANALYSIS NARRATIVE

BACKGROUND:

At the Charrette the Base personnel indicated a strong desire to design the HVAC system based on Ground Source Heat Pumps using a closed loop ground source well field similar to other facilities at Minot AFB. Their preference was to use Trane units as a BASIS FOR DESIGN. The base has over 1600 ground source wells on site. Implementing this system in Building 276 will preclude having a “different” system on base that maintenance personnel are not familiar with, requiring to be trained on the system maintenance, or providing additional parts storage for unit maintenance. The base additionally provided Leidos with a similar system design to this dormitory that has 20% glycol in HDPE black piping serving stacked units at the exterior wall of the dormitory rooms. An ERV will be used for the required ventilation air.

The LCCA summarized below verifies that with the required modifications to the existing facility and the additional annual costs incurred for training of maintenance personnel and parts storage that the Ground Source Heat Pump system is the most economical option over the 40-year Life Cycle Cost.

CALCULATIONS:

A computer energy analysis has been performed utilizing the Energy Analysis portion of the Carrier E20-ll Hourly Analysis Program (HAP). This program utilizes detailed 8,760 hour-by-hour energy simulation techniques for its operating cost analysis. The analysis has been performed to determine the most cost effective and efficient Mechanical heating and cooling system for this facility.

In order to determine the most cost effective HVAC system, Life Cycle Cost Analysis Calculations have been performed. Life Cycle Cost Analysis Calculations have been performed using the latest version of the Building Life Cycle Cost (BLCC) computer program (version 5.3).

UTILITY RATES:

Joey R. Specht, GS-12 USAF, Portfolio Optimization Chief, has provided the information for the utility rates at Minot Air Force Base. The rates are as follows:

Natural Gas: $4.70 MMBtu or $0.47 / therm

Electricity: $0.046 KWH

There is no demand or other charges for either of these utilities. The services are provided by Base Utilities Services.

EXECUTIVE SUMMARY:

The following brief summary provides a description of the alternatives that were studied.

Baseline system: VAV Rooftop system with Hot Water Reheat. This system includes a hot water boiler with pumps and VAV boxes with hot water reheat coils. Pipe and duct distribution systems are also included with required building modifications to accommodate a rooftop unit.

Proposed Design alternative #1: Fan coils with Hot Water Boiler and Reciprocating Chiller. System would be a 4 pipe system with hot and chilled water coils in the individual fan coil units. A hot water boiler with pumps would be included. A reciprocating chiller with pumps would be included. Ventilation for the spaces would be by direct introduction into the fan coil unit.

Proposed Basis of Design alternative: Geothermal Heat Pumps with a ground water field source of 36 bore holes. A separate dedicated outdoor air unit recovers exhaust from the toilets and janitors closets to preheat and precool the incoming ventilation for the entire facility. Ventilation air is ducted directly into each space from the Energy Recovery Ventilator. Water from the well field is piped to supply and return headers in the mechanical room and pumped to the individual heat pump units. Units are provided in each space.

Life Cycle Cost Analysis Calculations have been prepared using a 40 year life cycle. The costs are as shown below:

SYSTEM	FIRST COST	LIFE CYCLE COST
Baseline Vav with HW reheat	$889,500	$**2,261,891**
Fan Coil Units with HW heat & CHW	$1,125,400	$**2,641,163**
Proposed Geothermal Heat Pumps	$929,300	$**1,833,100**

Table 1. Annual Costs

Component	[B090] PTAC building ($)	[B180] PTAC building ($)	[B270] PTAC building ($)	Minot GSHP building ($)	PTAC building ($)
HVAC Components					
Electric	5,897	5,669	5,926	4,237	5,707
Natural Gas	7,587	7,587	7,587	7,587	7,587
Fuel Oil	0	0	0	0	0
Propane	0	0	0	0	0
Remote HW	0	0	0	0	0
Remote Steam	0	0	0	0	0
Remote CW	0	0	0	0	0
HVAC Sub-Total	**13,484**	**13,256**	**13,513**	**11,824**	**13,294**
Non-HVAC Components					
Electric	5,029	5,029	5,029	3,485	5,029
Natural Gas	0	0	0	0	0
Fuel Oil	0	0	0	0	0
Propane	0	0	0	0	0
Remote HW	0	0	0	0	0
Remote Steam	0	0	0	0	0
Non-HVAC Sub-Total	**5,029**	**5,029**	**5,029**	**3,485**	**5,029**
Grand Total	**18,513**	**18,284**	**18,542**	**15,309**	**18,322**

Table 2. Annual Energy Consumption

Component	[B090] PTAC building	[B180] PTAC building	[B270] PTAC building	Minot GSHP building	PTAC building
HVAC Components					
Electric (kWh)	128,199	123,234	128,834	92,116	124,057
Natural Gas (Therm)	16,142	16,142	16,142	16,142	16,142
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Remote CW (na)	0	0	0	0	0
Non-HVAC Components					
Electric (kWh)	109,321	109,321	109,321	75,751	109,321
Natural Gas (Therm)	0	0	0	0	0
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Totals					
Electric (kWh)	237,519	232,555	238,155	167,867	233,378
Natural Gas (Therm)	16,142	16,142	16,142	16,142	16,142
Fuel Oil (na)	0	0	0	0	0
Propane (na)	0	0	0	0	0
Remote HW (na)	0	0	0	0	0
Remote Steam (na)	0	0	0	0	0
Remote CW (na)	0	0	0	0	0

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	140,042	5.235
Heating Coil Loads	228,740	8.551
Grand Total	**368,782**	**13.787**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	53,453	1.998	190,902	7.137
Cooling	31,107	1.163	111,098	4.153
Heating	1,789,168	66.887	2,239,002	83.704
Pumps	54,805	2.049	195,733	7.317
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**1,928,533**	**72.097**	**2,736,734**	**102.312**
Lights	147,893	5.529	528,188	19.746
Electric Equipment	55,609	2.079	198,603	7.425
Misc. Electric	54,960	2.055	196,287	7.338
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**258,462**	**9.663**	**923,079**	**34.509**
Grand Total	**2,186,995**	**81.760**	**3,659,813**	**136.821**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	140,042	5.235
Heating Coil Loads	228,740	8.551
Grand Total	**368,782**	**13.787**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	314,299	11.750	1,122,497	41.964
Natural Gas	1,614,232	60.347	1,614,232	60.347
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**1,928,531**	**72.097**	**2,736,729**	**102.312**
Non-HVAC Components				
Electric	258,464	9.663	923,084	34.509
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**258,464**	**9.663**	**923,084**	**34.509**
Grand Total	**2,186,995**	**81.760**	**3,659,814**	**136.821**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	155,931	5.876
Heating Coil Loads	581,694	21.918
Grand Total	**737,625**	**27.794**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	38,846	1.464	138,737	5.228
Cooling	41,882	1.578	149,580	5.636
Heating	1,927,532	72.630	2,733,160	102.987
Pumps	29,260	1.103	104,500	3.938
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**2,037,520**	**76.775**	**3,125,976**	**117.788**
Lights	296,170	11.160	1,057,748	39.856
Electric Equipment	54,458	2.052	194,491	7.329
Misc. Electric	22,373	0.843	79,904	3.011
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**373,000**	**14.055**	**1,332,144**	**50.196**
Grand Total	**2,410,520**	**90.829**	**4,458,119**	**167.984**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26539.0** ft²
   Conditioned Floor Area .... **26539.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	155,931	5.876
Heating Coil Loads	581,694	21.918
Grand Total	**737,625**	**27.794**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	423,282	15.949	1,511,722	56.962
Natural Gas	1,614,232	60.825	1,614,232	60.825
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**2,037,514**	**76.774**	**3,125,954**	**117.787**
Non-HVAC Components				
Electric	373,002	14.055	1,332,150	50.196
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**373,002**	**14.055**	**1,332,150**	**50.196**
Grand Total	**2,410,516**	**90.829**	**4,458,104**	**167.983**

Notes:

1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26539.0** ft²
   Conditioned Floor Area .... **26539.0** ft²

Annual Energy and Emissions Summary

Building 276 Reno-Minot AFB LEED 24Feb16 02/25/2016
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Table 1. Annual Costs

Component	FAN COIL building ($)
HVAC Components	
Electric	1,615
Natural Gas	10,639
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**12,254**
Non-HVAC Components	
Electric	3,141
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**3,141**
Grand Total	**15,395**

Table 2. Annual Energy Consumption

Component	FAN COIL building
HVAC Components	
Electric (kWh)	35,105
Natural Gas (Therm)	22,637
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	68,287
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	103,392
Natural Gas (Therm)	22,637
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	115,243	5.166
Heating Coil Loads	581,533	26.067
Grand Total	**696,776**	**31.233**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	36,517	1.637	130,417	5.846
Cooling	20,133	0.903	71,905	3.223
Heating	2,263,677	101.469	2,263,677	101.469
Pumps	56,512	2.533	201,829	9.047
Heat Rejection Fans	6,618	0.297	23,636	1.060
HVAC Sub-Total	**2,383,457**	**106.839**	**2,691,464**	**120.645**
Lights	232,994	10.444	832,123	37.300
Electric Equipment	0	0.000	0	0.000
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**232,994**	**10.444**	**832,123**	**37.300**
Grand Total	**2,616,452**	**117.283**	**3,523,587**	**157.945**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **22309.0** ft²
   Conditioned Floor Area .... **22309.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	115,243	5.166
Heating Coil Loads	581,533	26.067
Grand Total	**696,776**	**31.233**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	119,780	5.369	427,784	19.175
Natural Gas	2,263,677	101.469	2,263,677	101.469
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**2,383,457**	**106.838**	**2,691,462**	**120.645**
Non-HVAC Components				
Electric	232,994	10.444	832,123	37.300
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**232,994**	**10.444**	**832,123**	**37.300**
Grand Total	**2,616,451**	**117.282**	**3,523,584**	**157.945**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **22309.0** ft²
   Conditioned Floor Area .... **22309.0** ft²

Table 1. Annual Costs

Component	VAV RTU building ($)
HVAC Components	
Electric	2,295
Natural Gas	11,527
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**13,822**
Non-HVAC Components	
Electric	4,795
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**4,795**
Grand Total	**18,618**

Table 2. Annual Energy Consumption

Component	VAV RTU building
HVAC Components	
Electric (kWh)	49,901
Natural Gas (Therm)	24,525
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	104,245
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	154,146
Natural Gas (Therm)	24,525
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	312,705	11.690
Heating Coil Loads	836,658	31.278
Grand Total	**1,149,362**	**42.968**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	56,102	2.097	200,365	7.491
Cooling	78,184	2.923	279,228	10.439
Heating	2,452,533	91.687	2,452,533	91.687
Pumps	35,975	1.345	128,482	4.803
Heat Rejection Fans	0	0.000	0	0.000
HVAC Sub-Total	**2,622,793**	**98.052**	**3,060,607**	**114.420**
Lights	294,848	11.023	1,053,027	39.367
Electric Equipment	55,609	2.079	198,603	7.425
Misc. Electric	5,222	0.195	18,650	0.697
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**355,678**	**13.297**	**1,270,280**	**47.489**
Grand Total	**2,978,472**	**111.349**	**4,330,887**	**161.908**

Notes:

1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	312,705	11.690
Heating Coil Loads	836,658	31.278
Grand Total	**1,149,362**	**42.968**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	170,262	6.365	608,077	22.733
Natural Gas	2,452,533	91.687	2,452,533	91.687
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**2,622,794**	**98.052**	**3,060,609**	**114.420**
Non-HVAC Components				
Electric	355,684	13.297	1,270,300	47.490
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**355,684**	**13.297**	**1,270,300**	**47.490**
Grand Total	**2,978,478**	**111.349**	**4,330,909**	**161.909**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area .... **26749.0** ft²
   Conditioned Floor Area .... **26749.0** ft²

NIST BLCC 5.3-15: Input Data Listing

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

General Information

File Name:	\\corp.leidos.com\ESG\ORG\FDB\1648-STL\AandE\Discipln\Facility_Design_Mechanical\Files from Craig Creason Computer\BLCC Files\projects\Minot AFB Dorm 276 Renovation Rev6.xml
Date of Study:	Thu Feb 25 16:15:42 CST 2016
Analysis Type:	MILCON Analysis, Non-Energy Project
Project Name:	Minot AFB Dorm 276 Renovation
Project Location:	North Dakota
Analyst:	R Streets
Base Date:	October 1, 2015
Beneficial Occupancy Date:	October 1, 2015
Study Period:	40 years 0 months (October 1, 2015 through September 30, 2055)
Discount Rate:	1.4%
Discounting Convention:	Mid-Year

Discount and Escalation Rates are REAL (exclusive of general inflation)

Alternative: VAV Hot Water Reheat

Energy: Electricity

Annual Consumption:	49,901.0 kWh
Price per Unit:	$0.04600
Demand Charge:	$0
Utility Rebate:	$0
Location:	North Dakota
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation

April 1, 2014	**1 year 0 months**	2.13%
April 1, 2015	**1 year 0 months**	2.12%
April 1, 2016	**1 year 0 months**	-0.04%
April 1, 2017	**1 year 0 months**	0.07%
April 1, 2018	**1 year 0 months**	1.44%
April 1, 2019	**1 year 0 months**	1.21%
April 1, 2020	**1 year 0 months**	0.72%
April 1, 2021	**1 year 0 months**	0.58%
April 1, 2022	**1 year 0 months**	0%
April 1, 2023	**1 year 0 months**	0.88%
April 1, 2024	**1 year 0 months**	0.44%
April 1, 2025	**1 year 0 months**	0.37%
April 1, 2026	**1 year 0 months**	0.63%
April 1, 2027	**1 year 0 months**	0%
April 1, 2028	**1 year 0 months**	-0.07%
April 1, 2029	**1 year 0 months**	0.17%
April 1, 2030	**1 year 0 months**	0.36%
April 1, 2031	**1 year 0 months**	0.53%
April 1, 2032	**1 year 0 months**	0.49%
April 1, 2033	**1 year 0 months**	0.36%
April 1, 2034	**1 year 0 months**	0.13%
April 1, 2035	**1 year 0 months**	0.45%
April 1, 2036	**1 year 0 months**	0.74%
April 1, 2037	**1 year 0 months**	0.86%
April 1, 2038	**1 year 0 months**	0.98%
April 1, 2039	**1 year 0 months**	0.57%
April 1, 2040	**1 year 0 months**	0.44%
April 1, 2041	**1 year 0 months**	0.44%
April 1, 2042	**1 year 0 months**	0.4%
April 1, 2043	**1 year 0 months**	0.43%
April 1, 2044	**Remaining**	0.45%

Energy: Natural Gas

Annual Consumption:	24,525.0 Therm
Price per Unit:	$0.47000
Demand Charge:	$0
Utility Rebate:	$0
End-Use:	Industrial Boiler, uncontrolled
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation
April 1, 2014	**1 year 0 months**	0%
April 1, 2015	**1 year 0 months**	-1.06%
April 1, 2016	**1 year 0 months**	-0.95%
April 1, 2017	**1 year 0 months**	3.13%
April 1, 2018	**1 year 0 months**	5.02%
April 1, 2019	**1 year 0 months**	3.33%
April 1, 2020	**1 year 0 months**	1.83%
April 1, 2021	**1 year 0 months**	1.27%
April 1, 2022	**1 year 0 months**	0.83%
April 1, 2023	**1 year 0 months**	1.14%
April 1, 2024	**1 year 0 months**	1.74%
April 1, 2025	**1 year 0 months**	0.4%
April 1, 2026	**1 year 0 months**	-0.8%
April 1, 2027	**1 year 0 months**	-0.4%
April 1, 2028	**1 year 0 months**	0.1%
April 1, 2029	**1 year 0 months**	1.32%
April 1, 2030	**1 year 0 months**	1.7%
April 1, 2031	**1 year 0 months**	1.67%
April 1, 2032	**1 year 0 months**	1.55%
April 1, 2033	**1 year 0 months**	1.52%
April 1, 2034	**1 year 0 months**	1.41%
April 1, 2035	**1 year 0 months**	1.02%
April 1, 2036	**1 year 0 months**	1.65%
April 1, 2037	**1 year 0 months**	3.24%
April 1, 2038	**1 year 0 months**	3.4%
April 1, 2039	**1 year 0 months**	1.77%
April 1, 2040	**1 year 0 months**	1.24%
April 1, 2041	**1 year 0 months**	1.31%
April 1, 2042	**1 year 0 months**	1.29%
April 1, 2043	**1 year 0 months**	1.28%
April 1, 2044	**Remaining**	1.38%

Component: Vav Rootop system with Hot water reheat

Initial Investment

Initial Cost (base-year $):	$889,500
Annual Rate of Increase:	1%
Expected Asset Life:	25 years 0 months
Residual Value Factor:	1%

Cost-Phasing

Cost Adjustment Factor: 0%

Years/Months (from Date)	Date	Portion
0 years 0 months	**October 1, 2015**	100%

Major Repair and Replacement: Boiler replacement

Years/Months:	25 years 0 months
Amount:	$10,000
Annual Rate Of Increase:	0%
Expected Asset Life:	25 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: VAV rooftop replacement

Years/Months:	15 years 0 months
Amount:	$35,000
Annual Rate Of Increase:	0%
Expected Asset Life:	15 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: Pumps replacement

Years/Months:	20 years 0 months
Amount:	$10,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: VAV Air Terminal replacement

Years/Months:	20 years 0 months

Amount:	$90,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: VAV rooftop 2nd replacement

Years/Months:	30 years 0 months
Amount:	$35,000
Annual Rate Of Increase:	0%
Expected Asset Life:	15 years 0 months
Residual Value Factor:	0%

Routine Recurring OM&R: Filter replacement

Amount:	$2,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Vav Rooftop Maintenance

Amount:	$6,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Spare Parts Storage

Amount:	$5,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Maintenance Training

Amount:	$10,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Alternative: Proposed Heat Pump System

Energy: Electricity

Annual Consumption:	93,066.0 kWh
Price per Unit:	$0.04600
Demand Charge:	$0
Utility Rebate:	$0
Location:	North Dakota
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation
April 1, 2014	**1 year 0 months**	2.13%
April 1, 2015	**1 year 0 months**	2.12%
April 1, 2016	**1 year 0 months**	-0.04%
April 1, 2017	**1 year 0 months**	0.07%
April 1, 2018	**1 year 0 months**	1.44%
April 1, 2019	**1 year 0 months**	1.21%
April 1, 2020	**1 year 0 months**	0.72%
April 1, 2021	**1 year 0 months**	0.58%
April 1, 2022	**1 year 0 months**	0%

April 1, 2023	**1 year 0 months**	0.88%
April 1, 2024	**1 year 0 months**	0.44%
April 1, 2025	**1 year 0 months**	0.37%
April 1, 2026	**1 year 0 months**	0.63%
April 1, 2027	**1 year 0 months**	0%
April 1, 2028	**1 year 0 months**	-0.07%
April 1, 2029	**1 year 0 months**	0.17%
April 1, 2030	**1 year 0 months**	0.36%
April 1, 2031	**1 year 0 months**	0.53%
April 1, 2032	**1 year 0 months**	0.49%
April 1, 2033	**1 year 0 months**	0.36%
April 1, 2034	**1 year 0 months**	0.13%
April 1, 2035	**1 year 0 months**	0.45%
April 1, 2036	**1 year 0 months**	0.74%
April 1, 2037	**1 year 0 months**	0.86%
April 1, 2038	**1 year 0 months**	0.98%
April 1, 2039	**1 year 0 months**	0.57%
April 1, 2040	**1 year 0 months**	0.44%
April 1, 2041	**1 year 0 months**	0.44%
April 1, 2042	**1 year 0 months**	0.4%
April 1, 2043	**1 year 0 months**	0.43%
April 1, 2044	**Remaining**	0.45%

Energy: Natural Gas

Annual Consumption:	16,142.0 Therm
Price per Unit:	$0.47000
Demand Charge:	$0
Utility Rebate:	$0
End-Use:	Industrial Boiler, uncontrolled
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation
April 1, 2014	**1 year 0 months**	0%

April 1, 2015	**1 year 0 months**	-1.06%
April 1, 2016	**1 year 0 months**	-0.95%
April 1, 2017	**1 year 0 months**	3.13%
April 1, 2018	**1 year 0 months**	5.02%
April 1, 2019	**1 year 0 months**	3.33%
April 1, 2020	**1 year 0 months**	1.83%
April 1, 2021	**1 year 0 months**	1.27%
April 1, 2022	**1 year 0 months**	0.83%
April 1, 2023	**1 year 0 months**	1.14%
April 1, 2024	**1 year 0 months**	1.74%
April 1, 2025	**1 year 0 months**	0.4%
April 1, 2026	**1 year 0 months**	-0.8%
April 1, 2027	**1 year 0 months**	-0.4%
April 1, 2028	**1 year 0 months**	0.1%
April 1, 2029	**1 year 0 months**	1.32%
April 1, 2030	**1 year 0 months**	1.7%
April 1, 2031	**1 year 0 months**	1.67%
April 1, 2032	**1 year 0 months**	1.55%
April 1, 2033	**1 year 0 months**	1.52%
April 1, 2034	**1 year 0 months**	1.41%
April 1, 2035	**1 year 0 months**	1.02%
April 1, 2036	**1 year 0 months**	1.65%
April 1, 2037	**1 year 0 months**	3.24%
April 1, 2038	**1 year 0 months**	3.4%
April 1, 2039	**1 year 0 months**	1.77%
April 1, 2040	**1 year 0 months**	1.24%
April 1, 2041	**1 year 0 months**	1.31%
April 1, 2042	**1 year 0 months**	1.29%
April 1, 2043	**1 year 0 months**	1.28%
April 1, 2044	**Remaining**	1.38%

Component: Cost of Mechanical system

Initial Investment

Initial Cost (base-year $):	$929,300
Annual Rate of Increase:	1%
Expected Asset Life:	25 years 0 months
Residual Value Factor:	1%

Cost-Phasing

Cost Adjustment Factor: 0%

Years/Months (from Date)	Date	Portion
0 years 0 months	**October 1, 2015**	100%

Major Repair and Replacement: Pumps replacement

Years/Months:	20 years 0 months
Amount:	$10,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: Heat Pump replacement

Years/Months:	24 years 0 months
Amount:	$250,000
Annual Rate Of Increase:	0%
Expected Asset Life:	24 years 0 months
Residual Value Factor:	0%

Routine Recurring OM&R: Filter replacement

Amount:	$8,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Heat Pump Maintenance

Amount:	$1,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Alternative: FAN COIL W HW HEAT/CHILLED WTR

Energy: Electricity

Annual Consumption:	35,105.0 kWh
Price per Unit:	$0.04600
Demand Charge:	$0
Utility Rebate:	$0
Location:	North Dakota
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation
April 1, 2014	**1 year 0 months**	2.13%
April 1, 2015	**1 year 0 months**	2.12%
April 1, 2016	**1 year 0 months**	-0.04%
April 1, 2017	**1 year 0 months**	0.07%
April 1, 2018	**1 year 0 months**	1.44%
April 1, 2019	**1 year 0 months**	1.21%
April 1, 2020	**1 year 0 months**	0.72%
April 1, 2021	**1 year 0 months**	0.58%
April 1, 2022	**1 year 0 months**	0%
April 1, 2023	**1 year 0 months**	0.88%
April 1, 2024	**1 year 0 months**	0.44%
April 1, 2025	**1 year 0 months**	0.37%
April 1, 2026	**1 year 0 months**	0.63%
April 1, 2027	**1 year 0 months**	0%
April 1, 2028	**1 year 0 months**	-0.07%
April 1, 2029	**1 year 0 months**	0.17%
April 1, 2030	**1 year 0 months**	0.36%
April 1, 2031	**1 year 0 months**	0.53%
April 1, 2032	**1 year 0 months**	0.49%
April 1, 2033	**1 year 0 months**	0.36%
April 1, 2034	**1 year 0 months**	0.13%

April 1, 2035	**1 year 0 months**	0.45%
April 1, 2036	**1 year 0 months**	0.74%
April 1, 2037	**1 year 0 months**	0.86%
April 1, 2038	**1 year 0 months**	0.98%
April 1, 2039	**1 year 0 months**	0.57%
April 1, 2040	**1 year 0 months**	0.44%
April 1, 2041	**1 year 0 months**	0.44%
April 1, 2042	**1 year 0 months**	0.4%
April 1, 2043	**1 year 0 months**	0.43%
April 1, 2044	**Remaining**	0.45%

Energy: Natural Gas

Annual Consumption:	22,637.0 Therm
Price per Unit:	$0.47000
Demand Charge:	$0
Utility Rebate:	$0
End-Use:	Industrial Boiler, uncontrolled
Rate Schedule:	Commercial
State:	North Dakota

Usage Indices

From Date	Duration	Usage Index
October 1, 2015	**Remaining**	100%

Escalation Rates

From Date	Duration	Escalation
April 1, 2014	**1 year 0 months**	0%
April 1, 2015	**1 year 0 months**	-1.06%
April 1, 2016	**1 year 0 months**	-0.95%
April 1, 2017	**1 year 0 months**	3.13%
April 1, 2018	**1 year 0 months**	5.02%
April 1, 2019	**1 year 0 months**	3.33%
April 1, 2020	**1 year 0 months**	1.83%
April 1, 2021	**1 year 0 months**	1.27%
April 1, 2022	**1 year 0 months**	0.83%
April 1, 2023	**1 year 0 months**	1.14%
April 1, 2024	**1 year 0 months**	1.74%
April 1, 2025	**1 year 0 months**	0.4%
April 1, 2026	**1 year 0 months**	-0.8%

April 1, 2027	**1 year 0 months**	-0.4%
April 1, 2028	**1 year 0 months**	0.1%
April 1, 2029	**1 year 0 months**	1.32%
April 1, 2030	**1 year 0 months**	1.7%
April 1, 2031	**1 year 0 months**	1.67%
April 1, 2032	**1 year 0 months**	1.55%
April 1, 2033	**1 year 0 months**	1.52%
April 1, 2034	**1 year 0 months**	1.41%
April 1, 2035	**1 year 0 months**	1.02%
April 1, 2036	**1 year 0 months**	1.65%
April 1, 2037	**1 year 0 months**	3.24%
April 1, 2038	**1 year 0 months**	3.4%
April 1, 2039	**1 year 0 months**	1.77%
April 1, 2040	**1 year 0 months**	1.24%
April 1, 2041	**1 year 0 months**	1.31%
April 1, 2042	**1 year 0 months**	1.29%
April 1, 2043	**1 year 0 months**	1.28%
April 1, 2044	**Remaining**	1.38%

Component:

Initial Investment

Initial Cost (base-year $):	$1,125,400
Annual Rate of Increase:	1%
Expected Asset Life:	25 years 0 months
Residual Value Factor:	1%

Cost-Phasing

Cost Adjustment Factor: 0%

Years/Months (from Date)	Date	Portion
0 years 0 months	**October 1, 2015**	100%

Major Repair and Replacement: Boiler replacement

Years/Months:	25 years 0 months
Amount:	$10,000
Annual Rate Of Increase:	0%
Expected Asset Life:	25 years 0 months

Residual Value Factor:	0%

Major Repair and Replacement: Chiller replacement

Years/Months:	20 years 0 months
Amount:	$35,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: Pumps replacement

Years/Months:	20 years 0 months
Amount:	$20,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Major Repair and Replacement: Fan coil replacement

Years/Months:	20 years 0 months
Amount:	$180,000
Annual Rate Of Increase:	0%
Expected Asset Life:	20 years 0 months
Residual Value Factor:	0%

Routine Recurring OM&R: Filter Replacement

Amount:	$8,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Fan Coil Maintenance

Amount:	$5,000
Annual Rate of Increase:	0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Copy of: Spare Parts Storage

Amount: $5,000

Annual Rate of Increase: 0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

Routine Recurring OM&R: Copy of: Maintenance Training

Amount: $10,000

Annual Rate of Increase: 0%

Usage Indices

From Date	Duration	Factor
October 1, 2015	**Remaining**	100%

NIST BLCC 5.3-15: Detailed LCC Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

General Information

File Name:	\\corp.leidos.com\ESG\ORG\FDB\1648-STL\AandE\Discipln\Facility_Design_Mechanical\Files from Craig Creason Computer\BLCC Files\projects\Minot AFB Dorm 276 Renovation Rev6.xml
Date of Study:	Thu Feb 25 16:19:16 CST 2016
Analysis Type:	MILCON Analysis, Non-Energy Project
Project Name:	Minot AFB Dorm 276 Renovation
Project Location:	North Dakota
Analyst:	R Streets
Base Date:	October 1, 2015
Beneficial Occupancy Date:	October 1, 2015
Study Period:	40 years 0 months (October 1, 2015 through September 30, 2055)
Discount Rate:	1.4%
Discounting Convention:	Mid-Year

Discount and Escalation Rates are REAL (exclusive of general inflation)

Alternative: VAV Hot Water Reheat

Initial Cost Data (not Discounted)

Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $889,500

Component: Vav Rootop system with Hot water reheat

Cost-Phasing

Date	Portion	Yearly Cost
October 1, 2015	100%	$889,500
	------------	------------
Total (for Component)		$889,500

Energy Costs: Electricity

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
49,901.0 kWh	$0.04600	$2,295	$0	$0

Energy Costs: Natural Gas

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
24,525.0 Therm	$0.47000	$11,527	$0	$0

Life-Cycle Cost Analysis

	Present Value	Annual Value
Initial Capital Costs	$889,500	$29,195
Energy Costs		
Energy Consumption Costs	$540,516	$17,741
Energy Demand Charges	$0	$0
Energy Utility Rebates	$0	$0

	------------	------------
Subtotal (for Energy):	$540,516	$17,741
Water Usage Costs	$0	$0
Water Disposal Costs	$0	$0
Routine Operating, Maintenance & Repair Costs		
Component: Vav Rootop system with Hot water reheat		
Routine Annually Recurring Costs	$705,669	$23,161
Routine Non-Annually Recurring Costs	$0	$0
	------------	------------
Subtotal (for OM&R):	$705,669	$23,161
Major Repair and Replacements		
Component: Vav Rootop system with Hot water reheat	$134,264	$4,407
	------------	------------
Subtotal (for Repair and Replacements):	$134,264	$4,407
Residual Value of Original Capital Components		
Component: Vav Rootop system with Hot water reheat	-$8,058	-$264
	------------	------------
Subtotal (for Residual Value):	-$8,058	-$264
Residual Value of Major Repair and Replacements		
Component: Vav Rootop system with Hot water reheat	$0	$0
	------------	------------
Subtotal (for Residual Value):	$0	$0
Total Life-Cycle Cost	$2,261,891	$74,239

Emissions Summary

Energy Name	Annual	Life-Cycle
Electricity:		
CO_2	56,555.14 kg	2,262,050.65 kg
SO_2	210.56 kg	8,421.69 kg
NO_x	116.78 kg	4,670.73 kg
Natural Gas:		
CO_2	129,540.86 kg	5,181,279.72 kg
SO_2	1,045.44 kg	41,814.56 kg
NO_x	152.68 kg	6,106.58 kg
Total:		
CO_2	186,096.00 kg	7,443,330.37 kg
SO_2	1,255.99 kg	50,236.25 kg
NO_x	269.45 kg	10,777.32 kg

Alternative: Proposed Heat Pump System

Initial Cost Data (not Discounted)

Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $929,300

Component: Cost of Mechanical system

Cost-Phasing

Date	Portion	Yearly Cost
October 1, 2015	100%	$929,300
	------------	------------
Total (for Component)		$929,300

Energy Costs: Electricity

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
93,066.0 kWh	$0.04600	$4,281	$0	$0

Energy Costs: Natural Gas

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
16,142.0 Therm	$0.47000	$7,587	$0	$0

Life-Cycle Cost Analysis

	Present Value	Annual Value
Initial Capital Costs	$929,300	$30,501
Energy Costs		
Energy Consumption Costs	$449,442	$14,751
Energy Demand Charges	$0	$0
Energy Utility Rebates	$0	$0

	------------	------------
Subtotal (for Energy):	$449,442	$14,751
Water Usage Costs	$0	$0
Water Disposal Costs	$0	$0
Routine Operating, Maintenance & Repair Costs		
Component: Cost of Mechanical system		
Routine Annually Recurring Costs	$276,131	$9,063
Routine Non-Annually Recurring Costs	$0	$0
	------------	------------
Subtotal (for OM&R):	$276,131	$9,063
Major Repair and Replacements		
Component: Cost of Mechanical system	$186,645	$6,126
	------------	------------
Subtotal (for Repair and Replacements):	$186,645	$6,126
Residual Value of Original Capital Components		
Component: Cost of Mechanical system	-$8,419	-$276
	------------	------------
Subtotal (for Residual Value):	-$8,419	-$276
Residual Value of Major Repair and Replacements		
Component: Cost of Mechanical system	$0	$0
	------------	------------
Subtotal (for Residual Value):	$0	$0
Total Life-Cycle Cost	$1,833,100	$60,166

Emissions Summary

Energy Name	Annual	Life-Cycle
Electricity:		
CO_2	105,476.05 kg	4,218,753.25 kg
SO_2	392.69 kg	15,706.56 kg
NO_x	217.79 kg	8,710.98 kg
Natural Gas:		
CO_2	85,261.92 kg	3,410,243.31 kg
SO_2	688.09 kg	27,521.74 kg
NO_x	100.49 kg	4,019.26 kg
Total:		
CO_2	190,737.97 kg	7,628,996.57 kg
SO_2	1,080.78 kg	43,228.30 kg
NO_x	318.28 kg	12,730.24 kg

Alternative: FAN COIL W HW HEAT/CHILLED WTR

Initial Cost Data (not Discounted)

Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $1,125,400

Component:

Cost-Phasing

Date	Portion	Yearly Cost
October 1, 2015	100%	$1,125,400
	------------	------------
Total (for Component)		$1,125,400

Energy Costs: Electricity

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
35,105.0 kWh	$0.04600	$1,615	$0	$0

Energy Costs: Natural Gas

(base-year dollars)

Average Annual Usage	Price/Unit	Average Annual Cost	Average Annual Demand	Average Annual Rebate
22,637.0 Therm	$0.47000	$10,639	$0	$0

Life-Cycle Cost Analysis

	Present Value	Annual Value
Initial Capital Costs	$1,125,400	$36,938
Energy Costs		
Energy Consumption Costs	$481,864	$15,816
Energy Demand Charges	$0	$0
Energy Utility Rebates	$0	$0

	------------	------------
Subtotal (for Energy):	$481,864	$15,816
Water Usage Costs	$0	$0
Water Disposal Costs	$0	$0
Routine Operating, Maintenance & Repair Costs		
Component:		
Routine Annually Recurring Costs	$859,076	$28,196
Routine Non-Annually Recurring Costs	$0	$0
	------------	------------
Subtotal (for OM&R):	$859,076	$28,196
Major Repair and Replacements		
Component:	$185,018	$6,073
	------------	------------
Subtotal (for Repair and Replacements):	$185,018	$6,073
Residual Value of Original Capital Components		
Component:	-$10,195	-$335
	------------	------------
Subtotal (for Residual Value):	-$10,195	-$335
Residual Value of Major Repair and Replacements		
Component:	$0	$0
	------------	------------
Subtotal (for Residual Value):	$0	$0
Total Life-Cycle Cost	$2,641,163	$86,688

Emissions Summary

Energy Name	Annual	Life-Cycle
Electricity:		
CO2	39,786.14 kg	1,591,336.61 kg
SO2	148.13 kg	5,924.60 kg
NOx	82.15 kg	3,285.83 kg
Natural Gas:		
CO2	119,568.46 kg	4,782,410.97 kg
SO2	964.96 kg	38,595.57 kg
NOx	140.92 kg	5,636.48 kg
Total:		
CO2	159,354.60 kg	6,373,747.58 kg
SO2	1,113.08 kg	44,520.17 kg
NOx	223.07 kg	8,922.31 kg

LCCA COST BACKUP DATA

Minot AFB Building 276 LCCA Back-Up Data (rev 25Feb16)

Systems' Equipment List

EQUIPMENT	Base System – VAV	Alternate #1 – FCUs	Ground Source Heat Pump
Cooling Plant	Packaged Rooftop Unit - DX	Chiller and cooling tower with pumps	GSHP Compressors w/ 36 - 195-ft wells and pumps
Heating Plant	Hot Water Boilers with pumps	Hot Water Boilers with pumps	GSHP Compressors w/ 36 - 195-ft wells and pumps
Air Distribution	Primary Air to VAVs w/ FDs at each floor.	FCUs in each room	GSHP in each room
Water Distribution	HW to VAVs	CHW & HW to FCUs	CW to GSHPs
Zone (Room) Units	VAV in each room	FCUs in each room	GSHP in each room
Ventilation Air	Outside Air at RTU	Ducted to each FCU	ERV from toilet exhaust. OA ducted to each room
Unoccupied Spaces	HW terminal unit	2-pipe FCU HW only	Electric resistance terminal units
Electrical Power	Rooftop Unit Boilers and pumps HW terminial units	Chiller and pumps Boilers and pumps FCUs	GSHPs Wellfield pumps Electric terminal units.
Controls Wiring	Rooftop Unit Boilers VAVs	Chiller Boilers FCUs	GSHPs ERV
Building Modifications	Add 3' attic space for primary air distribution	Add separate 20'x20' building for chiller plant	None
Spare Parts Storage	1000 SF rack storage leased @ $5/SF/yr	1000 SF rack storage leased @ $5/SF/yr	No extra required for GSHP units
Maintenance Training	3 persons every 3 years @ $10,000 each	3 persons every 3 years @ $10,000 each	No extra required for GSHP units

Note: Exhaust ductwork system is same in all options.

A. Baseline System of VAV Rooftops with Hot Water Reheat Boilers

1. Initial Investment

Cooling Plant - 25T Packaged Rooftop	$32,500
Heating Plant - Boilers	$10,000
Air Distribution - Primary Ductwork w/ FDs	$160,000
Air Distribution - VAV Ductwork	$90,000
Air Distributrion – Return Air Ductwork	$150,000
Water Distribution - Pumps/Piping	$250,000
Zone Units - VAV's -90 each	$90,000
Ventilation Air – in Rooftop Unit	$0
Unoccupied Spaces – HW Terminal Units – 15 each	$5,000
Electrical Power –	$2,000
Controls Wiring – in VAV's	$0
Building Modifications – Raise Roof 3' for attic space	$100,000
TOTAL	$**889,500**

2. Reoccurring Maintenance, Repair and Custodial Cost

Filter replacement	$2,000
VAV maintenance	$6,000
Spare parts storage	$5,000
Training – average/year	$10,000
Annual Costs	$**23,000**

3. Major Repair and Replacement Cost

Boiler Replacement (25 yr)	$10,000
VAV Rooftop Replacement (15 yr)	$70,000
Pumps Replacement (20 yr)	$10,000
VAV Air Terminal Replacement (20 yr)	$90,000

B. Proposed Design Alternative #1: Fan Coils with Hot Water Reheat Boilers

1. Initial Investment

Cooling Plant – Chiller & Cooling Tower		$55,200
Water Distribution - Pumps/Piping		$360,000
Heating Plant - Boilers		$10,000
Water Distribution - Pumps/Piping		$250,000
Air Distribution – with FCU's		$0
Zone Units - FCU's- 105 each		$210,000
Ventilation Air – Ductwork		$120,000
Unoccupied Spaces – with FCU's		$0
Electrical Power -		20,200
Controls Wiring - with FCU's		$0
Building Modifications – Chiller Building		$100,000
	TOTAL	$**1,125,400**

2. Reoccurring Maintenance, Repair and Custodial Cost

Filter replacement	$8,000
Fan Coil maintenance	$5,000
Spare parts storage	$5,000
Training – average/year	$10,000
Annual Costs	$**30,000**

3. Major Repair and Replacement Cost

Boiler Replacement (25 yr)	$10,000
Chiller Replacement (20 yr)	$35,000
Pumps Replacement (20 yr)	$20,000
Fan Coils Replacement (20 yr)	$300,000

C. Proposed Geothermal Heat Pump System

1. Initial Investment:

Cooling Plant – Wellfield – 36 @ 195' deep, pumps, piping		$209,000
Heating Plant – with GSHPs and wellfield		$0
Air Distribution - None		$0
Water Distribution - Piping		$223,300
Zone Units - GSHPs -90 each		$261,100
Ventilation Air – ERV & Ductwork		$167,000
Unoccupied Spaces – Elec Resist Terminal Units – 15 each		$47,400
Electrical Power –		$21,500
Controls Wiring – in GSHPs		$0
	TOTAL	$**929,300**

2. Reoccurring Maintenance, Repair and Custodial Cost

Filter replacement	$8,000
GSHP maintenance	$1,000
Annual Costs	$**9,000**

3. Major Repair and Replacement Cost

Pumps Replacement (20 yr)	$10,000
Heat Pumps Replacement (24 yr)	$250,000

Equipment life taken from 2015 ASHRAE Applications Ch.37 Table 4

Product Catalog

Water Source Heat Pump
Axiom™ High Efficiency Vertical Stack — GET
¾–3 Tons — 60 Hz

November 2013

WSHP-PRC020D-EN

Ingersoll Rand

Introduction

Water-Source Vertical High-Rise

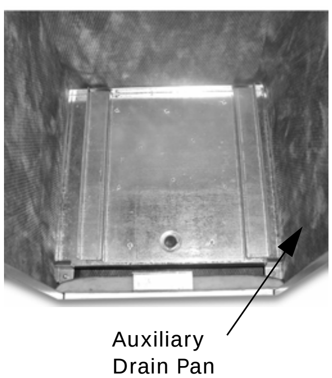
The 3/4-ton through 3-ton vertical high-rise water-source heat pump is a floor mounted, "furred-in" unit, designed to be hidden from view behind drywall to blend with the room's natural decor. In multi-story buildings, the units may be stacked one on top of the other to minimize piping and electrical costs. Supply, return and condensate riser piping may be factory mounted to simplify job site installation of the equipment.

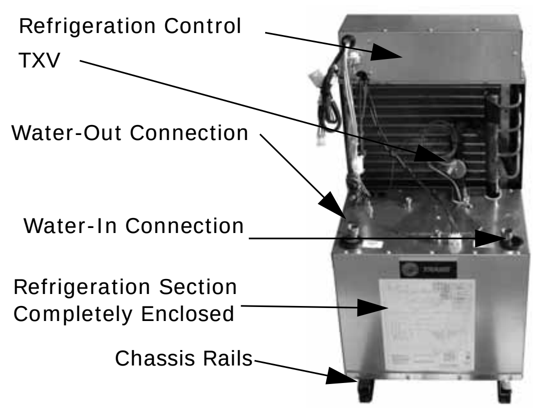
The high-rise configuration is often used in hotels, dorms and assisted living facilities where a single unit could provide comfort to a single or multiple room dwelling. Because the units are mounted directly in the space, ductwork is optional.

All water-source heat pumps are commissioned, tested and quality certified prior to leaving the factory. This assures global quality standards from controls, water, refrigeration, and aesthetics to the building owner and installing contractor.

Key features of the water-source, vertical stack heat pump include:

1. Removable/replaceable chassis
2. Ducted and free discharge cabinet selections available
3. Factory mounted flow control with strainer and isolation valve option
4. Plug-in chassis and plug-in thermostat design
5. Factory supplied riser options
6. Maintenance accessibility for coil fin cleaning
7. Extra quiet design includes enhanced and deluxe sound proofing choice
8. Through the front high and low pressure service ports accessible
9. Tamper proof hinged acoustical door option
10. Unit mounted switch and fuse option
11. Lower height cabinet for ducted applications
12. Auxiliary drain pan
13. Rust resistant chassis drain pan
14. Intelligent controls





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Revision Summary

WSHP-PRC020D-EN (09 November 2013): Performance Data (Efficiency Upgrades); WPRD Chassis

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Table of Contents

Features and Benefits

Unit Description

The vertical high-rise water-source heat pump is a floor mounted configuration available in a ¾ ton, 1 ton, 1¼ ton, 1½ ton, 2 ton and 3 ton sizes.

The unit cabinet may be ordered for early shipment to aid in early installation of drywall, plumbing and electrical. See "Model Number Descriptions," p. 14.The cabinet design is available in either an 88-inch height (free discharge) or 80-inch height (ducted) configuration. As many as 3 supply-air discharges are available for the 1¼ ton-3 ton, free discharge cabinets to provide multiple supply-air through one unit.

Air distribution is made through a rigid bar type extruded aluminum grille mounted to the sheetrock. It is both durable and attractive in design.

The return-air panel is a hinged acoustical door, see Figure 1, p. 4.The door allows for easy access to the unit's filter and for maintenance of the equipment.

The hinged acoustical panel provides greater sound attenuation, and is mounted flush to the wall. This panel is easily removed for filter maintenance or chassis removal through the magnetic catch door. An optional tamper proof latch is available on the hinged door design to impede access if required.

Figure 1. Return-air flush mounted hinged door

Blower/Motor Assembly

The unit's blower/motor assembly includes double width, double inlet (DWDI) blower with direct drive PSC motor or optional ECM motor for improved efficiency and power factor. It may be easily removed for cleaning or service after removal of the unit chassis.The PSC motor is a multi-speed design, factory wired to high speed or low speed (order specific).The tap will be wired and capped inside the unit control box for easy field convertibility.The ECM motor is programmed to provide four constant CFM profiles and is shipped on Profile B – the rated CFM of the unit.To change the PSC speed tap or the ECM CFM profile, see installation manual WSHP-SVX03*-EN for instructions.

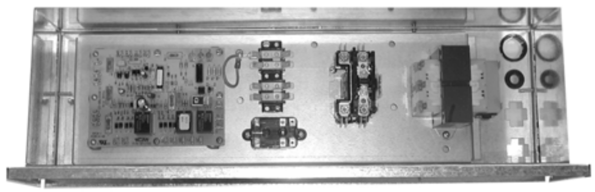
Controls

Standard controls include a 24V, micro-processor Deluxe controller for a wall-mounted thermostat option.The thermostat is typically placed above the return-air door. Even though the thermostat is considered to be unit mounted, the thermostat is mounted to the dry-wall that covers the front of the unit.

Thermostat selections are provided in the “Thermostats and Zone Sensors,” p. 55 section of the catalog. They are available in manual or automatic changeover options.

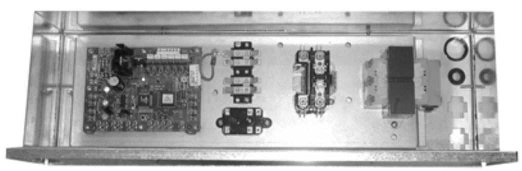
The deluxe controller includes relays for: anti-short cycle compressor protection, random start delay, brown-out protection low pressure time delay, compressor delay on start and night setback control. These extended control features offer greater system performance to extend the equipment’s life.

Figure 2. Deluxe control box



The Tracer™ ZN510 controller (option) is provided on the vertical stack design for direct digital control (DDC) systems. This controller offers the building owner innovative ways to optimize heating and cooling energy for the building. Faults and sensors include: random start delay, heating/cooling status, occupied/unoccupied mode, and fan/filter status.

Figure 3. ZN510 control box



The Tracer™ Loop Controller (TLC) may be added to either the Deluxe controls or the ZN510 controls to maintain system loop operation. See WMCA-IOP-1 for more information on the TLC.

The ZN510 controller may also be applied with the Tracker and Summit building management systems to further enhance system operation.

Non-fused switch and fused entrance block may be factory added to the equipment to save installation time of these components in the field where local building codes allow.

Deluxe 24V Electronic Controls

General alarm is accomplished through the lockout relay and is used to drive light emitting diodes. This feature will drive dry contacts only, and may not be used to drive field installed control inputs.

Factory Installed Flow Control

Optional factory mounting of the isolation valve and flow control valves is available to speed field equipment installation, and help provide optimum water flow balancing support.

Refrigeration Section

The unit’s compressor is a highly efficient, hermetically sealed with internal vibration isolation. External isolation is provided between the compressor and mounting plate to help reduce radiated noise that is typically associated with compressor start.

The air-to-refrigerant coil is easily accessible for cleaning purposes behind the unit’s removable return-air door/panel.

The water-to-refrigerant coil is a copper or cupro-nickel (option) co-axial tube-within-a-tube design. The inner-water tube is deeply fluted to enhance heat transfer and minimize fouling and scaling. The outer refrigerant gas tube is made from steel material. The coil is leak tested to assure there is no cross leakage between the water tube and the refrigerant gas (steel tube) coil. The ½” (009/012/015/018) and ¾”(024/036) threaded water connections to the water-coil are available on the exterior chassis top. A flexible hose connection with shut-off is typically used between the riser and water-coil in/out connections on the chassis to reduce water vibration.

The refrigerant flow metering is made through a thermal expansion valve (TXV). The TXV allows the unit to operate with an entering fluid temperature from 25°F to 120°F, and an entering air temperature from 40°F to 90°F. The valve precisely meters refrigerant flow through the circuitry to achieve desired heating or cooling.

Unlike cap-tube assemblies, the TXV allows the exact amount of refrigerant required to meet the coil load demands. This precise metering increases the over-all efficiency of the unit.

The unit’s reversing valve is piped to be energized in the cooling mode. All vertical high-rise units ship in a heat pump configuration with a system reversing valve.

Supply/Return/Condensate Risers

Supply, return and condensate risers are available as a factory mounted and shipped option. The risers are constructed from type L or M copper. The top of each riser is swaged to accept the same size diameter riser from above. This helps facilitate installation of the water supply, return and condensate to and from the unit. Insulation may be factory installed or field installed per order selection. The insulation helps keep moisture from forming on the pipes and damaging building construction.

The riser length may be ordered as standard in 96” to 120” lengths. See “Equipment Risers,” p. 9 for riser application information.

Unit Safety

All unit safety devices are provided to help prevent compressor damage. Low pressure switch and high pressure switch are added to help protect the compressor operation under a low charge (40 psig) or during high discharge (650 psig) pressures. In cases where a low charge, or excessive loss of charge occurs, each compressor comes equipped with an overload device to halt the compressor operation.

A safety lockout provides the mechanical communication of the low and high pressure switches to prevent compressor operation if the unit is under low or high refrigerant pressures, or during a condensate overflow condition. The lockout relay may be reset at the thermostat, by cycling power to the unit or through a LonTalk™ front end device (ZN510 control option).

Application Considerations

Advantages of Geothermal

The advantages of a geothermal heat pump system can literally decrease heating and cooling operating costs by 30%-40%. The units are durable, and typically last longer than conventional systems. They are protected from harsh outdoor weather conditions, because the unit is installed indoors and the loop underground. According to ASHRAE, the estimated service life for a commercial water-to-air heat pump is 19 years.

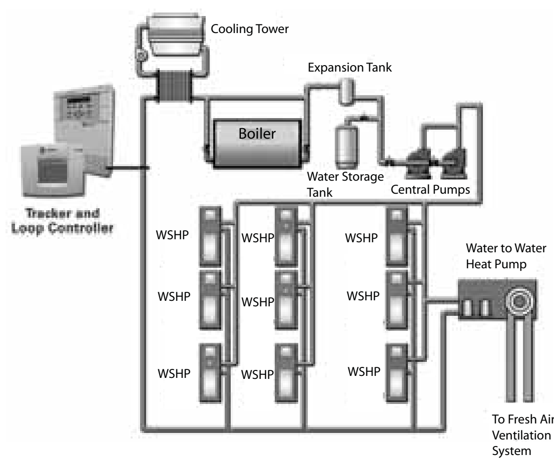
Geothermal heat pumps have fewer mechanical components, making them more reliable and less prone to failure.

Geothermal heat pumps work toward the preservation of the environment by reducing the environmental impacts of electric power generation.

Flexibility

The vertical, high-rise water-source heat pump system is versatile for installation in boiler/cooling tower applications, as well as ground-source (geothermal) applications. The system typically employs a central pumping design. The central pumping design involves a single pump design, usually located within a basement or mechanical room to fulfill pumping requirements for the entire building system. An auxiliary pump is typically applied to lessen the likelihood of system downtime if the main pump malfunctions.

Furring-In the Unit



The vertical high-rise water-source heat pump is designed to be a furred-in application. Dry-wall (sheetrock) is attached to furring studs (not unit cabinet) until the entire cabinet, except the front access panel, is enclosed. Access to the unit is made entirely through the front panel which spans approximately one-half of the unit height. The dry-wall enclosure allows the unit to blend in with the decor of the room. If renovations are needed, the drywall portion of the unit can simply be re-papered or repainted with the remainder of the room. With careful design, the high-rise WSHP can be incorporated into a room design, while occupying minimum floor space.

Installation Tips

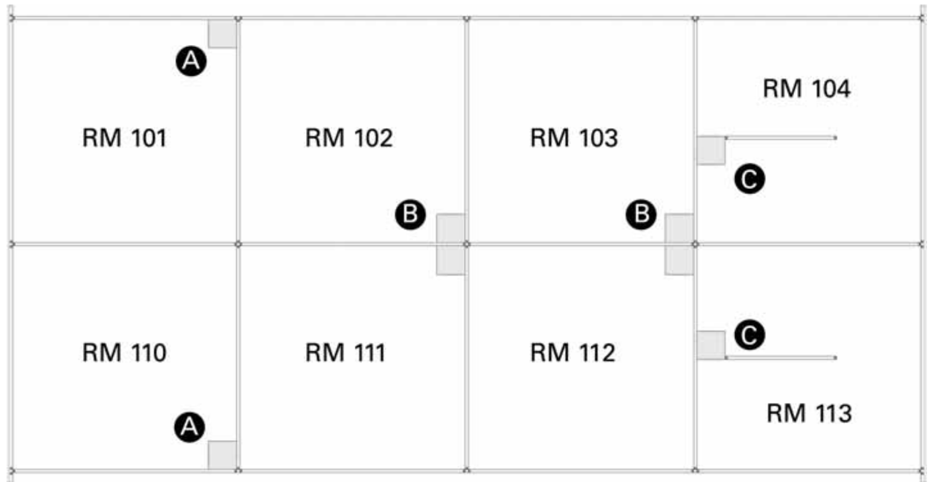
When installing a high-rise water-source heat pump, there are specific installation requirements that should be taken into consideration. These include:

- Noise control
- Riser location
- Furring-in the unit

Sound Attenuation

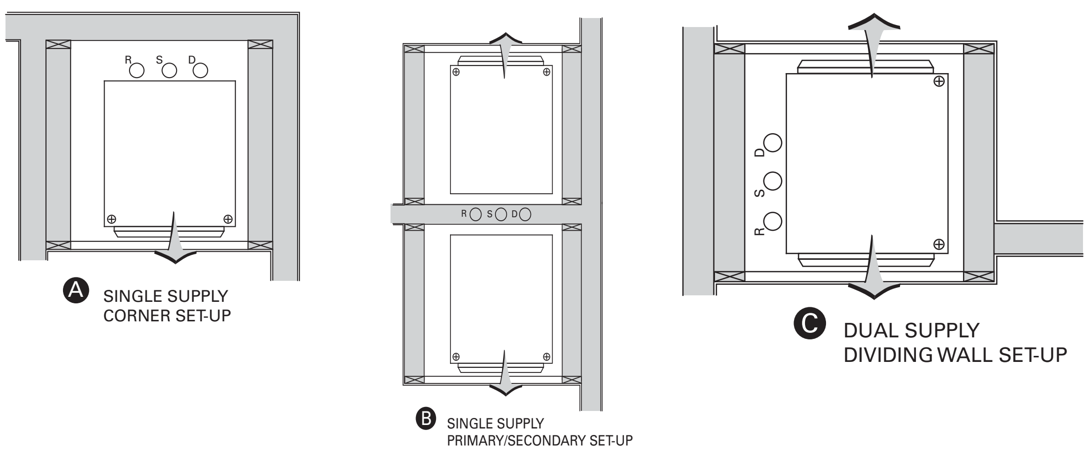
The high-rise heat pump is better suited for acoustically sensitive water-source heat pump applications than other water-source products. Compressor and water noise are attenuated by the filter panel, sheet rock and the acoustically lined door. Air noise is silenced through the extended and insulated duct portion at the top of the vertical cabinet.

Figure 4. Installation illustration

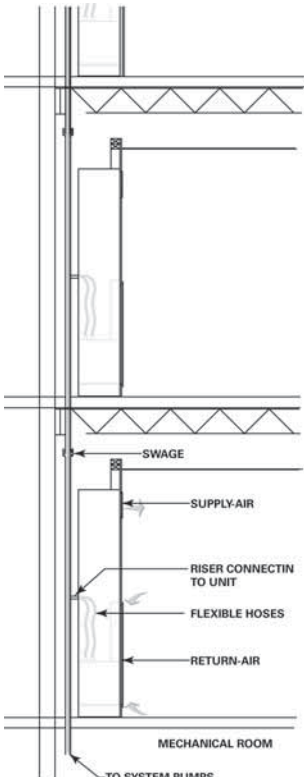


Equipment Installation

The vertical high-rise unit is versatile in design to fit numerous applications. It is typically applied to dorm rooms, hotels and motels where multiple supply air configurations may be required for individual tenant heating and cooling. The equipment requires little space, and is tucked away from sight, and rough handling. The vertical stack design is economical to install, requiring no ductwork for air supply. The riser design may be stacked one on top of another for multi-story applications, or shared between two units (see example B) when architectural design permits. Because the chassis is removable, serviceability to the equipment is enhanced. If service does become a requirement, the chassis is simple to remove from the cabinet, replaced with a back-up chassis, then repaired off-site at a convenient time.



Equipment Risers



The riser provides an easy way to facilitate the water flow through a multi-story building and the high-rise heat pump. The high-rise heat pump is best applied to a building with identical zones on each floor, and zones that are typically small. An example building might include a hotel, dorm, condominium or assisted living facility. With these types of buildings, the riser column (external to the unit cabinet) can be stacked one on top of the other. The piping installation for the entire HVAC system becomes very simple to install because it is pre-measured, and pre-fabricated at the factory.

Factory risers are available as Type K (design special), L (standard design), and M (standard design). The differences between these types of materials is the wall thickness of the copper. Table 1, p. 9 shows the wall thickness for the most common diameters of risers. It is recommended for most jobs to use type L or M copper. Type K risers are generally not necessary for most high-rise heat pump applications.

The riser design contains threaded stubouts to facilitate connection of the supply and return risers to the hose kits. The hose kits are then connected to the water-in/out of the unit's chassis.

Note: *Supply/return/drain risers that are ordered and supplied through the factory may be ordered as insulated.*

Drain risers are generally made of type M copper. If copper, drain risers are used, the risers should be insulated since the typical temperatures of condensate may cause the riser to sweat.

Table 1. Riser characteristics

Type K (special design)			
Riser Size (in.)	**I.D. (in.)**	**O.D. (in.)**	**Copper Wall Thickness (in.)**
1	0.995	1.125	0.065
1¼	1.245	1.375	0.065
1½	1.481	1.625	0.072
2	1.959	2.125	0.083
2½	2.435	2.625	0.095
3	2.907	3.125	0.109
Type L (standard)			
1	1.025	1.125	0.05
1¼	1.265	1.375	0.055
1½	1.505	1.625	0.06
2	1.985	2.125	0.07
2½	2.465	2.625	0.08
3	2.945	3.125	0.09
Type M (standard)			
Riser Size (in.)	**I.D. (in.)**	**O.D. (in.)**	**Copper Wall Thickness (in.)**
1	1.055	1.125	0.035
1¼	1.291	1.375	0.042

Table 1. Riser characteristics (continued)

Type M (standard)			
Riser Size (in.)	**I.D. (in.)**	**O.D. (in.)**	**Copper Wall Thickness (in.)**
1½	1.527	1.625	0.049
2	2.009	2.125	0.058
2½	2.495	2.625	0.065
3	2.981	3.125	0.072

Note: *Pressure ratings for risers are typically greater than the maximum pressure rating of the coaxial water-to-refrigerant heat exchangers. This is true with exception of Type M copper in a 3" diameter. The maximum pressure rating for Type M, 3" diameter copper is 380 psig. All other diameters for Type M copper, and all 1" through 3" Type L copper are greater than the 400 psig rating on the coaxial water-to-refrigerant heat exchanger.*

Riser Sizing

The proper selection of riser diameter is critical when designing a cost effective job. If the riser diameter is too small, the flow of water to the heat pump may be restricted, making the pumping power requirement excessive. On the other hand, if the riser diameter is too large, the cost of the equipment may become unnecessarily high.

To determine the riser size, calculate the flow at a particular riser. Riser columns will begin with large diameters at the bottom of the column and decrease diameter as the water travels up toward the top floor. The GPM at the first floor is determined by totaling the GPM of all the units on the riser column. The GPM for the second floor is then determined by taking the total GPM and subtracting the flow from the first floor.

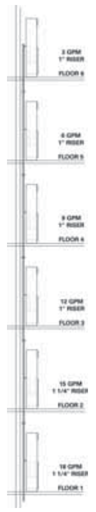
The proper size of the riser is determined by calculating the velocity of the water in the riser. The maximum water velocity that a riser should experience is about 6 or 7 feet/second. Table 2, p. 10 can be used as a quick reference chart for determining the maximum GPM allowed for a given riser size. Riser flow diagram can be found in the 2009 ASHRAE Fundamentals Handbook and may be used to calculate the precise water velocity for a given riser diameter and flow.

Table 2. Maximum riser flow rate

Riser Size (in.)	Max. GPM	Water Velocity (ft./sec.)	Head Loss (ft.100 ft.)
1	16	6.2	15.6
1¼	24	6.1	11.8
1½	34	6.1	9.38
2	58	6.0	6.6
2½	90	6.0	5.1
3	130	6.1	4.2

Note: *Table 2, p. 10 is for general design calculation reference. It is not intended to take the place of an engineered piping design.*

Riser Size Example

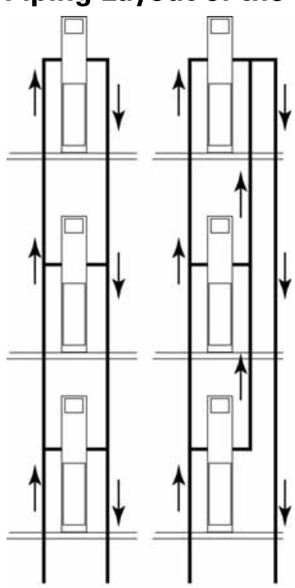


Assume a six story building is served by a high-rise water-source heat pump. When referencing the catalog, determine each high-rise heat pump uses 3 gallons per minute to meet the required capacity of the 1-ton unit. What is the minimum riser diameter that can be used on each floor?

With this arrangement, determine the volume of water used at each floor is 3 GPM. The top floor riser therefore only needs to be sized for 3 GPM. Referring to Table 2, p. 10, we know that a 1-inch type M riser can handle up to 16 GPM, therefore the riser size is determined to be 1-inch.

The first floor will see 18 GPM through the riser. Since 18 GPM will result in more than 6 ft./second in a 1" riser, it would be advisable to move to a 1¼" riser.

Piping Layout of the Riser



Two methods may be used when piping a riser column. These include direct return or reverse return.

Advantages may be seen in both types of piping methods. For a direct return installation, the riser system is straightforward leaving little confusion about properly sized risers. This provides a more cost effective advantage during the installation process.

The disadvantages of this system is the pressure drop. The total pressure drop on the unit for the sixth floor is much greater than the total pressure drop on the unit for the first floor. This means that the riser column will require balancing from floor-to-floor during installation.

Piping advantages for the reverse return system include the ability to design the riser column so that the total system pressure drop through each unit is equalized. The overall pressure drop is also lower, allowing some energy savings potential. This piping method however does not eliminate the need for proper balancing at each unit.

The disadvantage of this system relates to cost and complexity. The reverse return method typically costs more because of the additional pipe required for each riser column.

Central Plant Control

Proper central plant control is critical to the operation of a water-source heat pump system. Loss of waterflow or loop temperatures outside of the recommended range will severely impact the operation of the equipment. The following should be followed as minimum operational recommendation for the central plant:

- Heat rejector control (i.e. closed circuit cooling tower, or geothermal loop)
- Heat adder (i.e. boiler or geothermal loop)
- Circulating pumps
- Sensing elements

General Data

Table 3. General Data

Model Number		009	012	015	018	024	036
Compressor Type		Rotary	Rotary	Rotary	Rotary	Scroll	Scroll
Cabinet Size	Depth (in.)	16.0	16.0	18.0	18.0	24.0	24.0
	Height (in.)	88.0	88.0	88.0	88.0	88.0	88.0
	Width (in.)	16.0	16.0	20.0	20.0	24.0	24.0
	Depth (mm)	406.4	406.4	457.2	457.2	609.6	609.6
	Height (mm)	2235.2	2235.2	2235.2	2235.2	2235.2	2235.2
	Width (mm)	406.4	406.4	508.0	508.0	609.6	609.6
Approximate weight cabinet	with Pallet (lb.)	135	135	175	175	225	225
Approximate weight cabinet	without Pallet (lb.)	115	115	150	150	195	195
Approximate weight chassis	with Pallet (lb.)	88	107	112	117	174	190
Approximate weight chassis	without Pallet (lb.)	78	97	102	107	164	180
Air-to-Refrigerant Coil	Face Area (ft.2)	1.35	1.35	2.11	2.11	2.88	2.88
	Face Area (cm2)	1254	1254	1959	1959	2676	2676
	Rows	2	4	4	4	3	4
	Fins Per Inch	14	14	14	14	14	14
	Fins Per cm.	5.5	5.5	5.5	5.5	5.5	5.5
Nominal 1" Filter Size	Inches	14 x 20	14 x 20	18 x 25	18 x 25	20 x 30	20 x 30
	mm	356 x 508	356 x 508	457 x 635	457 x 635	508 x 762	508 x 762
Water In/Out size	NPTI	½"	½"	½"	½"	¾"	¾"
Condensate	Plastic Hose ID (in)	¾"	¾"	¾"	¾"	¾"	¾"
Riser Connection	NPTE	½"	½"	½"	½"	¾"	¾"
PSC Ducted Discharge	Blower	90-6TDD	90-6TDD	90-6RDD	100-6TDD	100-6TDD	120-8TDD11
	Motor HP	0.05	0.125	0.125	0.2	0.33	0.5
PSC Free Discharge	Blower	90-6TDD	90-6TDD	90-6RDD	100-6TDD	100-6TDD	120-8TDD11
	Motor HP	0.05	0.125	0.125	0.125	0.33	0.5
ECM Motor	Blower	90-6TDD	90-6TDD	100-6TDD	100-6TDD	120-8TDD11	120-8TDD11
	Motor HP	0.33	0.33	0.5	0.5	0.5	0.75
Water-to-Refrigerant Coil	Refrig. Side (PSIG)	650	650	650	650	650	650
	Water Side (PSIG)	400	400	400	400	400	400
	Internal Volume (gal)	0.081	0.081	0.228	0.228	0.271	0.368

Performance Data

Table 4. AHRI-ISO performance

Unit Size	Rated Flow Rate (GPM)	Rated Air Flow (CFM)	Water Loop Cooling Capacity (Mbtuh)	Water Loop EER	Water Loop Heating Capacity (Mbtuh)	Water Loop COP	Ground Water Cooling Capacity (Mbtuh)	Ground Water EER	Ground Water Heating Capacity (Mbtuh)	Ground Water COP	Ground Loop Cooling Capacity (Mbtuh)	Ground Loop EER	Ground Loop Heating Capacity (Mbtuh)	Ground Loop COP
PSC Motor														
GET 009	2.1	340	8200	12.8	10800	4.6	9700	18.4	8700	3.8	8800	14.9	6600	3.2
GET 012	2.8	440	11900	13.5	14100	4.6	13100	18.9	11800	4.0	12300	15.1	9000	3.2
GET 015	3.5	540	14700	13.1	17700	4.6	16600	20.1	13700	3.7	15400	14.8	11800	3.3
GET 018	4.2	650	18100	13.0	22900	4.5	19500	18.0	17900	3.7	18700	14.3	14800	3.3
GET 024	5.6	820	23300	13.1	26600	4.3	25600	18.6	23600	3.9	24300	14.9	18700	3.2
GET 036	8.4	1170	33700	13.0	41300	4.3	37900	18.7	34400	3.7	35100	14.6	27300	3.2
ECM Motor														
GET 009	2.1	340	8300	13.9	10500	4.6	9600	21.1	8500	3.9	8700	16.2	6500	3.2
GET 012	2.8	440	12000	14.2	14300	4.8	14100	23.2	11600	4.0	12600	16.5	8700	3.2
GET 015	3.5	540	14900	15.0	18000	5	17000	23.9	14800	4.3	15600	17.5	11300	3.5
GET 018	4.2	650	18500	14.6	22300	4.6	21100	22.6	18400	4.2	19500	17	14200	3.4
GET 024	5.6	820	24200	16.0	26300	4.8	26800	24	23100	4.4	25200	18.4	17800	3.5
GET 036	8.4	1170	34200	15.2	40200	4.6	38200	24	33500	4.1	35600	17.8	26300	3.3

Note: Certified in accordance with AHRI Water to Air and Brine to Air Heat Pump Certification Program which is based on ISO Standard 13256-1: 1998. Certified conditions are 80.6°F DB/66.2°F WB EAT in cooling and 68°F DB/59°F WB EAT in heating.

Table 5. GET 009 cooling performance

EWT	GPM	Total Gross (Mbtuh)	Gross Sen (Mbtuh)	SHR	Heat of Rej (Mbtuh)	Comp Pwr (kW)	LWT	WPD (feet head)
45	1.1	10.3	8.0	0.77	11.7	0.41	65.7	2.1
45	1.5	10.4	8.0	0.77	11.8	0.40	60.7	3.4
45	1.8	10.5	8.0	0.76	11.9	0.39	58.2	4.7
45	2.1	10.6	8.1	0.76	12.0	0.39	56.4	6.2
45	2.3	10.8	8.1	0.75	12.1	0.39	55.7	6.9
45	2.4	10.8	8.1	0.75	12.1	0.39	55.1	7.8
45	2.6	10.8	8.1	0.75	12.2	0.39	54.3	9.1
55	1.1	9.8	7.8	0.79	11.3	0.44	75.1	2.0
55	1.5	10.0	7.9	0.79	11.4	0.42	70.2	3.3
55	1.8	10.1	7.9	0.78	11.5	0.42	67.8	4.5
55	2.1	10.2	7.9	0.78	11.6	0.41	66.0	5.9
55	2.3	10.2	7.9	0.78	11.6	0.41	65.3	6.7
55	2.4	10.2	7.9	0.78	11.6	0.41	64.7	7.5
55	2.6	10.3	8.0	0.77	11.7	0.41	63.9	8.7
68	1.1	9.4	7.7	0.82	11.1	0.49	87.7	1.9
68	1.5	9.5	7.7	0.81	11.1	0.47	82.8	3.1
68	1.8	9.6	7.7	0.81	11.1	0.46	80.4	4.3
68	2.1	9.6	7.7	0.80	11.2	0.46	78.6	5.6
68	2.3	9.6	7.8	0.80	11.2	0.45	77.9	6.4
68	2.4	9.7	7.8	0.80	11.2	0.45	77.3	7.1
68	2.6	9.7	7.8	0.80	11.2	0.45	76.5	8.3
75	1.1	9.2	7.6	0.83	11.0	0.53	94.5	1.8
75	1.5	9.3	7.6	0.82	11.0	0.51	89.7	3.1

Unit Fan Performance

Table 19. PSC blower motor external static pressure without return air door (RAD) with filter

					External Static Pressure (in. of wg)															
Model No	Speed Tap	Ducted [(a)] Unit	CFM Max	CFM Min	0.00 CFM	0.00 KW	0.05 CFM	0.05 KW	0.10 CFM	0.10 KW	0.15 CFM	0.15 KW	0.20 CFM	0.20 KW	0.25 CFM	0.25 KW	0.30 CFM	0.30 KW	0.35 CFM	0.35 KW
GET 009	High	Yes	408		421	0.108	388	0.107	354	0.106	320	0.104	283	0.103	244	0.102				
	Low	Yes			355	0.073	332	0.072	307	0.070	278	0.068	245	0.067						
	High	No			357	0.073	333	0.071	309	0.070	282	0.069	253	0.067						
	Low	No		272	307	0.061	297	0.060	280	0.059	258	0.058								
GET 012	High	Yes	453		453	0.140	433	0.137	412	0.134	390	0.130	367	0.127	342	0.124	316	0.121	288	0.118
	Low	Yes			401	0.112	383	0.109	362	0.106	340	0.103	318	0.100	295	0.097				
	High	No			418	0.125	400	0.122	379	0.120	356	0.117	332	0.113	309	0.110	286	0.107		
	Low	No		304	345	0.097	331	0.095	313	0.092	292	0.090								
GET 015	High	Yes	648						652	0.191	634	0.187	616	0.183	598	0.179	579	0.175	558	0.170
	Low	Yes			560	0.155	539	0.153	523	0.152	511	0.149	499	0.146	487	0.143	472	0.139	455	0.135
	High	No			553	0.169	538	0.167	524	0.165	510	0.162	496	0.159	481	0.155	464	0.151	444	0.147
	Low	No		432	445	0.135	433	0.135	422	0.134										
GET 018	High	Yes	780																785	0.330
	Low	Yes			665	0.253	644	0.249	625	0.246	608	0.242	592	0.237	575	0.232	556	0.227	537	0.221
	High	No			696	0.361	675	0.354	654	0.348	632	0.342	610	0.336	588	0.330	566	0.324	544	0.318
	Low	No		520	544	0.271	526	0.266	506	0.262										
GET 024	High	Yes	984												988	0.402	955	0.392	920	0.382
	Low	Yes			908	0.344	895	0.335	876	0.327	854	0.318	829	0.310	803	0.301	778	0.293	754	0.285
	High	No			850	0.317	827	0.310	806	0.303	787	0.297	768	0.291	750	0.286	730	0.280	710	0.274
	Low	No		656	799	0.292	781	0.286	764	0.280	746	0.275	727	0.269	709	0.264	690	0.258	671	0.252
GET 036	High	Yes	1404														1420	0.686	1396	0.674
	Low	Yes			1303	0.651	1293	0.638	1282	0.625	1270	0.614	1256	0.603	1240	0.592	1222	0.582	1202	0.572
	High	No			1330	0.642	1304	0.630	1277	0.618	1248	0.606	1219	0.593	1188	0.581	1155	0.568	1122	0.555
	Low	No		936	1059	0.523	1051	0.516	1042	0.510	1033	0.503	1022	0.496	1011	0.488	998	0.480	984	0.472

					External Static Pressure (in. of wg)															
Model No	Speed Tap	Ducted Unit	CFM Max	CFM Min	0.40 CFM	0.40 KW	0.45 CFM	0.45 KW	0.50 CFM	0.50 KW	0.55 CFM	0.55 KW	0.60 CFM	0.60 KW	0.65 CFM	0.65 KW	0.70 CFM	0.70 KW	0.75 CFM	0.75 KW
GET 015	High	Yes	648		535	0.165	510	0.160	480	0.154	445	0.148	404	0.141						
	Low	Yes			433	0.130	405	0.125												
	High	No			421	0.142														
	Low	No		432																
GET 018	High	Yes	780		758	0.323	729	0.317	697	0.311	661	0.305	620	0.300	573	0.295	518	0.291		
	Low	Yes			517	0.215														
	High	No			521	0.312	497	0.305												
	Low	No		520																
GET 024	High	Yes	984		884	0.371	847	0.359	810	0.348	774	0.336	739	0.324	706	0.312	676	0.299	649	0.287
	Low	Yes			732	0.277	712	0.268	693	0.260	675	0.251	658	0.243	641	0.234				
	High	No			689	0.267	666	0.260	642	0.251										
	Low	No		656	651	0.246														
GET 036	High	Yes	1404		1371	0.662	1346	0.650	1320	0.638	1293	0.625	1265	0.613	1236	0.601	1206	0.588	1175	0.575
	Low	Yes			1181	0.562	1160	0.553	1138	0.543	1117	0.533	1097	0.522	1076	0.511	1055	0.498	1031	0.486
	High	No			1086	0.542	1048	0.528	1007	0.515	965	0.501	919	0.487						
	Low	No		936	967	0.464	949	0.454	927	0.444										

					External Static Pressure (in. of wg)													
Model No	Speed Tap	Ducted Unit	CFM Max	CFM Min	0.80 CFM	0.80 KW	0.85 CFM	0.85 KW	0.90 CFM	0.90 KW	0.95 CFM	0.95 KW	1.00 CFM	1.00 KW	1.05 CFM	1.05 KW	1.10 CFM	1.10 KW
GET 036	High	Yes	1404		1142	0.563	1107	0.550	1071	0.536	1032	0.523	991	0.509	947	0.495	900	0.481
	Low	Yes			1003	0.472	967	0.456	919	0.440								
	High	No																
	Low	No		936														

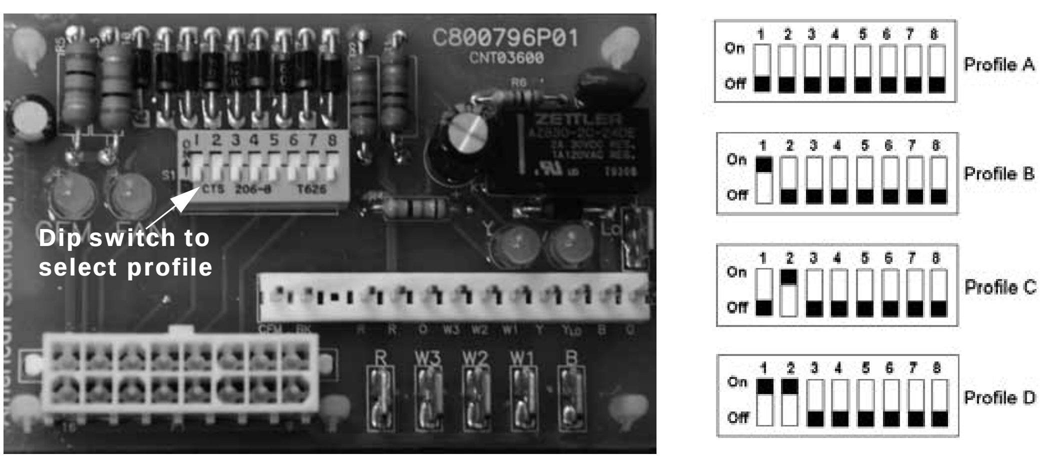
(a) The NO “Ducted” option is for non-ducted (free return) units. Units specified as “non-ducted” (free return) are factory wired to low-speed. Units specified as “ducted” are factory wired to high-speed.

Table 20. ECM Blower motor external static pressure without return air door (RAD) with filter

Model No.	Speed Profile	CFM	External Static Pressure (in. of wg) 0.00 kW	0.05 kW	0.10 kW	0.15 kW	0.20 kW	0.25 kW	0.30 kW	0.35 kW	0.40 kW	0.45 kW	0.50 kW	0.55 kW	0.60 kW	0.65 kW	0.70 kW
GET 009	A	374	0.025	0.037	0.050	0.062	0.075	0.087	0.098	0.110	0.121	0.133	0.144	0.155	0.165	0.176	0.176
	B	344	0.023	0.035	0.046	0.057	0.068	0.079	0.090	0.100	0.110	0.120	0.130	0.140	0.149	0.159	0.159
	C	313	0.021	0.032	0.042	0.052	0.062	0.071	0.081	0.090	0.099	0.108	0.117	0.126	0.134	0.143	0.143
	D	285	0.017	0.027	0.036	0.045	0.054	0.063	0.071	0.080	0.088	0.096	0.104	0.112	0.120	0.127	0.127
GET 012	A	487	0.027	0.042	0.057	0.071	0.086	0.100	0.114	0.128	0.142	0.155	0.168	0.181	0.193	0.206	0.206
	B	442	0.025	0.038	0.052	0.065	0.077	0.090	0.103	0.115	0.127	0.139	0.151	0.162	0.173	0.184	0.184
	C	403	0.023	0.034	0.046	0.057	0.069	0.080	0.091	0.102	0.112	0.122	0.133	0.142	0.152	0.161	0.161
	D	368	0.019	0.029	0.039	0.049	0.059	0.068	0.078	0.087	0.096	0.105	0.114	0.123	0.131	0.139	0.139
GET 015	A	594	0.062	0.072	0.081	0.090	0.100	0.109	0.119	0.128	0.138	0.148	0.158	0.168	0.179	0.191	0.202
	B	540	0.044	0.054	0.064	0.073	0.083	0.092	0.101	0.111	0.121	0.131	0.141	0.151	0.162	0.173	0.185
	C	486	0.032	0.042	0.051	0.060	0.069	0.079	0.088	0.097	0.106	0.116	0.126	0.136	0.146	0.157	0.168
	D	432	0.025	0.034	0.042	0.051	0.059	0.068	0.076	0.085	0.093	0.102	0.111	0.120	0.130	0.140	0.150
GET 018	A	712	0.097	0.109	0.121	0.134	0.148	0.163	0.178	0.193	0.208	0.223	0.239	0.253	0.268	0.282	0.282
	B	648	0.077	0.087	0.098	0.110	0.123	0.136	0.150	0.163	0.177	0.191	0.205	0.218	0.230	0.242	0.242
	C	584	0.056	0.066	0.076	0.087	0.099	0.111	0.123	0.135	0.148	0.160	0.172	0.183	0.194	0.204	0.204
	D	522	0.039	0.048	0.058	0.069	0.080	0.091	0.102	0.114	0.125	0.136	0.147	0.157	0.166	0.175	0.175
GET 024	A	903	0.100	0.118	0.135	0.152	0.168	0.185	0.201	0.216	0.232	0.247	0.261	0.276	0.290	0.303	0.303
	B	827	0.081	0.096	0.111	0.125	0.140	0.154	0.168	0.182	0.196	0.209	0.222	0.236	0.248	0.261	0.261
	C	746	0.060	0.073	0.085	0.098	0.110	0.123	0.136	0.148	0.161	0.173	0.185	0.198	0.210	0.222	0.222
	D	659	0.041	0.052	0.063	0.074	0.085	0.097	0.109	0.121	0.133	0.145	0.157	0.169	0.182	0.194	0.194
GET 036	A	1293	0.285	0.306	0.328	0.349	0.370	0.392	0.413	0.433	0.454	0.475	0.496	0.516	0.537	0.557	0.557
	B	1178	0.214	0.233	0.253	0.272	0.292	0.311	0.330	0.349	0.369	0.388	0.406	0.425	0.444	0.463	0.463
	C	1063	0.158	0.175	0.193	0.210	0.227	0.245	0.262	0.279	0.296	0.313	0.331	0.348	0.365	0.382	0.382
	D	950	0.117	0.133	0.148	0.163	0.178	0.193	0.208	0.223	0.238	0.254	0.269	0.284	0.299	0.314	0.314

Note: The ECM motor is programmed for constant CFM. The CFM is factory set on Profile B. The ECM motor will reduce airflow to 50% in fan only mode for additional energy savings.

Figure 5. ECM control board and dip switch setting



Unit Fan Performance

Table 21. Pressure drop due to return air door (RAD)

Model No.	CFM	DP	CFM	DP	CFM	DP
GET 009	272	0.04	340	0.05	408	0.08
GET 012	303	0.04	380	0.07	456	0.11
GET 015	432	0.06	540	0.09	648	0.12
GET 018	520	0.08	650	0.12	780	0.16
GET 024	656	0.06	820	0.08	984	0.12
GET 036	936	0.10	1170	0.16	1404	0.23

Note: The pressure drop across the RAD door should be included in the TOTAL ESP when determining airflow and fan motor power usage. If the door is supplied by another vendor, the pressure drop across that door must be included in the TOTAL ESP when determining airflow and fan motor power usage.

Table 22. Antifreeze correction factors

	Methanol					
	Concentration by Volume					
Item	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**
Cooling Capacity	1.000	0.998	0.997	0.995	0.993	0.992
Heating Capacity	1.000	0.995	0.990	0.985	0.979	0.974
Pressure Drop	1.000	1.023	1.057	1.091	1.122	1.160
	Ethylene Glycol					
	Concentration by Volume					
Item	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**
Cooling Capacity	1.000	0.996	0.991	0.987	0.983	0.979
Heating Capacity	1.000	0.993	0.985	0.977	0.969	0.961
Pressure Drop	1.000	1.024	1.068	1.124	1.188	1.263
	Propylene Glycol					
	Concentration by Volume					
Item	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**
Cooling Capacity	1.000	0.993	0.987	0.980	0.974	0.968
Heating Capacity	1.000	0.986	0.973	0.960	0.948	0.935
Pressure Drop	1.000	1.040	1.098	1.174	1.273	1.405
	Brine (NaCL)					
	Concentration by Volume					
Item	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**
Cooling Capacity	1.000	0.994	0.987	0.979	0.971	0.963
Heating Capacity	1.000	0.993	0.987	0.982	0.978	0.976
Pressure Drop	1.000	1.154	1.325	1.497	1.669	1.841

Figure 6. Cooling capacity correction factor

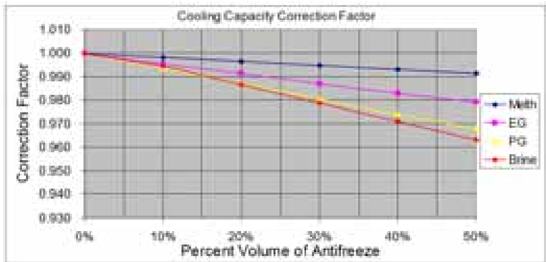


Figure 7. Heating capacity correction factor

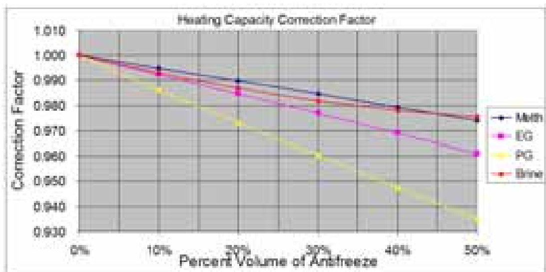
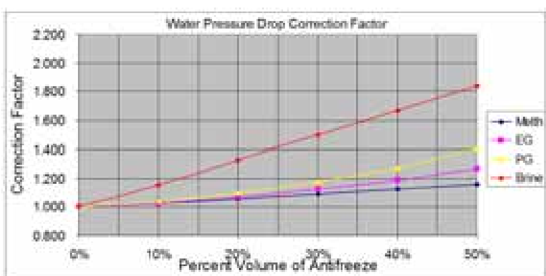


Figure 8. Water pressure drop correction factor



Example 1 (Ethylene Glycol): The antifreeze solution is 20% by volume of Ethylene Glycol. Determine the corrected cooling capacity and waterside pressure drop for a GET009 when the EWT is 86°F and the GPM is 2.3.

From the catalog data, the cooling capacity at these conditions with 100% water is 8.3 Mbtuh, and the waterside pressure drop is 9.1 feet of head. At 20% Ethylene Glycol, the correction factor for cool capacity is 0.9912 and the pressure drop is 1.068.

The corrected cooling capacity (Mbtuh) = 8.50* 0.9912 = 8.43. The corrected water side pressure drop (Ft. head) = 9.1 * 1.068 = 9.72.

Example 2 (Propylene Glycol): The antifreeze solution is 30% by volume of Propylene Glycol. Determine the corrected heating capacity and waterside pressure drop for a GET009 when the EWT is 45°F and the GPM is 2.3.

From the catalog data, the heating capacity at these conditions with 100% water is 8.3 Mbtuh, and the waterside pressure drop is 11.1 feet of head. At 30% Propylene Glycol, the correction factor for heat capacity is 0.9603 and the pressure drop is 1.174.

The corrected heating capacity (Mbtuh) = 8.3 * 0.9603 = 7.97. The corrected water side pressure drop (Ft. head) = 11.1 * 1.174 = 13.03.

Electrical Data

Table 23. Electrical performance

Model No.	Motor Option	Unit Volts	Total FLA	Comp RLA (ea)	Comp LRA	Blower Motor FLA	Blower Motor HP	Minimum Circuit Ampacity	Maximum Overcurrent Protective Device
GET 009	PSC Motor	208/60/1	4.3	3.7	16.0	0.60	1/20	5.23	15
		230/60/1	4.1	3.5	17.0	0.60	1/20	4.98	15
		265/60/1	3.3	2.8	13.0	0.50	1/20	4.00	15
	ECM Motor	208/60/1	4.3	3.7	16.0	0.55	1/3	5.18	15
		230/60/1	4.1	3.5	17.0	0.55	1/3	4.93	15
		265/60/1	3.4	2.8	13.0	0.55	1/3	4.05	15
GET 012	PSC Motor	208/60/1	7.0	6.3	30.0	0.70	0.13	8.58	15
		230/60/1	7.0	6.3	30.0	0.70	0.13	8.58	15
		265/60/1	5.6	5.0	23.0	0.60	0.13	6.85	15
	ECM Motor	208/60/1	6.9	6.3	30.0	0.60	1/3	8.48	15
		230/60/1	6.9	6.3	30.0	0.60	1/3	8.48	15
		265/60/1	5.6	5.0	23.0	0.60	1/3	6.85	15
GET 015	PSC Motor	208/60/1	8.6	7.9	36.0	0.70	1/8	10.58	15
		230/60/1	8.6	7.9	36.0	0.70	1/8	10.58	15
		265/60/1	7.0	6.4	30.0	0.60	1/8	8.60	15
	ECM Motor	208/60/1	8.5	7.9	36.0	0.60	1/2	10.48	15
		230/60/1	8.5	7.9	36.0	0.60	1/2	10.48	15
		265/60/1	7.0	6.4	30.0	0.60	1/2	8.60	15
GET 018	Free Discharge PSC Motor	208/60/1	10.3	9.6	42.0	0.70	1/8	12.70	20
		230/60/1	10.3	9.6	42.0	0.70	1/8	12.70	20
		265/60/1	8.3	7.7	35.0	0.60	1/8	10.23	15
	ECM Motor	208/60/1	10.2	9.6	42.0	0.60	1/2	12.60	20
		230/60/1	10.2	9.6	42.0	0.60	1/2	12.60	20
		265/60/1	8.3	7.7	35.0	0.60	1/2	10.23	15
	Ducted PSC Motor	208/60/1	11.3	9.6	42.0	1.70	1/5	13.70	20
		230/60/1	11.3	9.6	42.0	1.70	1/5	13.70	20
		265/60/1	8.8	7.7	35.0	1.10	1/5	10.73	15
GET 024	PSC Motor	208/60/1	15.7	13.5	58.3	2.20	1/3	19.08	30
		230/60/1	15.7	13.5	58.3	2.20	1/3	19.08	30
		265/60/1	10.8	9.0	54.0	1.80	1/3	13.05	20
	ECM Motor	208/60/1	14.5	13.5	58.3	0.95	1/2	17.83	30
		230/60/1	14.5	13.5	58.3	0.95	1/2	17.83	30
		265/60/1	10.0	9.0	54.0	0.95	1/2	12.20	20
GET 036	PSC Motor	208/60/1	17.7	14.1	77.0	3.60	1/2	21.23	35
		230/60/1	17.7	14.1	77.0	3.60	1/2	21.23	35
		265/60/1	15.0	12.2	72.0	2.77	1/2	18.02	30
	ECM Motor	208/60/1	16.1	14.1	77.0	2.00	3/4	19.63	30
		230/60/1	16.1	14.1	77.0	2.00	3/4	19.63	30
		265/60/1	14.2	12.2	72.0	2.00	3/4	17.25	25

Dimensional Data

Figure 9. Unit cabinet/riser

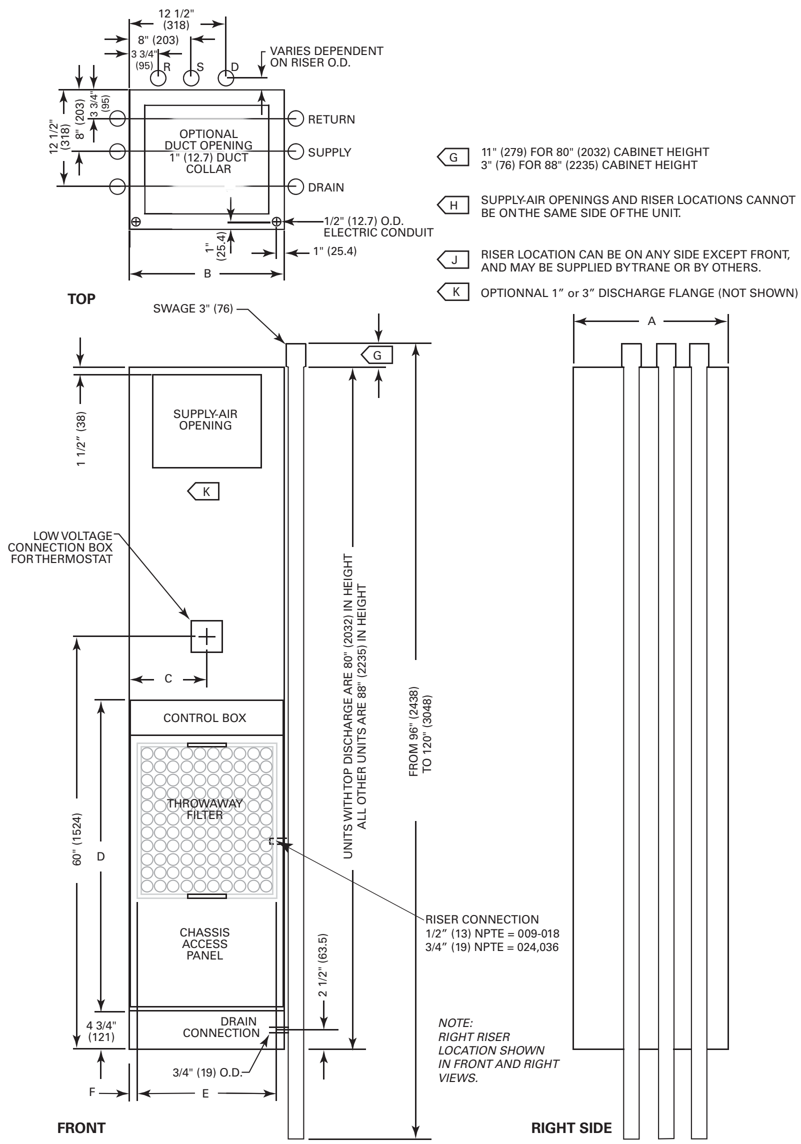


Table 24. Unit cabinet/riser

GET	A	B	C	D	E	F
009, 012	16¼" (413)	16¼" (413)	8 1/8" (206)	39 1/8" (994)	14¾" (375)	¾" (19)
015-018	18" (457)	20" (508)	10" (254)	40 5/8" (1032)	18¾" (476)	¾" (19)
024-036	24" (610)	24" (610)	12" (305)	49 5/8" (1260)	22 5/8" (575)	¾" (19

Dimensional Data

Figure 10. Unit cabinet/riser

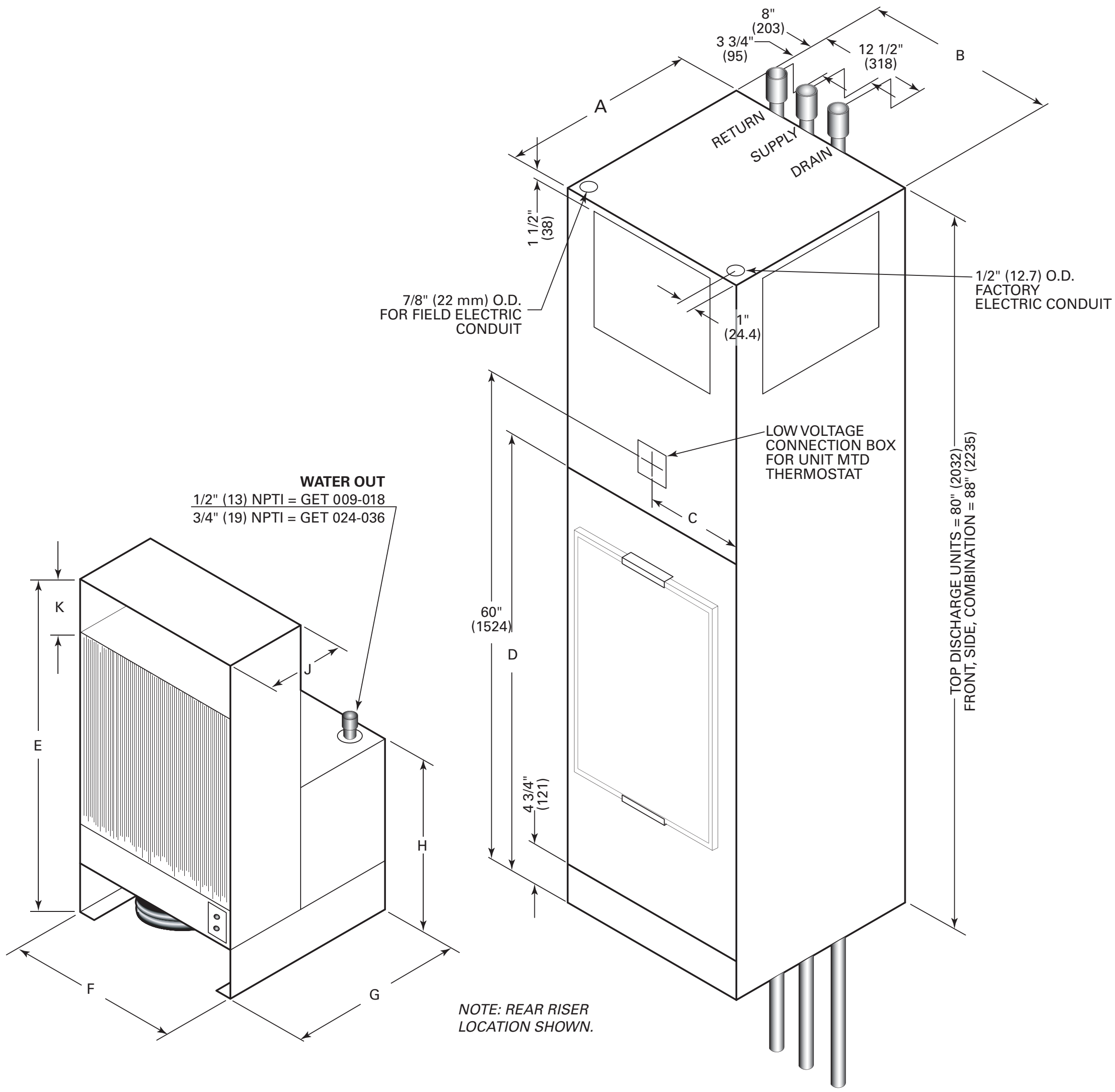


Table 25. Dimensional data - unit cabinet/riser

Unit Size	A	B	C	D	E	F	G	H	J	K
009	16¼" (413)	16¼" (413)	8 1/8" (206)	43 7/8" (1114)	32½" (826)	13 5/8" (346)	14" (356)	16 7/8" (429)	4 3/8" (111)	6¾" (171)
012	16¼" (413)	16¼" (413)	8 1/8" (206)	43 7/8" (1114)	32½" (826)	13 5/8" (346)	14" (356)	16 3/8" (416)	4 3/8" (111)	6¾" (171)
015-018	18" (457)	20" (508)	10" (254)	45 3/8" (1153)	34 8/9" (886)	17 3/8" (441)	16 1/8" (410)	18½" (470)	5¾" (146)	4¾" (121)
024-036	24" (610)	24" (610)	12" (305)	54 3/8" (1381)	41" (1041)	21 3/8" (543)	22" (559)	21¾" (552)	4" (102)	6" (152)

Water Flow Control

The factory installed water flow control option is hard piped to the copper or cupro-nickel water coil. The selection is available in a high or low flow option. An isolation valve and strainer are standard when the factory flow device is selected.

Two foot hose and ball valves are recommended for these units. The hoses and ball valves are optional and can be selected with the chassis portion of the order, or can be field provided. These items are shipped separate from the chassis.

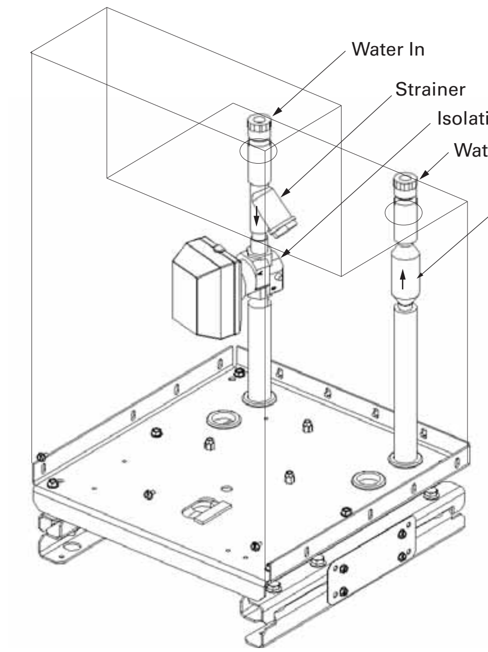
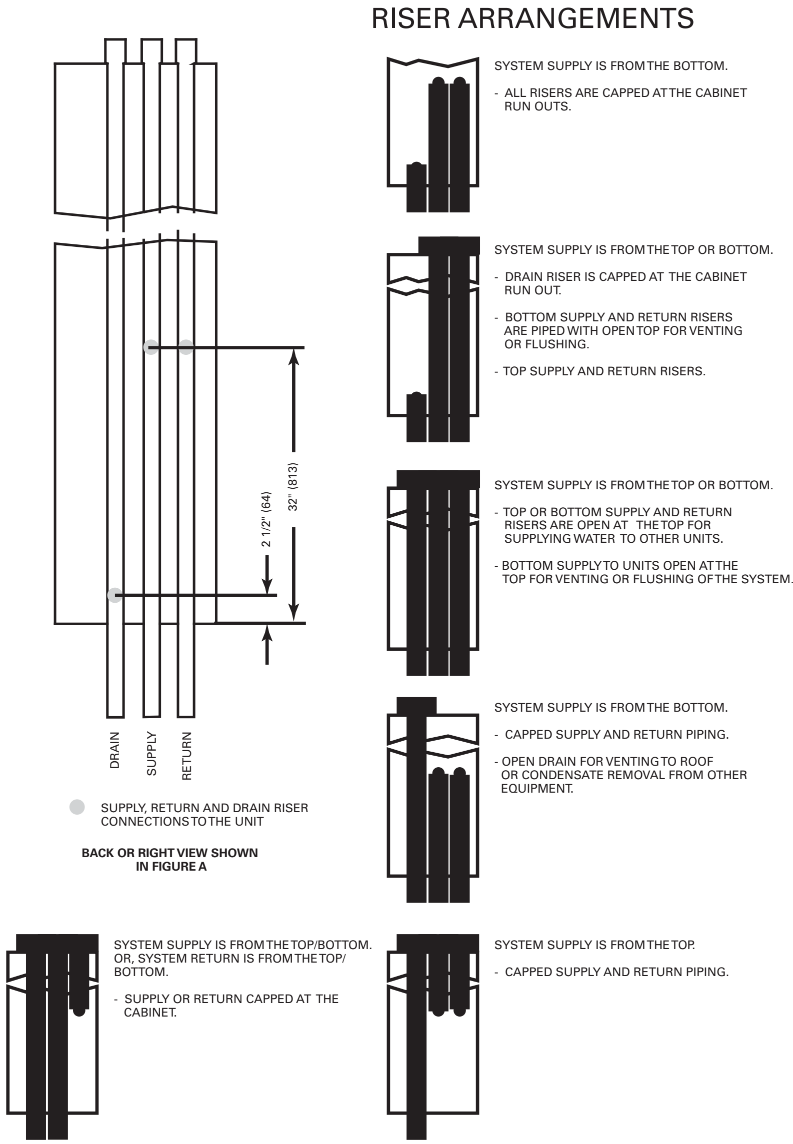


Table 26. Factory hose kit flow options

Unit Size	Low Flow Digit 9 = 3,4	High Flow Digit 9 = 5,6
009	1.5 GPM	2.0 GPM
012	2.0 GPM	2.5 GPM
015	2.5 GPM	3.5 GPM
018	3.0 GPM	4.0 GPM
024	4.0 GPM	6.0 GPM
036	6.0 GPM	8.0 GPM

Dimensional Data

Figure 11. Riser to unit connection



Note: *This page may be used in riser schedule preparation for field installed risers.*

Factory installed risers are only available as shown in Figure 11, p. 46.

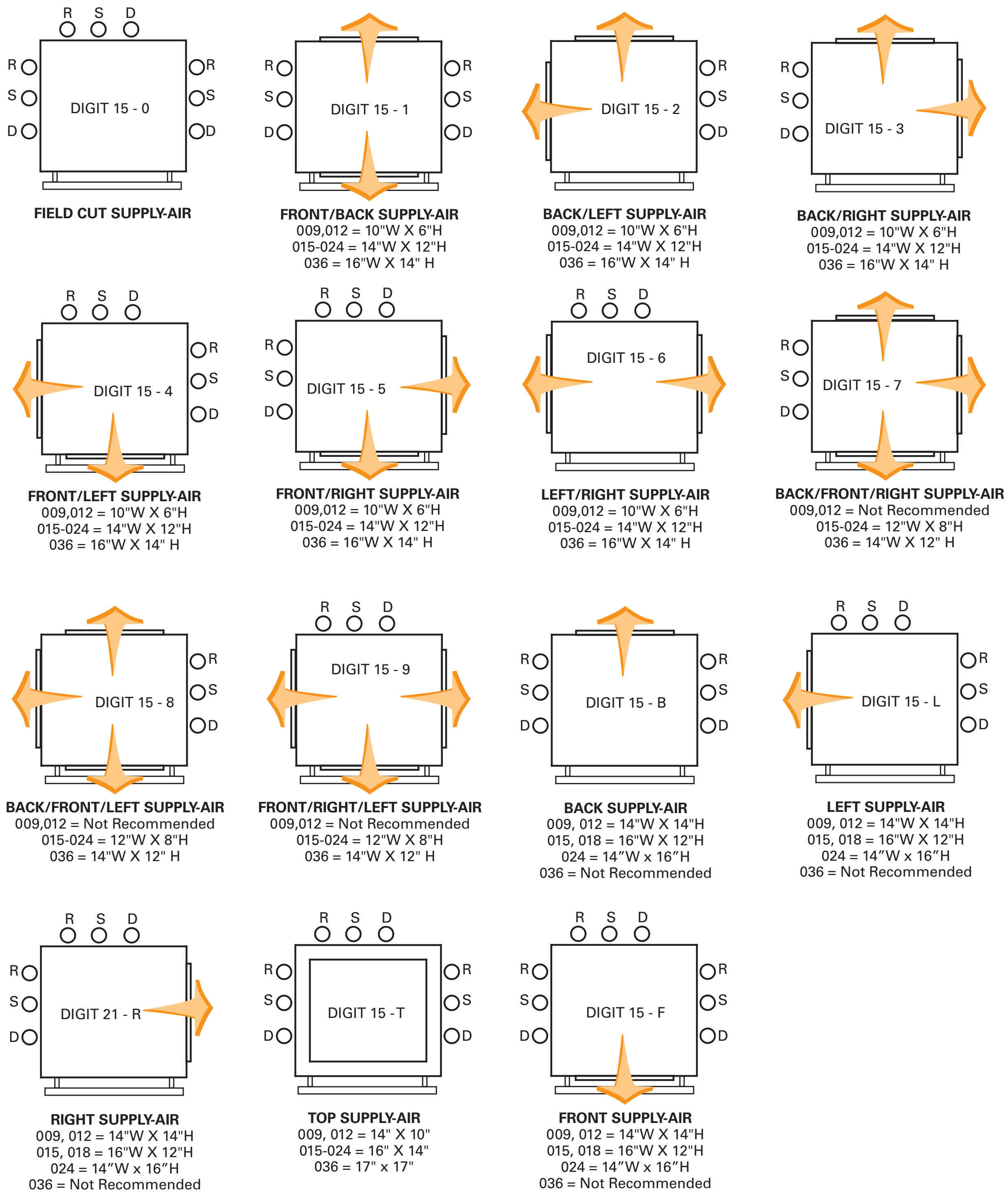
Modification to the factory riser may be required in the field to fit the contractor's riser schedule.

Riser location and appropriate hose length for ease of service is an important factor during unit installation. Recommended hose length per riser location includes:

- 2" hose = All riser locations.

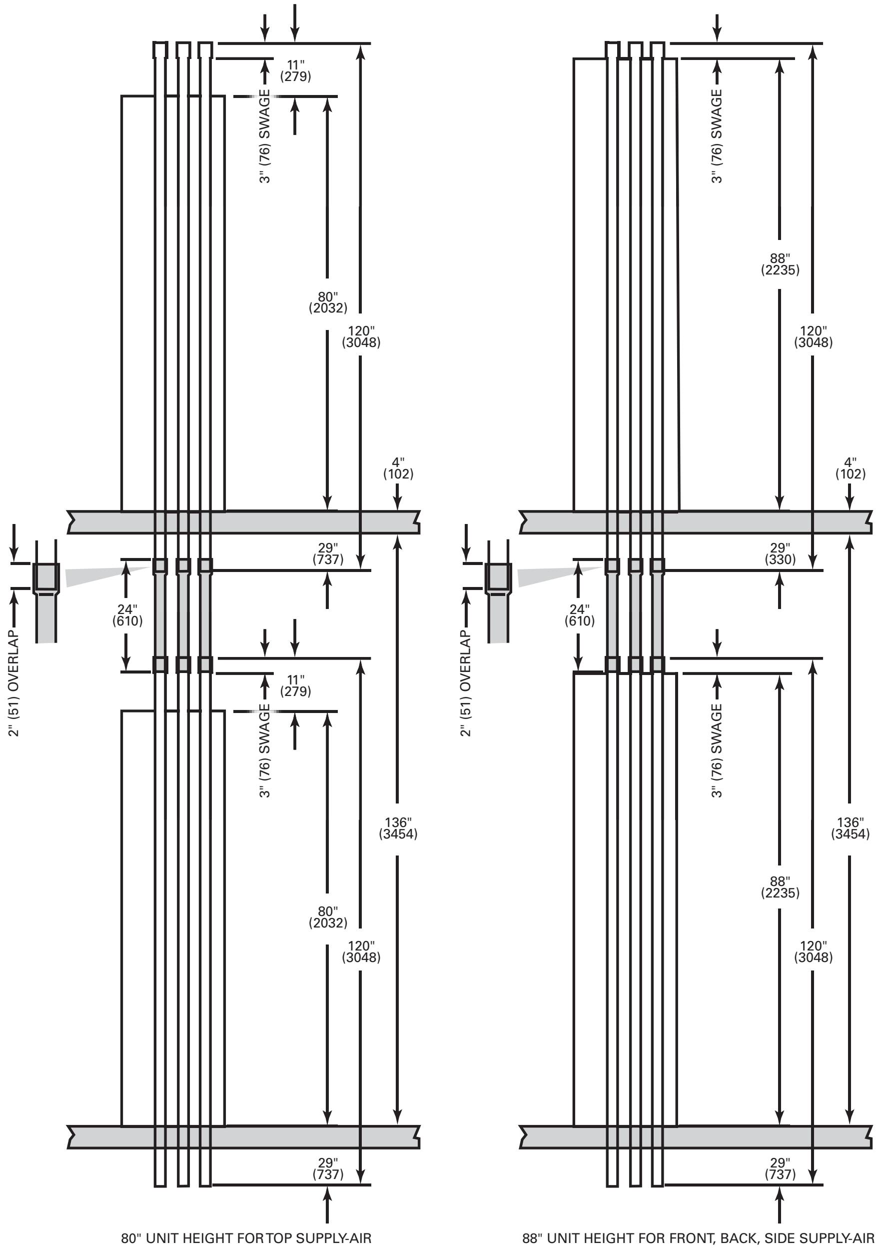
Trapping the main condensate riser is recommended but not mandatory as the unit condensate line is trapped internal to the equipment.

Figure 12. Supply-air arrangements



Dimensional Data

Figure 13. Riser extensions



Riser Extensions are field provided and installed.

Note: *Riser expansion must be considered when calculating total riser length.*

Figure 14. Hinged acoustical door

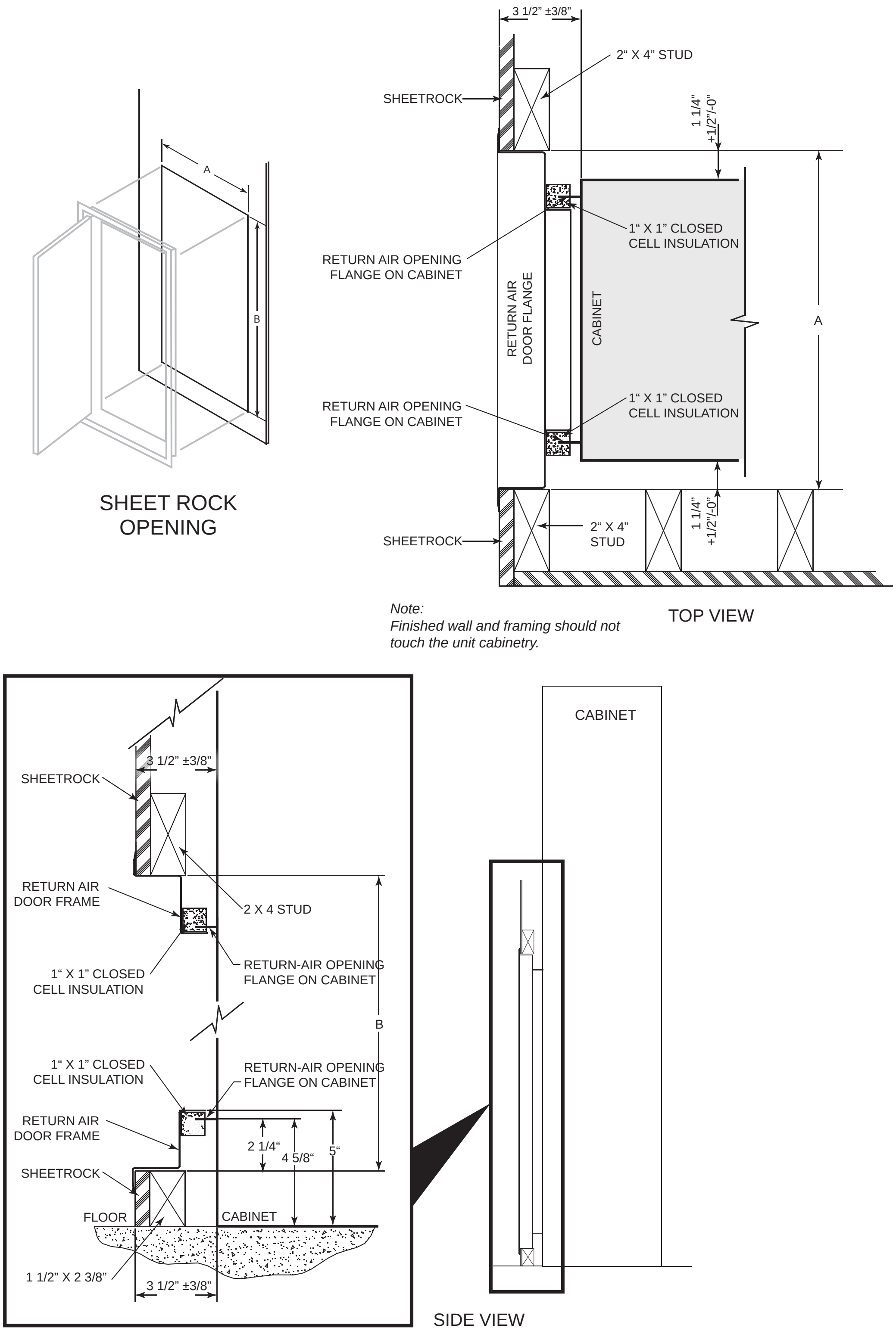


Table 27. Return air hinged acoustical door

Unit Size	A	B
009 012	19¼” (489)	44 1/8” (1121)
015 018	23¼” (591)	45¼” (1149)
024 036	27 1/8” (689)	54 5/8” (1387)

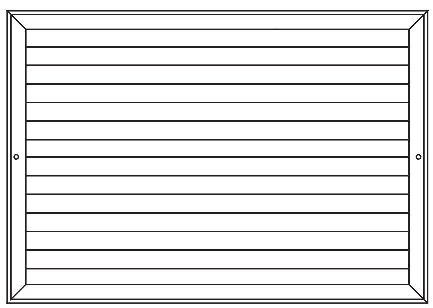
Return Air (hinged) Acoustical Door

The hinged acoustical door is recessed into the wall so that the door is flush with the surface of the wall.

The opening through the wall for the door assembly must be centered with the return-air opening of the unit cabinet. For full installing instructions of the return-air acoustical door, see WSHP-SVN08*-EN.

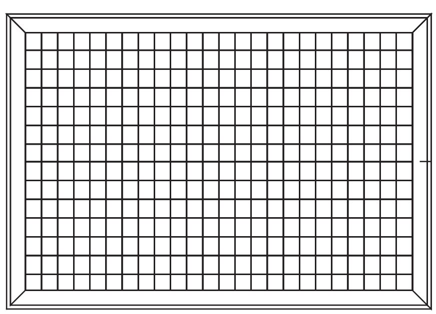
The dimensional data shown is based on Trane's factory supplied return air door.

Figure 15. Single deflection grille



Blades are adjustable for controlling horizontal discharge path.

Figure 16. Double deflection grille



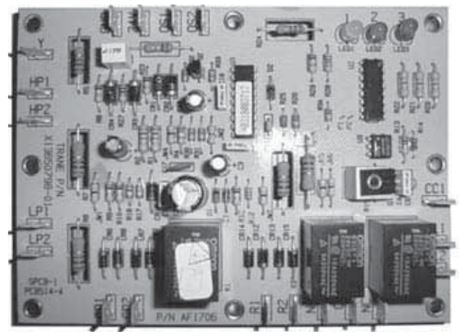
Blades are adjustable for controlling discharge path in both horizontal and vertical paths.

Table 28. Supply air opening size

GET	Single Grille 100% CFM	Two Grille 50% CFM	Three Grille 33% CFM	Top Discharge up to 100% CFM
009, 012	14”W x 14”H	10”W x 6”H	Not Recommended	14”W x 10”H
015, 018	16”Wx12”H	14”Wx12”H	12”Wx8”H	16”Wx14”H
024	22”Wx18”H	14”Wx12”H	12”Wx8”H	16”Wx14”H
036	Not Recommended	16”Wx14”H	14”Wx12”H	17”Wx17”H

Controls

Deluxe 24V Electronic Controls



The 24V deluxe design is a microprocessor-based control board conveniently located in the control box. The board is unique to Trane water-source products and is designed to control the unit as well as provide outputs for unit status and fault detection.

The board is factory wired to a terminal strip to provide all necessary terminals for field connections.

The deluxe 24V electronic unit control contains upgraded features to maximize system performance to extend the system life. Each device, is factory mounted, wired, and tested in the unit. Other features include compressor contactor, compressor lockout function, anti-short cycle compressor protection, random start delay, brown-out protection, low pressure time delay, low pressure switch, condensate overflow, freeze protection, high pressure switch, compressor delay on start, reversing valve coil (for heating and cooling units), multi-speed fan motor, soft lockout mode.

Note: *Electric heat is optional.*

Deluxe 24V features include:

Anti-short Cycle Timer

The anti-short cycle timer provides a three minute time delay between compressor stop and compressor restart. Once thermostat is enabled, an automatic 3 minute delay is provided for compressor protection.

Brown-out Protection

The brown-out protection function measures the input voltage to the controller and halts the compressor operation. Once a brown-out situation has occurred, the anti-short cycle timer will become energized. The general fault contact will not be affected by this condition. The voltage will continue to be monitored until the voltage increases. The compressors will be enabled at this time if all start-up time delays have expired, and all safeties have been satisfied.

Compressor Disable

The compressor disable relay provides a temporary disable in compressor operation. The signal would be provided from a water loop controller in the system. It would disable the compressor because of low water flow, peak limiting or if the unit goes into an unoccupied state. Once the compressor has been disabled, the anti-short cycle time period will begin. Once the compressor disable signal is no longer present, and all safeties are satisfied, the control will allow the compressor to restart.

Diagnostics

Three LEDs (light emitting diodes) are provided for indicating the operating mode of the controller. See the unit IOM for diagnostics or troubleshooting through the use of the LEDs.

Random Start

The random start relay provides a time delay start-up of the compressor when cycling in the occupied mode. A new start delay time between 3 and 10 seconds is applied each time power is enabled to the unit.

Safety Control

The deluxe microprocessor receives separate input signals from the refrigerant high pressure switch, low suction pressure switch and condensate overflow.

In a high pressure situation, the compressor contactor is de-energized, which suspends compressor operation. The control will go into soft lockout mode initializing a three minute time delay and a random start of 3 to 10 second time delays. Once these delays have expired, the unit will be allowed to run. If a high pressure situation occurs within one hour of the first situation, the control will be placed into a manual lockout mode, halting compressor operation, and initiating the general alarm.

In a low temperature situation, the low pressure switch will transition open after the compressor starts. If the switch is open for 45 seconds during compressor start, the unit will go into soft lockout mode initializing a three minute time delay and a random start of 3 to 10 second time delays. Once these delays have expired, the unit will be allowed to run. If the low pressure situation occurs again within 30 minutes, and the device is open for more than 45 seconds, the control will be placed into a manual lockout mode, halting compressor operation, and initiating the general alarm.

In a condensate overflow situation, the control will go into manual lockout mode, halting compressor operation, and initiating the general alarm.

The general alarm is initiated when the control goes into a manual lockout mode for either high pressure, low pressure or condensate overflow conditions. The alarm can be reset at the thermostat or by cycling power to the unit.

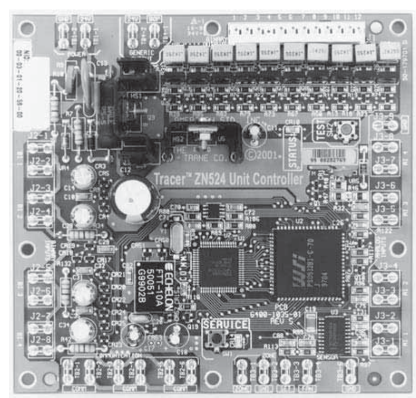
Small Building Control

The deluxe 24V electro-mechanical design may be applied as a stand-alone control system or as a multi-unit installation system. With a stand-alone design, units run independently of one another with an electronic digital thermostat.

With a multiple unit installation, the units may be daisy-chained directly to the Trane Tracer loop controller (TLC), pump(s), boiler, and tower for a complete net worked water-source system.

Direct Digital Controls

When the ZN510 controller is linked directly to the Tracer Summit, each Tracer Summit building automation system can connect a maximum of 120 Tracer ZN510 controllers.



Tracer ZN510 Controls

The Tracer ZN510 direct digital control (DDC) system is specifically designed for single water-source equipment to provide control of the entire unit, as well as outputs for unit status and fault detection. This device is factory installed, commissioned, and tested to ensure the highest level of quality in unit design.

Each of the controller's features and options were selected to coordinate with the unit hardware to provide greater energy efficiency and equipment safety to prolong the equipment life.

Because the ZN510 is LonTalk certified, it is capable of working with, and talking to other LonTalk certified controllers providing the building owner more choices, and the design engineers more flexibility to meet the challenges of building automation. Features include 75 VA transformer, compressor contactor, compressor lockout relay, compressor run capacitor, random start delay, heating/cooling status, occupied/unoccupied mode, low pressure switch, high pressure switch, fan and filter status, reversing valve coil, two-speed fan motor and water isolation valve support (for variable speed pumping).

Note: *Optional: condensate overflow*

Tracer ZN510 functions include:

Building Control Advantages

The Tracer ZN510 controller has the ability to share information with one or several units on the same communication link. This sharing of information is made possible via a twisted pair of wire and a building automation system or through Trane's Rover™ service tool.

An advantage of installing a ZN510 is its capability to work with other LonTalk™ certified controllers. This provides greater flexibility to the building owner, as well as greater flexibility in design.

Integrating the ZN510 on water-source equipment, and tying it to a Tracer Summit system provides a complete building management system. Each Tracer Summit can connect to a maximum of 120 controllers. With the ICS system, the Tracer can initiate an alarm on a loss of performance on equipment malfunctions; allowing problems to be handled in a timely manner before compromising comfort.

This type of application would most commonly be used for a large space(s) that may require more than one unit. In addition to this application design, the Tracer ZN510 controller provides a way for units located within the same space to share the same zone sensor to prevent units from simultaneously heating and cooling in the same space.

Compressor Operation

The compressor is cycled on and off to meet heating or cooling zone demands. The control of the unit uses the units' capacity and pulse width modulation (PWM) logic along with minimum on/off timers to determine the compressor's operation. The compressor is controlled ON for longer periods as capacity increases and shorter periods as capacity decreases.

Condensate Overflow

When condensate reaches the trip point, a condensate overflow signal generates a diagnostic which disables the fan, unit water valves (if present), and compressor. The unit will remain in a halted state until the condensation returns to a normal level. At this time, the switch in the drain pan will automatically reset. However, the controller's condensate overflow diagnostic must be manually reset to clear the diagnostic and restart the unit.

Data Sharing

The Tracer ZN510 controller is capable of sending or receiving data (setpoints, fan request, or space temperature) to and from other controllers on the communication link. This allows multiple units to share a common space temperature sensor in both stand-alone and building automation applications.

Fan Operation

The supply air fan operates at the factory wired speed in the occupied or occupied standby mode. When switch is set to AUTO, the fan is configured for cycling ON with heating or cooling. In heat mode, the fan will run for 30 seconds beyond compressor shutdown in both occupied and unoccupied mode.

Fan Run Timer

The controller's filter status is based on the unit fan's cumulative run hours. The controller compares the fan run time against an adjustable fan run hours limit and recommends unit maintenance as required.

High and Low Pressure Safety Controls

The Tracer ZN510 controller detects the state of the high pressure or low pressure switches. When a fault is sensed by one of these switches, the corresponding message is sent to the controller to be logged into the fault log. When the circuit returns to normal, the high pressure control and low pressure control automatically reset. If a second fault is detected within a thirty-minute time span, the unit must be manually reset.

Random Start

To prevent all of the units in a building from energizing major loads at the same time, the controller observes a random start from 0 to 25 seconds. This timer halts the controller until the random start time expires.

Reversing Valve Operation

For cooling, the reversing valve output is energized simultaneously with the compressor. It will remain energized until the controller turns on the compressor for heating. At this time, the reversing valve moves to a de-energized state. In the event of a power failure or controller OFF situation, the reversing valve output will default to the heating (de-energized) state.

Thermostats and Zone Sensors

Table 29. Thermostat/sensor selection

Thermostat / Sensor	Part Number	Description
	X13511211010	3 Heat/2 Cool Digital Display Thermostat • 3 H/2 C • Non Programmable
	X13511212010	2 Heat/2 Cool Digital Display Programmable Thermostat • 2 H/2 C • 7-Day Programmable
	X13511213010	2 Heat/2 Cool Digital Display Programmable Thermostat with Touch Screen • 2 H/2 C • 7-Day Programmable with Touch Screen
	X13511214010	3 Heat/2 Cool Digital Display Programmable Thermostat with Relative Humidity Sensing Built-in • 3 H/2 C • 7-Day Programmable • Humidity Sensing
	X13651467020	Communication Module • Sold in packs of 12 • Compatible with X1351529010 and X13511527010
	X13511529010	Zone Sensor • Tracer ZN510 and ZN524 compatible • External setpoint adjustment wheel
	X13511527010	Zone Sensor • Tracer ZN510 and ZN524 compatible • External setpoint adjustment wheel • ON and CANCEL buttons
	X1379084501	Zone Sensor • Tracer ZN510 and ZN524 compatible • External setpoint adjustment wheel • ON and CANCEL buttons • Fan switch AUTO-OFF

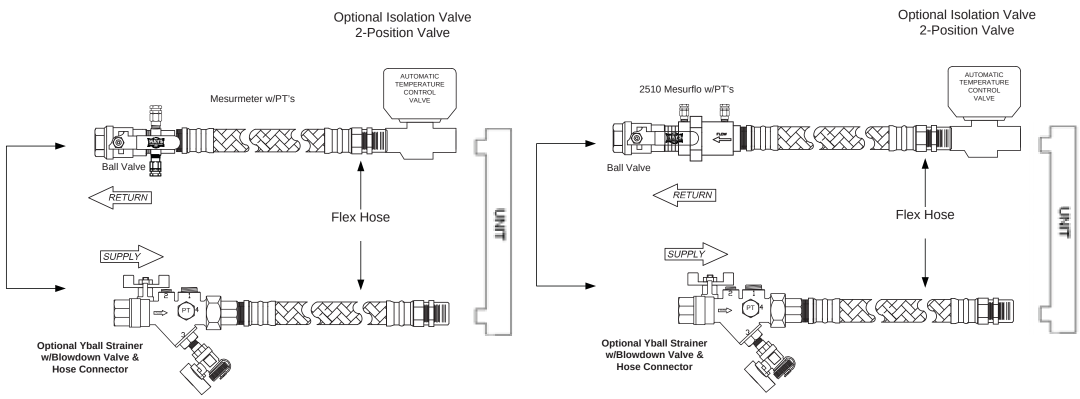
Accessories

System balancing hose kit

For automatic system balancing of a water source heat pump, the Mesurflo® self-balancing hose kit provides a constant flow rate over the pressure differential rage of 2 to 80 psid. As system pressure changes (through further addition of heat pumps, for example) each individual flow control valve will automatically adjust to the new system conditions. In variable water volume applications, a self-balancing hose kit can provide continuous balancing because of its ability to automatically adjust to the varying system conditions.

Note: *At low differential pressure the flow area required to achieve higher flow can exceed the flow area available for the respective series. Therefore, the minimum pressure differential requirement is increased for the higher flow ranges of each series Mesurflo valve.*

Figure 17. Ball valve kit (manual)/MeasurfloVac kit (automatic)



Tracer Loop Controller

Trane's Tracer Loop Controller (TLC) is a cost effective way of controlling the WSHP equipment, as well as the mechanical components of the system. Fluid coolers, boilers, pumps and water-source heat pump units can be connected and controlled by the loop controller for total system optimization. The Tracer loop control panel has the ability to lower or raise the water loop temperature during low energy use hours (typically during the night time hours) to provide a greater optimization during the time of day where energy consumption may be at it's greatest. Using the loop controller as a means of coordinating cooling or heating storage, the building owner can expect better efficiencies from the WSHP equipment.

Mechanical Specifications

General

Equipment is factory assembled, piped, internally wired, fully charged with R-410A refrigerant and oil. Units are tested at the factory.

Products are certified in accordance with AHRI Water to Air and Brine to Air Heat Pump Certification Program which is based ISO Standard 13256-1: 1998. All units have an ETL label that meets USA (UL std) and Canadian (CSA std).

Casing

The cabinet assembly is constructed of heavy-gauge galvanized steel. It houses the blower, fan and control hook-up to the unit thermostat or zone sensor. A basepan with condensate hose is included with the cabinet design. Base rails allow ease of chassis installation/removal for service or maintenance. One, two or three supply air openings shall are factory provided. Optional one or three inch flanges are provided on all free discharge openings.

The chassis is constructed of heavy-gauge galvanized steel. The chassis houses the compressor, reversing valve, water-to-refrigerant heat exchanger, air-to-refrigerant heat exchanger, thermal expansion valve, corrosive resistant condensate pan, and water inlet/outlet connections. The chassis is installed into the cabinet by sliding it in place on the locating rails within the cabinet design.

The insulation contains a flame spread rating of less than 25 and smoke density rating of less than 50 (as tested in accordance with ASTM-85). The elastomer insulation has a UL 94-5V rating.

Sound Attenuation

Sound attenuation is applied as a standard feature in the product design. The enhanced reduction package includes a heavy gage base plate, and gasket/insulation around the compressor enclosure.

An optional deluxe sound reduction package is also available. It includes a heavy gage base plate, gasket and insulation around the compressor enclosure, and vibration isolation between the chassis and cabinet. An additional dampening treatment is applied around the compressor enclosure to achieve greater acoustical reductions.

Filters

One inch, throwaway filters are standard and factory installed. The filters have an average resistance of 76% and dust holding capacity of 26-grams per square foot.

Compressors

All units have direct-drive, hermetic, rotary (unit sizes 009-018) and scroll (unit sizes 024 and 036) type compressors. The compressor contains rubber isolation to aid in noise reduction during compressor start/stop.

Internal thermal overload protection and compressor anti-short cycle timers are also provided. Protection against excessive discharge pressure is provided by means of a high pressure switch. Loss of charge protection is provided by a low pressure switch.

Refrigerant Circuits

The refrigerant circuit contains a thermal expansion device, service pressure ports, and system safety devices factory-installed as standard.

Air-to-Refrigerant Coil

Internally finned, 3/8” copper tubes mechanically bonded to a configured aluminum plate fin are standard. Coils are leak tested at the factory to ensure the pressure integrity. The coil is leak tested to 200 psig and pressure tested to 650 psig.

Drain Pan

The condensate pan is constructed of corrosive resistant material. The bottom of the drain pan is sloped in two planes to pitch the condensate towards the drain connection. Condensate is piped to a lower base pan through condensate hose for ease of chassis removal. A clear drain hose is factory clamped onto the drain connection for field hook-up.

Water-to-Refrigerant Heat Exchanger

The water-to-refrigerant heat exchanger is of a high quality co-axial coil for maximum heat transfer. The copper or optional cupro-nickel coil is deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil has a working pressure of 650 psig on the refrigerant side and 400 psig on the water side.

Indoor Fan

The blower is a double width, double inlet (DWDI) forward curved wheel. The blower is a direct drive PSC or optional ECM fractional horsepower motor. The blower/motor assembly is designed for efficient and quiet operation. The PSC motor is multi-speed and is wired for a HIGH or LOW setting. The ECM motor is programmed to provide four constant CFM profiles and is shipped on Profile B – the rated CFM of the unit. The motor is also factory programmed to provide 50% airflow in the fan only mode for additional energy savings. Service or maintenance to the blower/motor is easily achieved by removal of a single bracket.

Risers

Factory provided supply and return risers are Type L copper. The drain riser is Type M copper. Swages from one diameter to another are performed as specified by the engineer in the field. Diameters and length are specified by the equipment model number. Riser insulation (optional) contains a flame rating per UL94-5V with flame spread rate of no more than 25.

Controls

The unit control box contains all necessary devices to allow heating and cooling operation to occur from a unit mounted, plug-in thermostat or sensor. The devices are as follows:

- 24 VAC energy limiting class II 75 VA breaker type transformer.
- 24 VAC blower motor relay
- 24 VAC compressor contactor for compressor control
- Lockout relay which controls cycling of the compressor is provided to protect the compressor during adverse operating conditions. The device may be reset by interrupting the 24 VAC control circuit. Reset may be done either at the thermostat or by momentary main power interruption.
- A high pressure switch protects the compressor against operation at refrigerant system pressures exceeding 650 psig.
- A low pressure switch is provides that trips at 40 psig. A freezestat is provided - tripping at either 35° or 20°F.
- Factory installed wire harness is available for the Deluxe and ZN510 control packages.
- Power connections are made through a factory installed conduit located at the top of the unit's cabinet. An optional disconnect is provided. The conduit grants access directly to the control box.

Nameplate information is given for the application of either time-delay fuses or HACR circuit breakers for branch circuit protection from the primary source of power.

Single phase, single voltage rated equipment is designed to operate between plus or minus 10% of nameplate utilization voltage.

Operation outside of this range may adversely effect the service life of the equipment.

Deluxe Controls (option)

The deluxe control package provides a 75 VA transformer with circuit breaker. The Micro-processor based controller is designed to include a lockout relay, anti-short cycle compressor protection, random start delay, brown-out protection, low pressure time delay, compressor delay on start and an open relay for night setback or pump request. Optional wiring from the factory for condensate overflow and compressor enable are also supplied. LEDs (light emitting diodes) are included for diagnostics of the equipment. The deluxe controller accepts a standard 24V digital thermostat.

ZN510 Controller (option)

This system utilizes factory furnished and mounted DDC controls for operation on a COMM 5 (LonMark) link. The Tracer™ ZN510 control package includes a 75 VA transformer. The controller provides random start delay, heating/cooling status, occupied/unoccupied mode, fan status and filter maintenance options. Optional wiring from the factory for condensate overflow is also available. Three LEDs (light emitting diodes) are included for diagnostics of the equipment.

Return-Air Hinged Acoustical Door (option)

A frame mounted acoustical door is provided to attenuate noise. The door is hinged to the wall frame, and contains magnetic latches to keep the door aesthetically in place. It is flush mounted to the wall as to not protrude into the owner space. The door allows access to the unit for ease of filter replacement

The door is constructed from heavy-gauge formed galvanized steel and painted Polar white. It is made available in a keylock design and a keyless design to fit several design applications.

Supply-Air Grilles (option)

Supply air grilles are available for air discharge from the unit. The grilles are made in either a vertical louver, or a bi-directional louver option. The grilles are painted the Polar White to match the door assembly.

Ball Valves (option)

Ball valves are field installed between the riser stub out and the flexible hose.

Hoses (option)

Hoses shall consist of a stainless steel outer braid with an inner core of tube made of a nontoxic synthetic polymar material. The hoses shall be suitable for water temperatures ranging between 33°F and 211°F without the use of glycol.

Automatic Flow Devices (option)

The automatic self-balancing device shall automatically limit the rate of flow to within 10-percent of the specified amount, over a 40 to 1 differential pressure operating range of 2 to 80 PSID. The operational temperature shall be rated from fluid freezing, to 225°F.

The valve body shall be suited for working pressures of 400 PSIG. The valve internal core shall consist of one or more high temperature elastomeric diaphragms and precision orifice with sculptured orifice seat.

Dual pressure/temperature test ports shall be standard for verifying the pressure differential and system temperature.

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Document 476412
Energy Recovery Ventilators

Installation, Operation and Maintenance Manual

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

Models:

ERV-10
ERV-20
ERV-45
ERV-55
ERV-90
ERV-120

General Safety Information

Only qualified personnel should install this system. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if high winds or seismic activity are present. If more information is needed, contact a licensed professional engineer before moving forward.

DANGER

Always disconnect power before working on or near this equipment. Lock and tag the disconnect switch or breaker to prevent accidental power up.

CAUTION

When servicing the unit, the internal components may be hot enough to cause pain or injury. Allow time for cooling before servicing.

CAUTION

Precaution should be taken in explosive atmospheres.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC), the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electrical Code (CEC) in Canada.
2. All moving parts must be free to rotate without striking or rubbing any stationary objects.
3. Unit must be securely and adequately grounded.
4. Do not spin fan wheel faster than maximum cataloged fan RPM. Adjustments to fan speed significantly effects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to the unit while it is running.

Table of Contents

Product Overview

The ERV brings in fresh, outdoor air and removes stale, exhaust air. Prior to discharging the exhaust air, the energy recovery wheel transfers energy from the exhaust air to the outdoor air at an efficiency of 70-80%. Simply put, this unit preconditions the outdoor air to save money on heating and cooling costs.

Supplemental IOMs

Refer to the following Installation, Operation and Maintenance (IOM) Manuals for additional details:

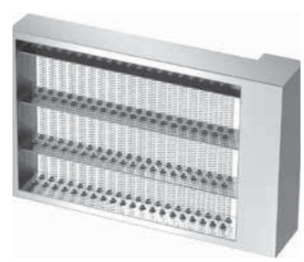
- ERV-90 and ERV-120 Curbs
- ERV Exhaust Weatherhood

Optional Subassemblies

Electric Heater Application/Operation

Factory installed electric heaters can be provided for preheat frost control. An electric preheater warms the outdoor air prior to the energy recovery wheel to prevent frosting on the wheel. Electric heaters are available in 208, 230, or 460 VAC (refer to heater nameplate for voltage).

Preheaters: Preheaters are standard as single-stage on/off control. Preheaters are single point wired at the factory. A thermodisc temperature sensor (with a 5°F set point) is mounted in the outdoor airstream after the preheater to turn the preheater on. See Frost Control Application/Operation for typical set points. If the temperature falls below the set point and the wheel pressure drop sensor is triggered, the preheater will turn on.



Access to the preheater control panel is through the outdoor air filter door.

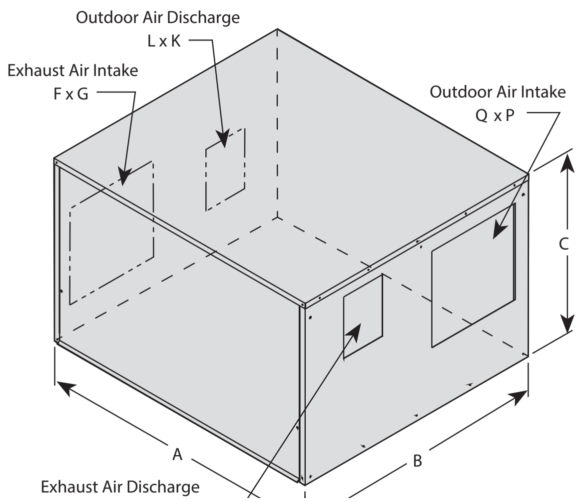
Installation

Dimensional Data

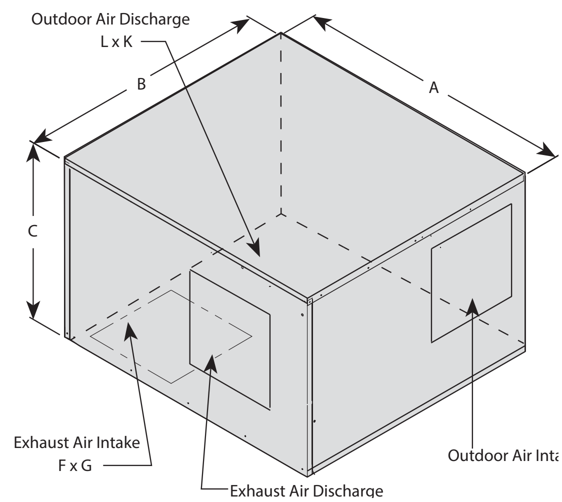
ERV-10, 20, 45 and 55

Unit Size	Exterior Dimensions			Unit Opening Dimensions					
	A	B	C	F	G	K	L	Q	P
ERV-10	46	34	27	10	16	6¾	7	10	16
ERV-20	62	51	34	18	18	8⅜	11½	19	18
ERV-45	67	67	44	24	24	10¾	13½	26	26
ERV-55	75	70	67	22	27	16	18¾	28	48

All dimensions are in inches.



Arrangement A



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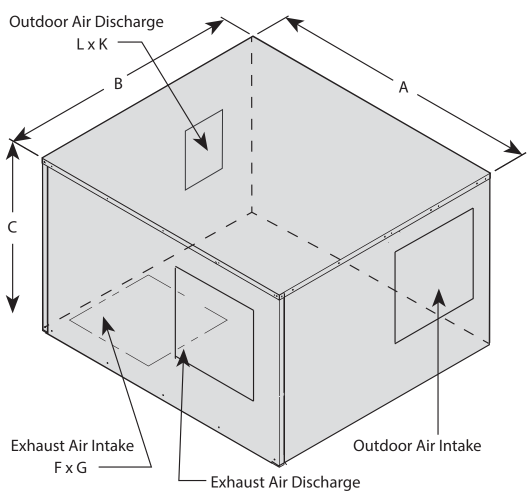

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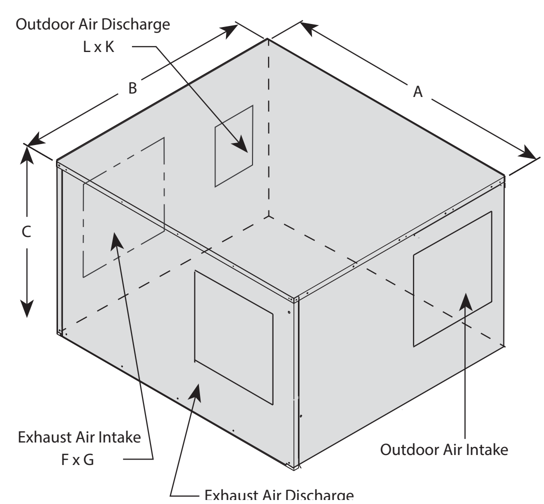


Arrangement D

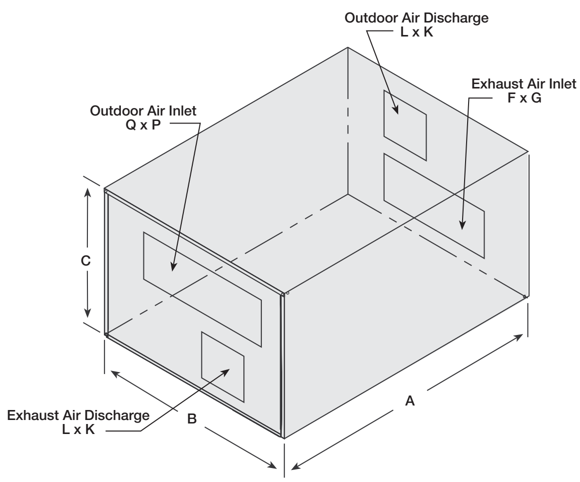
Installation

Dimensional Data

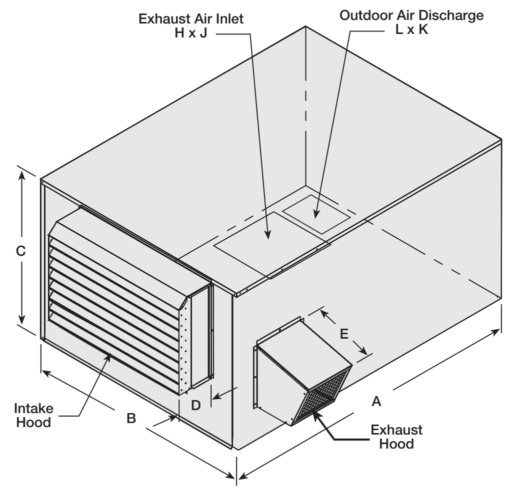
ERV-90 and 120

Unit Size	Exterior Dimensions					Unit Opening Dimensions					
	A	B	C	D	E	F	G	K	L	Q	P
ERV-90L	124	84	64	16	19	48	25	16	18⅝	60	25
ERV-90H	124	84	64	16	19	48	25	19	22	60	25
ERV-120H	146	97	77	17½	26¾	60	28	23	25	70	30

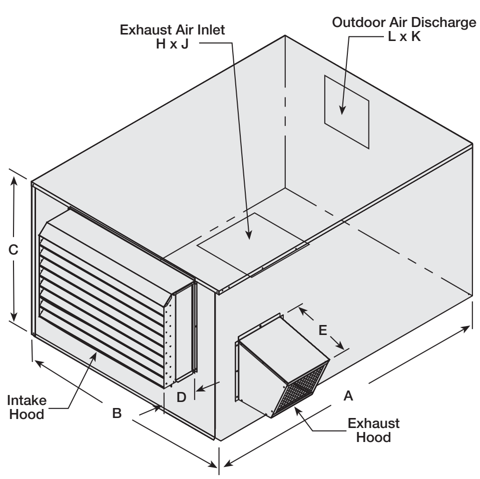
All dimensions are in inches.



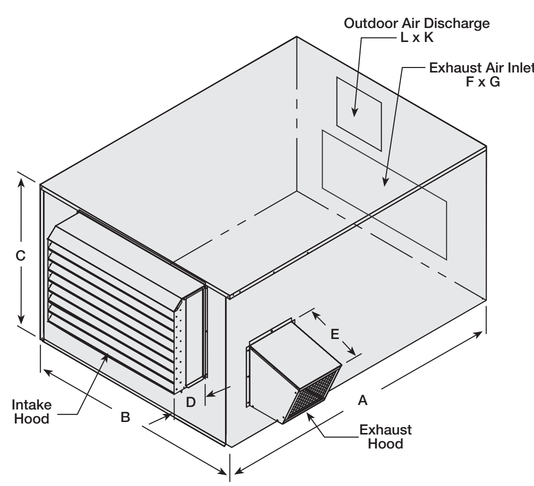
Arrangement A



Arrangement B



Arrangement C



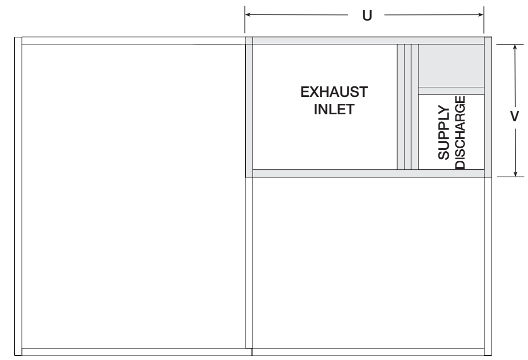
Arrangement D

Recommended Roof Openings & Weights

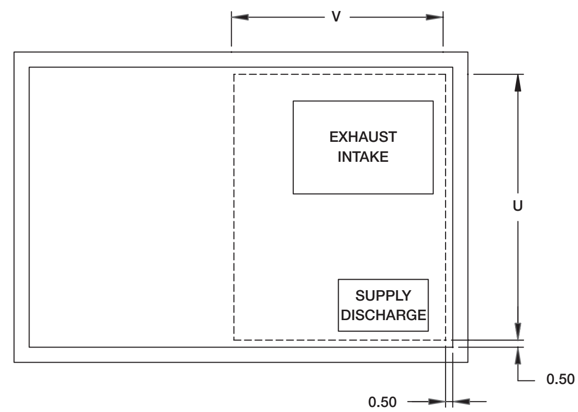
Position the unit roof opening such that the supply discharge and exhaust inlet of the unit will line up with the corresponding ductwork. Be sure to allow for the recommended service clearances when positioning opening (see Service Clearances).
Do not face the outdoor air intake of the unit into prevailing wind and keep the intake away from any other exhaust fans. Likewise, position the exhaust discharge opening away from outdoor air intakes of any other equipment.

When cutting only duct openings, cut opening 1 inch *(25 mm)* larger than duct size to allow clearance for installation. Area enclosed by roof curb must comply with clearance to combustible materials. If the roof is constructed of combustible materials, area within the roof curb must be ventilated, left open, or covered with non-combustible material which has an "R" value of at least 5. If area within curb is open, higher radiated sound levels may result.

Where the supply or warm air duct passes thru a combustible roof, a clearance of one inch must be maintained between the outside edges of the duct and combustible material in accordance with NFPA Standard 90A.



ERV-90 and 120



ERV-10, 20, 45 and 55

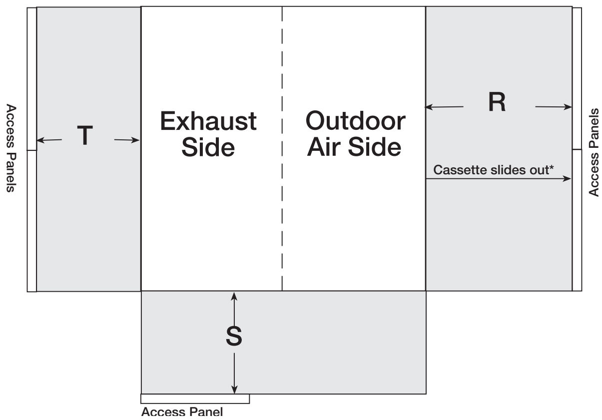
Unit Size	U	V	Approx. Weight (lbs.)
ERV-10	26.5	20	340
ERV-20	43	26	860
ERV-45	58	35	1290
ERV-55	60	30	1470
ERV-90	62	36	3230
ERV-120	77	38	3700

All dimensions are in inches. *Weight assumes outdoor unit with filters, weatherhoods and outdoor air intake damper.

Service Clearances

ERV-10, 20, 45 and 55 units require minimum clearances to perform routine maintenance, such as filter replacement, energy wheel cassette inspection, and fan belt adjustment. Blower and motor assemblies, energy recovery wheel cassette and filter sections are always provided with a service door or panel for proper component access. *Clearances for component removal may be greater than the service clearances, refer to drawings below for these dimensions.*

ERV-10, ERV-20, ERV-45, ERV-55



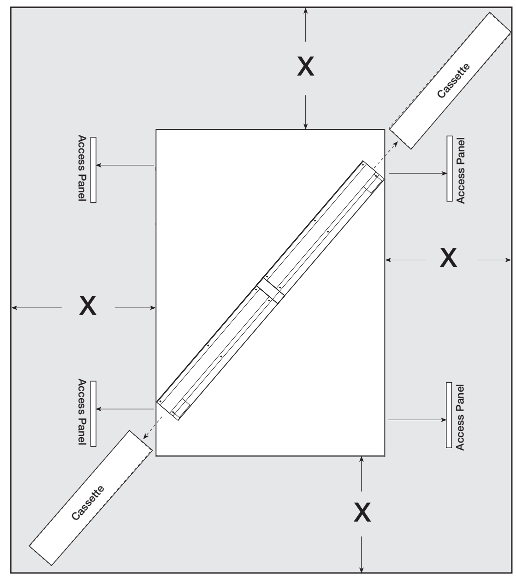
*ERV-10, 20, and 45 only.

Arrangement A

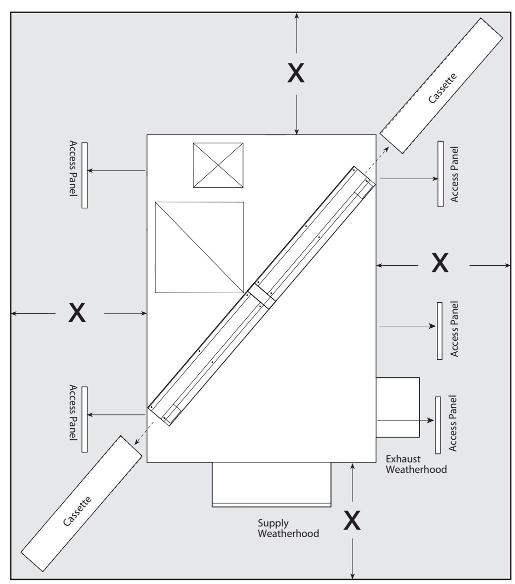
Recommended Service Clearances				
Unit Size	**R**	**S**	**T**	**X**
ERV-10	32	30	42	
ERV-20	44 (30 for maintenance)	30	42	
ERV-45	60 (39 for maintenance)	40	42	
ERV-55	65 (32 for maintenance)	40	42	
ERV-90				42
ERV-120				42

All dimensions are in inches.

ERV-90, ERV-120



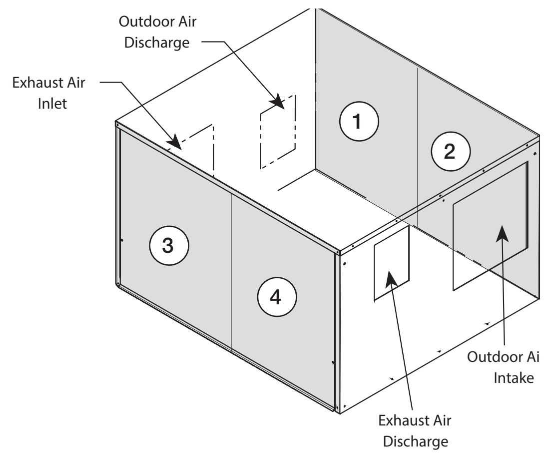
Arrangement A



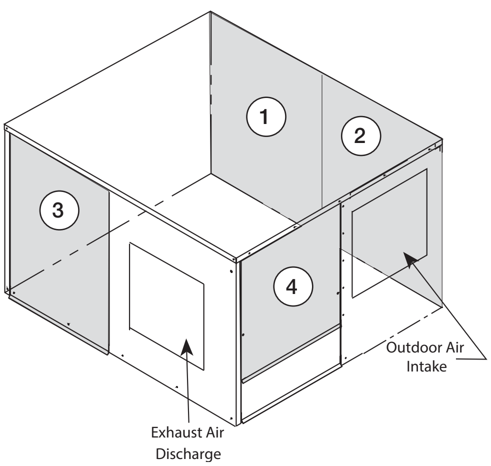
Arrangement B, C or D

Access Panel Locations

ERV-10, ERV-20, ERV-45, ERV-55



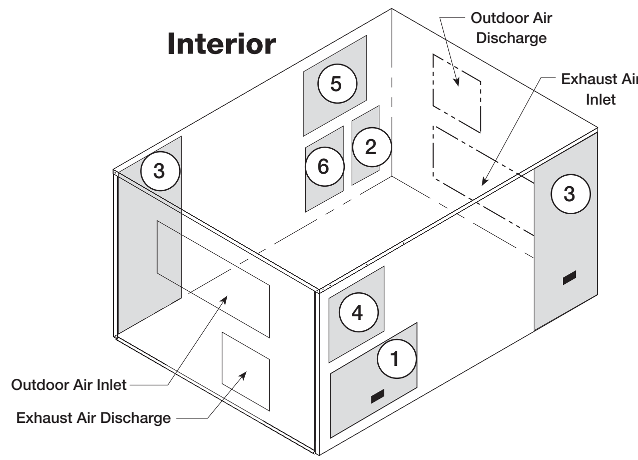
Arrangement A



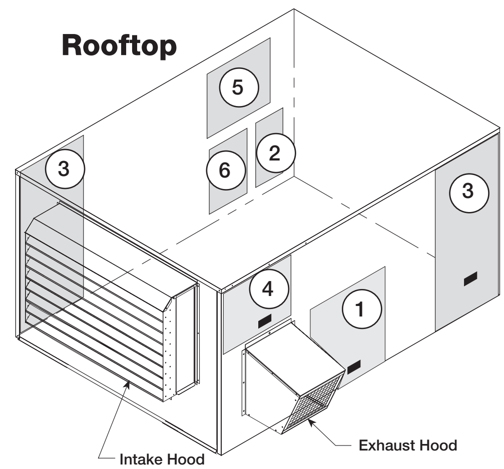
Arrangement B, C or D

1	Outdoor air blower and motor Energy wheel cassette
2	Energy wheel cassette Internal filters Outdoor air intake damper Frost control Outdoor air sensors
3	Main disconnect Electrical control center Internal filters
4	Exhaust air blower and motor

ERV-90



Arrangement A

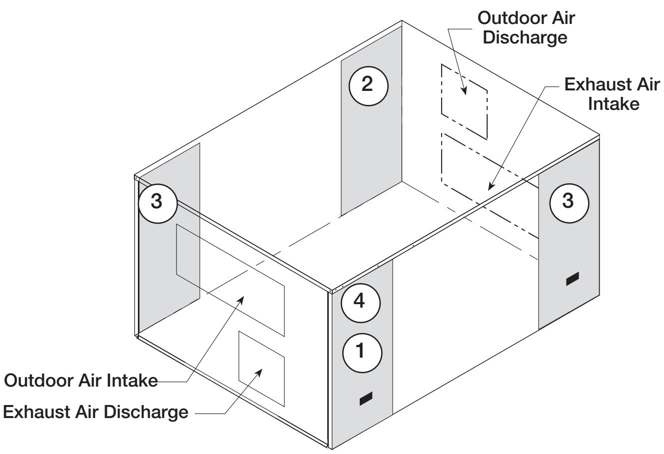


Arrangement B, C or D

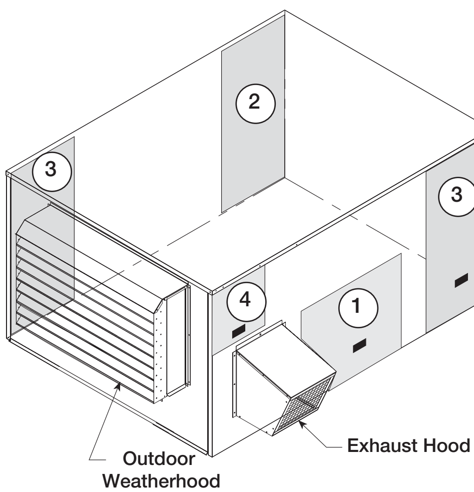
1	Exhaust blower and motor
2	Electric control center Main Disconnect
3	Energy wheel cassette Internal filters Frost control Outdoor air sensors
4	Preheater controls Outdoor air intake damper
5	Supply blower and motor
6	Exhaust air intake damper

Access Panel Locations continued

ERV-120



Arrangement A



Arrangement B, C or D

1	Exhaust blower and motor
2	Electric control center Main disconnect Supply blower and motor Exhaust air intake damper
3	Energy wheel cassette Internal filters Frost control Outdoor air sensor
4	Preheater controls Outdoor air intake damper

Handling

While this unit was constructed with quality and dependability in mind, damage still may occur during handling of the unit for installation. Exercise extreme caution to prevent any damage from occurring to the refrigerant system.

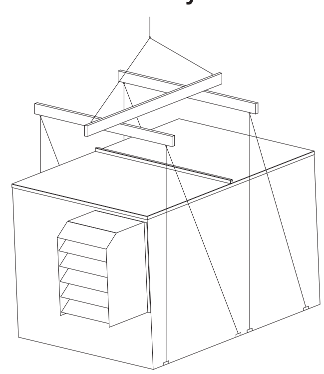
The system design and installation should follow accepted industry practice, such as described in the ASHRAE Handbook. Adequate space should be left around the unit for filter replacement and maintenance. Sufficient space should be provided on the side of the unit for routine service and component removal should that become necessary.

Lifting

WARNING

All factory provided lifting lugs must be used when lifting the unit. Failure to comply with this safety precaution could result in property damage, serious injury or death.

1. Before lifting, be sure that all shipping material has been removed from unit.
2. To assist in determining rigging requirements, weights are shown below.
3. Unit must be lifted by all lifting lugs provided on base structure.
4. Rigger to use suitable mating hardware to attach to unit lifting lugs.
5. Spreader bar(s) must span the unit to prevent damage to the cabinet by the lift cables.



6. Always test-lift the unit to check for proper balance and rigging before hoisting to desired location.
7. Never lift units by weatherhoods.
8. Never lift units in windy conditions.
9. Preparation of curb and roof openings should be completed prior to lifting unit to the roof.
10. Check to be sure that gasketing (supplied by others) has been applied to the curb prior to lifting the unit and setting on curb.
11. Do not use fork lifts for handling unit.

Roof Curb Mounting

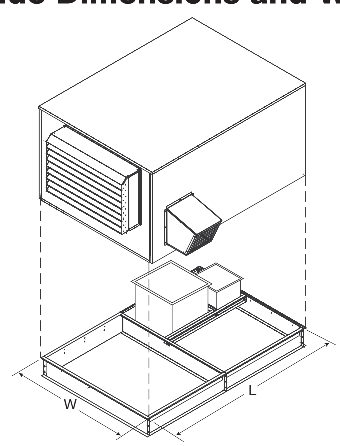
Roof curb details including duct location dimensions, are available on ERV-90 & 120 Roof Curb Assembly Instructions.

Rooftop units require curbs to be mounted first. The duct connections must be located so they will be clear of structural members of the building.

1. **Factory Supplied Roof Curbs:** Roof curbs are Model GPI or GPNS for the ERV-10, 20, 45, 55. The GPI or GPNS ships assembled and includes a duct adapter.

   Roof curbs are Model GKD for the ERV-90 and 120. The GKD ships in a knockdown kit (includes duct adapter) and requires field assembly (by others). Assembly instructions are included with the GKD curbs.
2. **Install Curb:** Locate curb over roof opening and fasten in place. (Refer to Recommended Roof Openings). Check that the diagonal dimensions are within ±1/8 inch of each other and adjust as necessary. For proper unit operation, it is important that the installation be level. Shim as required to level.
3. **Install Ductwork:** Installation of all ducts should be done in accordance with SMACNA and AMCA guidelines. Duct adapter provided to support ducts prior to setting the unit.
4. **Set the Unit:** Lift unit to a point directly above the curb and duct openings. Guide unit while lowering to align with duct openings. Roof curbs fit inside the unit base. Make sure the unit is properly seated on the curb and is level.

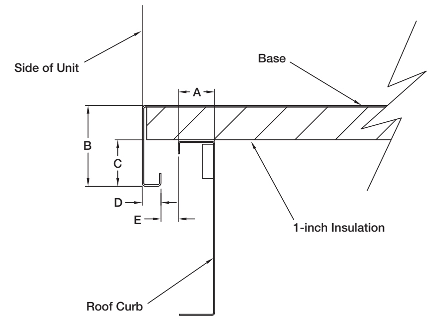
Curb Outside Dimensions and Weights



ERV-90 and 120

Unit Size	L	W	Curb Weight (lbs.)
ERV-10	42.5	30.5	60
ERV-20	58.5	47.5	115
ERV-45	63.5	63.5	160
ERV-55	71.8	66	185
ERV-90	120.5	80.5	520
ERV-120	142.25	93	700

All dimensions are in inches. Weights are for 12-inch high GPI type curbs.



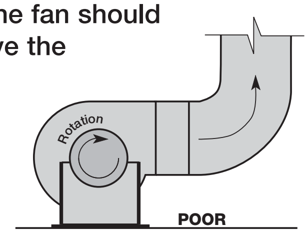
Curb Cap Details for Factory Supplied Roof Curbs

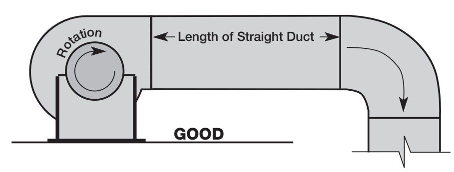
Unit Size	A	B	C	D	E
ERV-10	1.75	2.00	1.00	1.125	0.750
ERV-20	1.75	2.00	1.00	1.200	0.875
ERV-45	1.75	2.00	1.00	0.813	0.875
ERV-55	1.75	2.00	1.00	0.813	0.750
ERV-90	1.813	4.00	1.75	1.000	0.750
ERV-120	1.938	4.125	1.938	1.125	0.625

All dimensions are in inches.

Ductwork Connections

Examples of poor and good fan-to-duct connections are shown. Airflow out of the fan should be directed straight or curve the same direction as the fan wheel rotates. Poor duct installation will result in low airflow and other system effects.





Recommended Discharge Duct Size and Length			
Model	**Blower Size**	**Duct Size**	**Straight Duct Length**
ERV-10	10	9 x 9	36
ERV-20	10	14 x 14	36
ERV-45	12	20 x 20	36
ERV-55	15	28 x 28	60
ERV-90L	15	28 x 28	60
ERV-90H	18	32 x 32	60
ERV-120	20	34 x 34	72

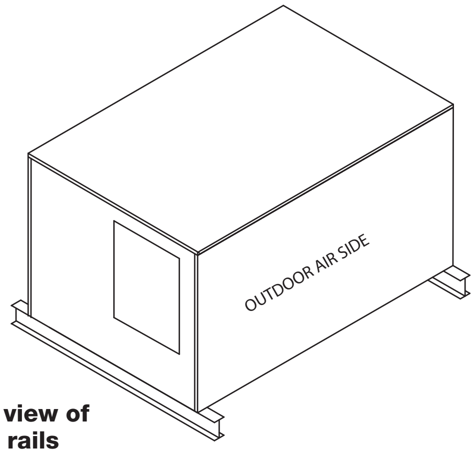
All dimensions shown in inches.

- Recommended duct sizes are based on velocities across the cfm range of each model at approximately 800 feet per minute (FPM) at minimum airflow and up to 1600 fpm at maximum airflow. Recommended duct sizes are only intended to be a guide and may not satisfy the requirements of the project. Refer to plans for appropriate job specific duct size and/or velocity limitations.
- Straight duct lengths were calculated based on 100% effective duct length requirements as prescribed in AMCA Publication 201. Calculated values have been rounded up to nearest foot.

Rail Mounting / Layout

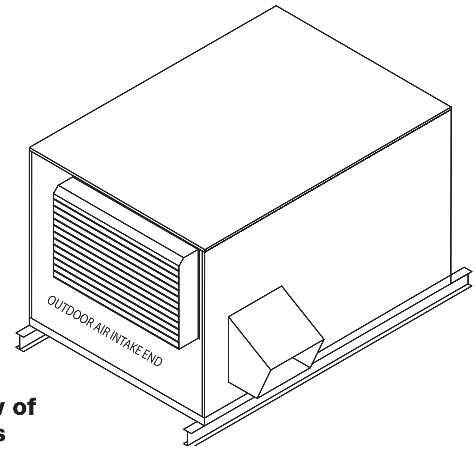
- Rails designed to handle the weight of the ERV should be positioned as shown on the diagram (rails by others).
- Make sure that rail positioning does not interfere with the supply air discharge opening or the exhaust air intake opening on the ERV unit. Avoid area dimensioned “B” below.
- Rails should extend beyond the unit a minimum of 12 inches on each side.
- Set unit on rails.

ERV-10
ERV-20
ERV-45
ERV-55

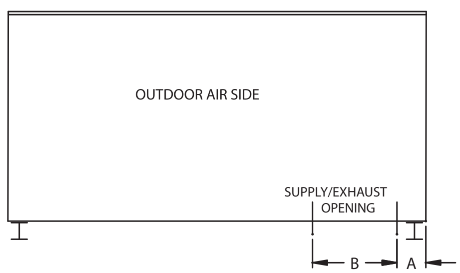


Isometric view of ERV on rails

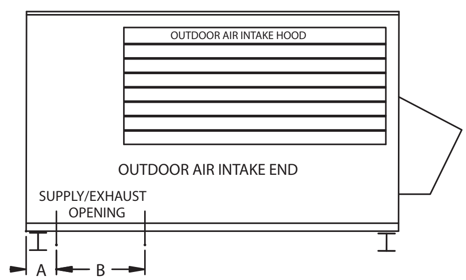
ERV-90
ERV-120



Isometric view of ERV on rails



Side view of ERV on rails



Side view of ERV on rails

Unit Size	A	B
ERV-10	4.50	16
ERV-20	4.75	18
ERV-45	5.75	24
ERV-55	4.875	22

All dimensions are in inches.

Unit Size	A	B
ERV-90	4.625	32
ERV-120	4.875	33.25

All dimensions are in inches.

Outdoor Air Weatherhood

Outdoor air weatherhood will be factory mounted.

Exhaust Weatherhood

The exhaust weatherhood is shipped separately as a kit with its own instructions.

Dampers

Backdraft dampers are always included as an integral part of the exhaust hood assemblies. Motorized outdoor air and exhaust air dampers are optional and are factory mounted (and wired) at the intake.

Electrical Information

The unit must be electrically grounded in accordance with the current National Electrical Code, ANSI/NFPA 70. In Canada, use current CSA Standard C22.1, Canadian Electrical Code, Part 1. In addition, the installer should be aware of any local ordinances or electrical company requirements that might apply. System power wiring must be properly fused and conform to the local and national electrical codes. System power wiring is to the unit main disconnect (door interlocking disconnect switch standard on most units) or distribution block and must be compatible with the ratings on the nameplate: supply power voltage, phase, and amperage (Minimum Circuit Amps - MCA, Maximum Overcurrent Protection - MOP). All wiring beyond this point has been done by the manufacturer and cannot be modified without affecting the unit's agency / safety certification.

If field installing an additional disconnect switch, it is recommended that there is at least four feet of service room between the switch and system access panels. When providing or replacing fuses in a fusible disconnect, use dual element time delay fuses and size according to the rating plate.

If power supply is desired through bottom of unit, run the wiring through the curb, cut a hole in the cabinet bottom, and wire to the disconnect switch. Seal penetration in cabinet bottom to prevent leakage.

The electric supply to the unit must meet stringent requirements for the system to operate properly. Voltage supply and voltage imbalance between phases should be within the following tolerances. If the power is not within these voltage tolerances, contact the power company prior to operating the system.

Voltage Supply: See voltage use range on the rating plate. Measure and record each supply leg voltage at all line disconnect switches. Readings must fall within the allowable range on the rating plate.

Voltage Imbalance: In a 3-phase system, excessive voltage imbalance between phases will cause motors to overheat and eventually fail. Maximum allowable imbalance is 2%. To determine voltage imbalance, use recorded voltage measurements in this formula.

Key: V1, V2, V3 = line voltages as measured

VA (average) = (V1 + V2 + V3) / 3

VD = Line voltage (V1, V2 or V3) that deviates farthest from average (VA)

Formula: % Voltage Imbalance = [100 x (VA-VD)] / VA

CAUTION

If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring material having a temperature rating of at least 105ºC.

WARNING

To prevent injury or death due to electrocution or contact with moving parts, lock disconnect switch open.

Most factory supplied electrical components are prewired. To determine what electrical accessories require additional field wiring, refer to the unit specific wiring diagram located on the inside of the unit control center access door. The low voltage control circuit is 24 VAC and control wiring should not exceed 0.75 ohms.

Refer to Field Control Wiring Length/Gauge table for wire length maximums for a given wire gauge.

Field Control Wiring Length/Gauge

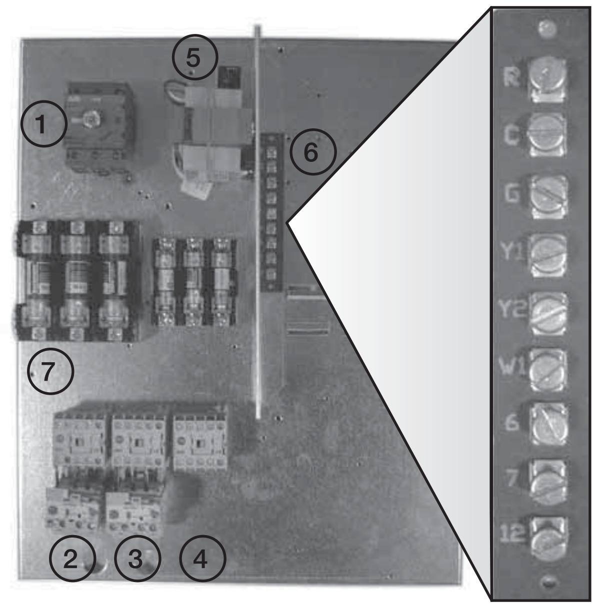
Total Wire Length	Minimum Wire Gauge
125 ft.	18
200 ft.	16
300 ft.	14
450 ft.	12

Control wires should not be run inside the same conduit as that carrying the supply power. Make sure that field supplied conduit does not interfere with access panel operation.

If wire resistance exceeds 0.75 ohms, an industrial-style, plug-in relay should be added to the unit control center and wired in place of the remote switch (typically between terminal blocks R and G on the terminal strip (refer to Typical Control Center Components). The relay must be rated for at least 5 amps and have a 24 VAC coil. Failure to comply with these guidelines may cause motor starters to "chatter" or not pull in which can cause contactor failures and/or motor failures.

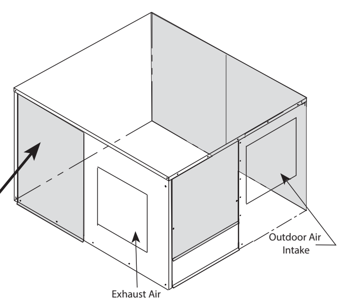
Typical Control Center Components

1. Main Disconnect (non-fusible, lockable)
2. Motor Starter – Exhaust Air Fan
3. Motor Starter – Outdoor Air Fan
4. Motor Contactor – Energy Wheel
5. 24 VAC Control Transformer
6. 24 VAC Terminal strip
7. Fuses for blower motors



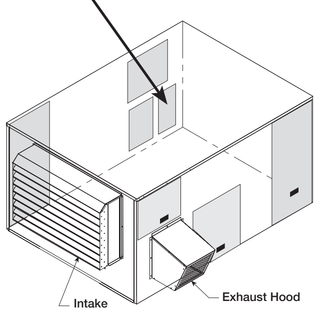
Exploded Detail of Terminal Strip

ERV-10, 20, 45, 55

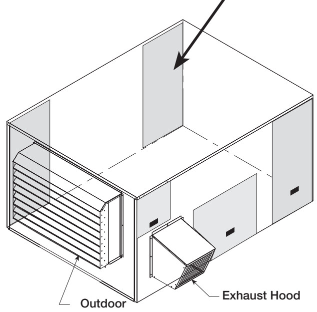


Access to Control Center Components is gained through the access panel indicated.

ERV-90



ERV-120



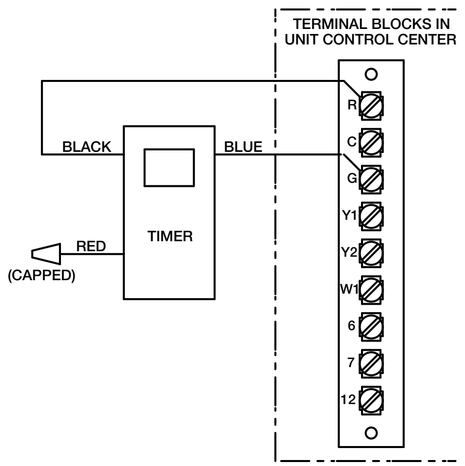
Optional Accessory Wiring Schematics

Remote Panel

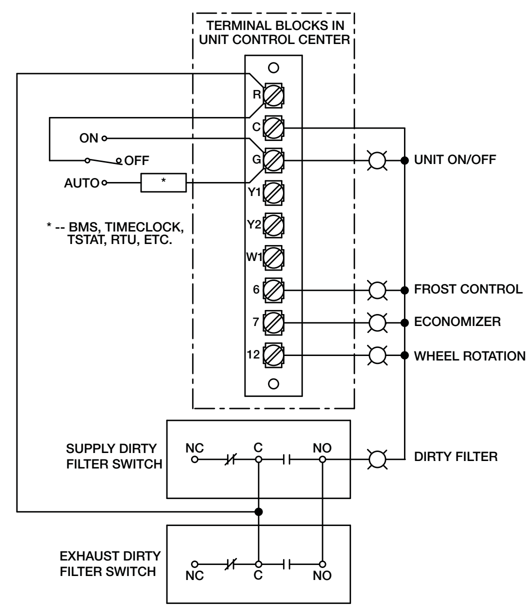
The remote panel is available with a number of different alarm lights and switches to control the unit. The remote panel ships loose and requires mounting and wiring in the field. The remote panel is available with the following options:

- Unit on/off switch
- Unit on/off light
- 7-day time clock
- Hand/off/auto switch
- Dirty filter light
- Economizer light
- Frost control light
- Wheel rotation sensor light

7-Day Timer



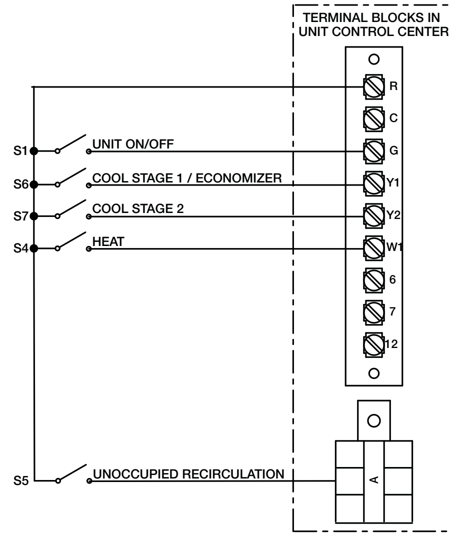
On/Off/Auto Switch & Indictor Light Wiring



ON/OFF/AUTO SWITCH ALLOWS THREE MODES OF OPERATION
"ON" - UNIT IS TURNED ON MANUALLY
"OFF" - UNIT IS TURNED OFF MANUALLY
"AUTO" - UNIT IS CONTROLLED VIA SCHEDULER OF BMS, TIMECLOCK, TSAT, ETC.

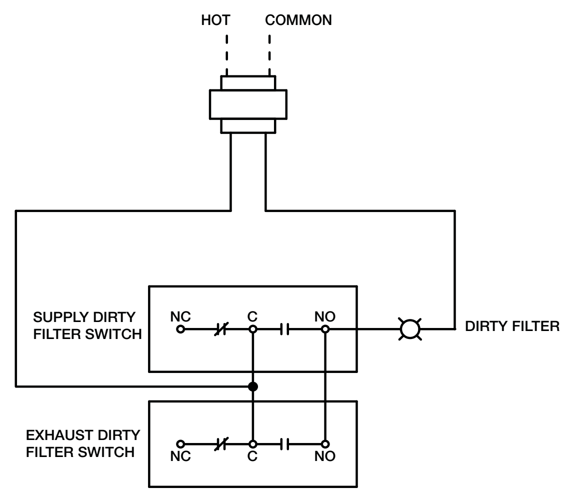
Unit Interfacing Terminals

Heating/Cooling Switches & Night Setback Switch/Timer



Dirty Filter Indicator

(powered by others)



Unit Overview

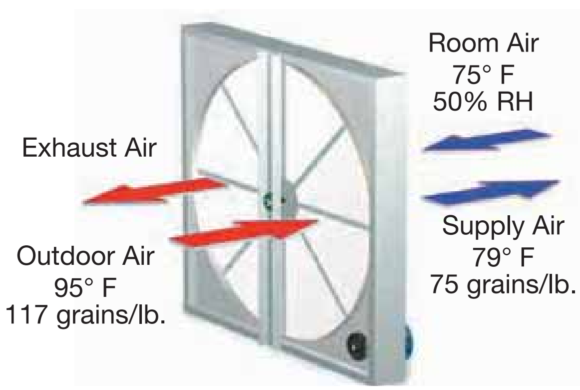
Basic Unit

The unit is pre-wired such that when a call for outside air is made (via field-supplied 24 VAC control signal wired to unit control center), the supply fan, exhaust fan, and energy wheel are energized and optional motorized dampers open.

The unit can be supplied with or without heating and cooling coils. For units with coils, controls can be supplied by manufacturer or by the controls contractor. If supplied by the controls contractor, they would provide, mount, and wire any temperature controllers and temperature or relative humidity sensors required for the unit to discharge air at the desired conditions. However, temperature, pressure, and current sensors can be provided by manufacturer for purposes of monitoring via the BMS.

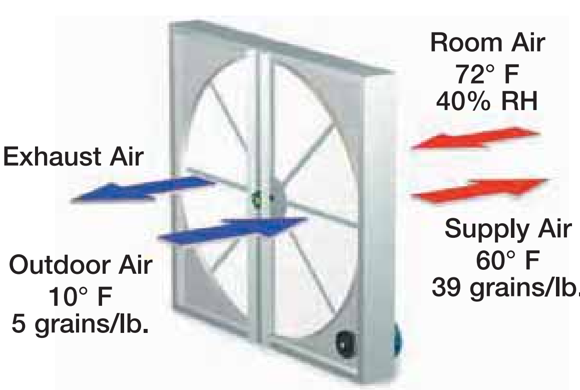
Summer Operation

Outdoor air is preconditioned (temperature and moisture levels are decreased) by the transfer of energy from the cooler, drier exhaust air via the energy recovery wheel. The preconditioned air is typically mixed with return air going back to the air handler for final conditioning.



Winter Operation

Outdoor air is preconditioned (temperature and moisture levels are increased) by the transfer of energy from the warmer, more humid exhaust air via the energy recovery wheel. The preconditioned air is typically mixed with return air going back to the air handler for final conditioning.



Optional Component Overview

Economizer

The energy wheel operation can be altered to take advantage of economizer operation (free cooling). Two modes are available:

1. Stopping the wheel
2. Modulating the wheel

Stopping the wheel: A field-supplied call for cool (Y1) is required. De-energizing the wheel is accomplished one of three ways:

1. The outdoor air temperature is less than the outdoor drybulb set point (DRYBLB SET)
2. The outdoor air temperature is less than the return air temperature
3. The outdoor air enthalpy is within the preset enthalpy curve

A low temperature lock out (LOW T LOCK) is also set to deactivate mechanical cooling when it exceeds the outdoor air temperature (factory default 32ºF). Effectively, the two sensors create a deadband where the energy recovery wheel will not operate and free cooling from outside can be brought into the building unconditioned.

Modulating the wheel (factory): A variable frequency drive is fully programmed at the factory. A “call for cool” must be field wired to the unit (terminals provided in unit-refer to wiring diagram in unit control center) to allow for initiation of economizer mode. The unit recognizes economizer conditions based one of the previously mention sensors and set points. The unit will then modulate the wheel speed to maintain the mixed air temperature set point (MAT SET).

Modulating the wheel (by others): A variable frequency drive is fully programmed at the factory. A field-supplied 0-10 VDC signal will be required for operation of the energy wheel. The field will be required to have full control of the energy wheel speed at all times. If no 0-10 VDC signal is provided, the energy wheel will run at the factory default of 3 Hz and no energy transfer will be captured.

Frost Control

Extremely cold outdoor air temperatures can cause moisture condensation and frosting on the energy recovery wheel. Frost control is an optional feature that will prevent/control wheel frosting. Three options are available:

1. Timed exhaust frost control
2. Electric preheat frost control
3. Modulating wheel frost control

All of these options are provided with a thermodisc mounted in the outdoor air intake compartment and a pressure sensor to monitor pressure drop across the energy wheel.

An outdoor air temperature of below 5ºF and an increase in pressure drop would indicate that frost is occurring. Both the pressure sensor and the outdoor air thermodisc must trigger in order to initiate frost control. The two sensors together ensure that frost control is only initiated during a real frost condition.

Timed exhaust frost control includes a timer in addition to the thermodisc and wheel pressure sensor. When timed exhaust frost control is initiated, the timer will turn the supply blower off. Time exhaust using default timer setting will shut down the supply fan for 5 minutes every 30 minutes to allow exhaust to defrost energy wheel. Use the test procedure in the Optional Start-Up Accessories section for troubleshooting.

Electric preheat frost control includes an electric heater (at outdoor air intake) in addition to the thermodisc and pressure sensor on wheel. When electric preheat frost control is initiated, the electric preheater will turn on and warm the air entering the energy wheel to avoid frosting. Use the test procedure in the Optional Start-Up Accessories section for troubleshooting.

Modulating wheel frost control includes a variable frequency drive (VFD) in addition to the thermodisc and pressure sensor. When modulating wheel frost control is initiated, the VFD will reduce the speed of the wheel. Reducing the speed of the energy wheel reduces its effectiveness, which keeps the exhaust air condition from reaching saturation, thus, eliminating condensation and frosting. If the outdoor air temperature is greater than the frost threshold temperature OR the pressure differential is less than the set point, the wheel will run at full speed. If the outdoor air temperature is less than 5ºF AND the pressure differential is greater than the set point, the wheel will run at reduced speed until the pressure differential falls below the set point. The VFD will be fully programmed at the factory.

Variable Frequency Drives (VFD)

VFDs are used to control the speed of the fan as either multi-speed or modulating control. Multi-speed VFDs reference a contact which can be made by a switch or a sensor with a satisfied set point. Modulating control references a 2-10 VDC signal to the VFD which will vary the fan speed from a minimum 50% to full 100% rpm. An optional CO_2 sensor is available to provide both a set point contact or a modulating 2-10 VDC signal.

CO_2 Sensor

This accessory is often used in Demand Control Ventilation (VDC) applications. The factory provided sensors can either be set to reference a set point for multi-speed operation, or output a 2-10 VDC signal to modulate the fan speed. These can either be shipped loose to mount in the ductwork, or can be factory mounted in the return air intake. Follow instructions supplied with sensor for installation and wiring details.

Rotation Sensor

The rotation sensor monitors energy wheel rotation. If the wheel should stop rotating, the sensor will close a set of contacts in the unit control center. Field-wiring of a light (or other alarm) between terminals R and 12 in the unit control center will notify maintenance personnel when a failure has occurred.

Dirty Filter Sensor

Dirty filter sensors monitor pressure drop across the outdoor air filters, exhaust air filters, or both. If the pressure drop across the filters exceeds the set point, the sensor will close a set of contacts in the unit control center. Field-wiring of a light (or other alarm) to these contacts will notify maintenance personnel when filters need to be replaced. The switch has not been set at the factory due to external system losses that will affect the switch. This switch will need minor field adjustments after the unit has been installed with all ductwork complete. The dirty filter switch is mounted in the exhaust inlet compartment next to the unit control center or in unit control center.

Service Outlet

120 VAC GFCI service outlet ships loose for field installation. Requires separate power source so power is available when unit main disconnect is turned off for servicing.

Start-Up

DANGER
Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit to OFF at disconnect switch(es). Unit may have multiple power supplies.

WARNING
Use caution when removing access panels or other unit components, especially while standing on a ladder or other potentially unsteady base. Access panels and unit components can be heavy and serious injury may occur.
Do not operate energy recovery ventilator without the filters and birdscreens installed. They prevent the entry of foreign objects such as leaves, birds, etc.

CAUTION
Do not run unit during construction phase. Damage to internal components may result and void warranty.

General Start-Up Information

Every installation requires a comprehensive start-up to ensure proper operation of the unit. As part of that process, the following checklist must be completed and information recorded. Starting up the unit in accordance with this checklist will not only ensure proper operation, but will also provide valuable information to personnel performing future maintenance. Should an issue arise which requires factory assistance, this completed document will allow unit experts to provide quicker resolve. Qualified personnel should perform start-up to ensure safe and proper practices are followed.

Unit Model Number ______________________________
(e.g. ERV-20)

Unit Serial Number ______________________________
(e.g. 04C99999 or 10111000)

Energy Wheel Date Code ______________________________
(e.g. 0450)

Start-Up Date ______________________________

Start-Up Personnel Name ______________________________

Start-Up Company ______________________________

Phone Number ______________________________

Pre Start-Up Checklist – check as items are completed.

- ☐ Disconnect and lock-out all power switches
- ☐ Remove any foreign objects that are located in the energy recovery unit.
- ☐ Check all fasteners, set-screws, and locking collars on the fans, bearings, drives, motor bases and accessories for tightness.
- ☐ Rotate the fan wheels and energy recovery wheels by hand and ensure no parts are rubbing. If rubbing occurs, refer to Start-Up section for more information.
- ☐ Check the fan belt drives for proper alignment and tension (refer to Start-Up section for more information).
- ☐ Filters can load up with dirt during building construction. Replace any dirty pleated filters and clean the aluminum mesh filters in the intake hood (refer to Routine Maintenance section).
- ☐ Verify that non-motorized dampers open and close properly.
- ☐ Check the tightness of all factory wiring connections.
- ☐ Verify control wire gauge (refer to the Electrical Connections section).
- ☐ Verify diameter seal settings on the energy recovery wheel (refer to Start-Up section for more information).

SPECIAL TOOLS REQUIRED
• Voltage Meter (with wire probes) • Amperage Meter • Thermometer • Tachometer • Incline manometer or equivalent

Start-Up Checklist

The unit will be in operational mode during start-up. Use necessary precautions to avoid injury. All data must be collected while the unit is running. In order to measure volts & amps, the control center door must be open, and the unit energized using a crescent wrench to turn the disconnect handle.

Check line voltage at unit disconnect

_______ L1-L2 volts
_______ L2-L3 volts
_______ L1-L3 volts

Motor Amp Draw

• Supply Fan
_______ L1 amps
_______ L2 amps
_______ L3 amps

• Exhaust Fan
_______ L1 amps
_______ L2 amps
_______ L3 amps

• Energy Wheel
_______ L1 amps
_______ L2 amps
_______ L3 amps

Fan RPM

_______ Supply Fan _______ Exhaust Fan

Correct fan rotation direction

Supply Fan Yes / No
Exhaust Fan Yes / No

Optional Accessories Checklist

Refer to the respective sections in this Installation, Operation and Maintenance Manual for detailed information.

Refer to wiring diagram in unit control center to determine what electrical accessories were provided.

Provided with Unit?

Frost Control Application / Operation section:

			Setting	Factory Default
Yes	No	Frost Control set point		5ºF
		Differential		2ºF
		Timer		Refer to IOM
Yes	No	Frost Control Modulating		Refer to IOM

Economizer Application / Operation section:

Yes	No	Economizer (temperature)		
		Set point		65ºF
		Offset		20ºF
		Differential		2ºF
Yes	No	Economizer (enthalpy)		
		Set point		D
Yes	No	Economizer (modulating)		Refer to IOM

Optional Accessories section:

			Operational		
Yes	No	Wheel Rotation Sensor	Yes	No	N/A
Yes	No	OA Dirty Filter Sensor	Yes	No	N/A
Yes	No	EA Dirty Filter Sensor	Yes	No	N/A
Yes	No	CO_2 Sensor	Yes	No	N/A
Yes	No	Service Outlet	Yes	No	N/A
Yes	No	Remote Control Panel	Yes	No	N/A

Variable Frequency Drives section:

			Operational		
Yes	No	Blower VFDs	Yes	No	N/A
Yes	No	Wheel VFD	Yes	No	N/A

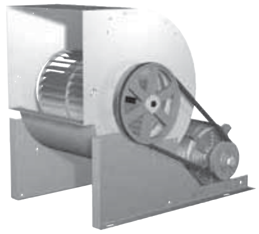
Damper section:

			Operational		
Yes	No	Outdoor Air Damper	Yes	No	N/A
Yes	No	Exhaust Air Damper	Yes	No	N/A

Start-Up Components

Fans

The ERV models contain two forward curved (supply ans exhaust) fans. These forward curved fans should be checked for free rotation. If any binding occurs, check for concealed damage and foreign objects in the fan housing. Be sure to check the belt drives per the start-up recommendations in the following section.



Forward Curved Exhaust Fan

CAUTION
When operating conditions of the fan are to be changed (speed, pressure, temperature, etc.), consult Greenheck to determine if the unit can operate safely at the new conditions.

Fan Performance Modifications

Due to job specification revisions, it may be necessary to adjust or change the sheave or pulley to obtain the desired airflow at the time of installation. Start-up technician must check blower amperage to ensure that the amperage listed on the motor nameplate is not exceeded. Amperage to be tested with access doors closed and ductwork installed.

Fan Belt Drives

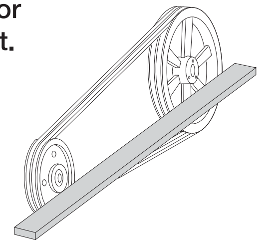
The fan belt drive components, when supplied by Greenheck, have been carefully selected for the unit's specific operating condition. Utilizing different components than those supplied could result in unsafe operating conditions which may cause personal injury or failure of the following components:

- Fan Shaft
- Bearings
- Motor
- Fan Wheel
- Belt

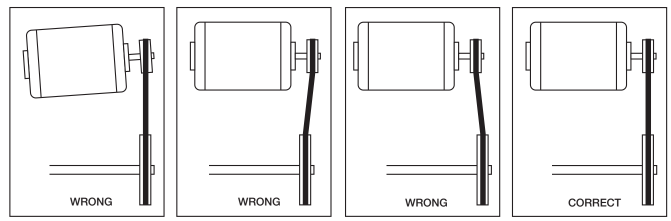
Tighten all fasteners and set screws securely and realign drive pulleys after adjustment. Check pulleys and belts for proper alignment to avoid unnecessary belt wear, noise, vibration and power loss. Motor and drive shafts must be parallel and pulleys in line (see diagrams in this section).

Belt Drive Installation

1. Remove the protective coating from the end of the fan shaft and assure that it is free of nicks and burrs.
2. Check fan and motor shafts for parallel and angular alignment.
3. Slide sheaves on shafts. Do not drive sheaves on as this may result in bearing damage.

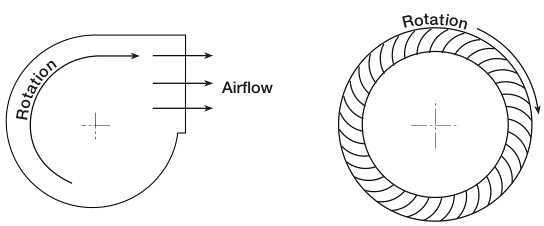


4. Align fan and motor sheaves with a straight-edge or string and tighten.
5. Place belts over sheaves. Do not pry or force belts, as this could result in damage to the cords in the belts.
6. With the fan off, adjust the belt tension by moving the motor base. (See belt tensioning procedures in the Routine Maintenance section of this manual). When in operation, the tight side of the belts should be in a straight line from sheave to sheave with a slight bow on the slack side.



Direction of Fan Wheel Rotation

Blower access is labeled on unit. Check for proper wheel rotation by momentarily energizing the fan. Rotation is determined by viewing the wheel from the drive side and should match the rotation decal affixed to the fan housing (see Rotation Direction figures).
If the wheel is rotating the wrong way, direction can be reversed by interchanging any two of the three electrical leads. Check for unusual noise, vibration, or overheating of bearings. Refer to the Troubleshooting section of this manual if a problem develops.



Forward Curved

Fan RPM

Supply fan and exhaust fan will have an adjustable motor pulley (on 15 HP and below) preset at the factory to the customer specified RPM. Fan speed can be increased or decreased by adjusting the pitch diameter of the motor pulley. Multi-groove variable pitch pulleys must be adjusted an equal number of turns open or closed. Any increase in fan speed represents a substantial increase in load on the motor. Always check the motor amperage reading and compare it to the amperage rating shown on the motor nameplate when changing fan RPM. All access doors must be installed except the control center door. *Do not operate units with access doors open or without proper ductwork in place as the fan motors will overload.*

Vibration

Excessive vibration may be experienced during initial start-up. Left unchecked, excessive vibration can cause a multitude of problems, including structural and/or component failure. The most common sources of vibration are listed.

- Wheel Unbalance
- Drive Pulley Misalignment
- Incorrect Belt Tension
- Bearing Misalignment
- Mechanical Looseness
- Faulty Belts
- Drive Component Unbalance
- Poor Inlet/Outlet Conditions
- Foundation Stiffness

Many of these conditions can be discovered by careful observation. Refer to the Troubleshooting section of this manual for corrective actions. If observation cannot locate the source of vibration, a qualified technician using vibration analysis equipment should be consulted. If the problem is wheel unbalance, in-place balancing can be done.

Generally, fan vibration and noise is transmitted to other parts of the building by the ductwork. To eliminate this undesirable effect, the use of heavy canvas connectors is recommended.

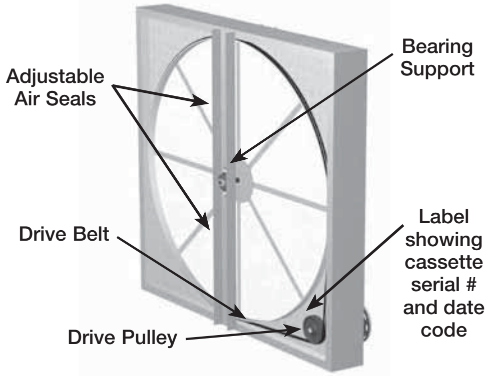
Energy Recovery Wheel

The ERV models contain a total energy recovery wheel. The wheels are inspected for proper mechanical operation at the factory. However, during shipping and handling, shifting can occur that may affect wheel operation. The wheel is accessible through the access door marked “Energy Wheel Cassette Access”. For the ERV-10, 20, 45, and 90, the wheel cassette(s) slide out. Due to the size and weight of the ERV-55 and 120 wheels, they remain stationary and all maintenance is performed in place. There is room inside the unit to perform energy recovery wheel servicing.

Turn the energy recovery wheels by hand to verify free operation. The wheel should rotate smoothly and should not wobble.

Drive Belt

Inspect the drive belt. Make sure the belt rides smoothly through the pulley and over the wheel rim.



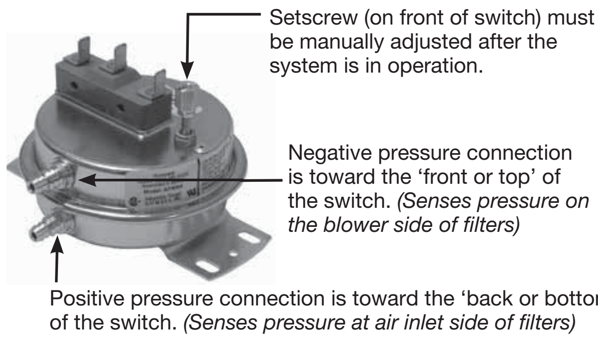
Air Seals

Check that the air seals located around the outside of the wheel and across the center (both sides of wheel) are secure and in good condition. Air seal clearance is determined by placing a sheet of paper, to act as a feeler gauge, against the wheel face. To access seals, enter the unit for the ERV-55 and 120, or pull out the cassette for the ERV-10, 20, 45, and 90, following the instructions in the Energy Recovery Wheel Maintenance section. To adjust the air seals, loosen all eight seal retaining screws. These screws are located on the bearing support that spans the length of the cassette through the wheel center. Tighten the screws so the air seals tug slightly on the sheet of paper.

Replace cassette into unit, plug in wheel drive, replace access door and apply power. Observe by opening door slightly (remove filters if necessary to view wheel) the wheel should rotate freely at about 50-60 RPM.

Optional Start-Up Components

Dirty Filter Switch



To adjust the switch, the unit must be running with all of the access doors in place, except for the compartment where the switch is located (exhaust intake compartment). The adjusting screw is located on the top of the switch.

1. Open the filter compartment and place a sheet of plastic or cardboard over 50% of the filter media.
2. Replace the filter compartment door.
3. Check to see if there is power at the alert signal leads (refer to electrical diagram).
4. Whether there is power or not, turn the adjustment screw on the dirty filter gauge (clockwise if you did not have power, counter-clockwise if you did have power) until the power comes on or just before the power goes off.
5. Open the filter compartment and remove the obstructing material.
6. Replace the door and check to make sure that you do **not** have power at the alert signal leads.

The unit is now ready for operation.

Economizer

Relevant Set Points

1. MAT SET   The mixed air temperature set point after the energy wheel. The control will modulate the energy wheel to maintain temperature as best as it can. (Set point menu, default 53°F)
2. LOW T LOCK   The set point for the low temperature mechanical cooling lockout. (Set point menu, default 32°F)
3. DRYBLB SET   The outdoor air set point to call for economizer. (Set point menu, default 63°F)
4. MIN POS   The minimum signal voltage sent to the energy wheel. This must be set to 2 VDC. (Set point menu, default 2.8 VDC)
5. AUX1 O   The controllers operating sequence structure. (Set point menu, default 'None')
6. ERV OAT SP   The set point for low temperature economizer lockout. This is the low temperature set point when AUX1 O is set to ERV. (Set point menu, default 32°F)
7. STG3 DLY   Time delay after second cooling stage is enabled (Advanced setup menu, default 2 hrs.)

Using the Keypad with Settings and Parameters

To use the keypad when working with Set points, System and Advanced Settings, Checkout tests, and Alarms:

1. Navigate to the desired menu.
2. Press ↵ (enter) to display the first item in the currently displayed menu.
3. Use the ▲ and ▼ buttons to scroll to the desired parameter.
4. Press ↵ (enter) to display the value of the currently displayed item.
5. Press the ▲ button to increase (change) the displayed parameter value.[a]
6. Press the ▼ button to increase (change) the displayed parameter value.[a]
7. Press ↵ (enter) to accept the displayed value and store it in non-volatile RAM.
8. CHANGE STORED displays.
9. Press ↵ (enter) to return the current menu parameter.
10. Press ⏻ (escape) to return to the current menu parameter.

[a] When values are displayed, pressing and holding the ▲ or ▼ button causes the display to automatically increment.

The table shows which set points are relevant to the given sequences. Refer to the wiring diagram for the units's sequence.

	MODULATE WHEEL			STOP WHEEL		
	OA Temp	OA Enthalpy	OA/RA Temp Differential	OA Temp	OA Enthalpy	OA/RA Temp Differential
DRYBLB SET	X			X		
MAT SET	X	X	X	X	X	X
LOW T LOCK	X	X	X	X	X	X
ERV OAT SP				X	X	X
MIN POS	X	X	X			
AUX1 OUT				ERV	ERV	ERV
STG3 DLY	X	X	X	X	X	X

Stop Wheel

1. Navigate to the Checkout menu and press ↵ (enter).
2. The energy wheel and cooling should stop.
3. Navigate to Connect ERV and press ↵ (enter) twice to run the test.
4. Voltage between AUX1-O and C should be 24 VAC. The energy wheel should activate.

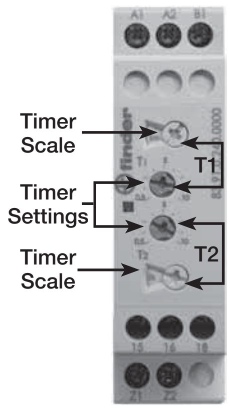
Modulate Wheel

1. Navigate to the Checkout menu and press ↵ (Enter).
2. The cooling should turn off and the wheel should be rotating at full speed.
3. Navigate to Damper Open and press ↵ (enter) twice to run the test.
4. Voltage between terminals ACT 2-10 and ACT COM should be 10 VDC. This will slow the wheel down to minimum speed.
5. Press ⏻ (escape), navigate to Damper Close and press ↵ (enter) twice to run the test.
6. Voltage between terminal ACT 2-10 and ACT COM should be 2 VDC. This will speed the wheel up to maximum speed.

Frost Control

Timed Exhaust

1. Remove power from unit.
2. Jumper the frost indicating wheel pressure switch in the unit control center.
3. Jumper the temperature indicating thermodisc in the unit control center. Thermodisc has a pre-set temperature of 5ºF.
4. Set the frost control timer scale for T1 and T2 to 1m. Set the timer settings for T1 and T2 to 10.
5. Add power to the unit. Blower should cycle on for one minute, then turn off for one minute.
6. Remove power from unit and remove jumpers that were placed. Re-set timer settings.
   - **T1** timer setting set to **5** and timer scale set to **10m** for 5 minutes of wheel off time.
   - **T2** timer setting set to **5** and timer scale set to **1h** for 30 minutes of wheel on time.



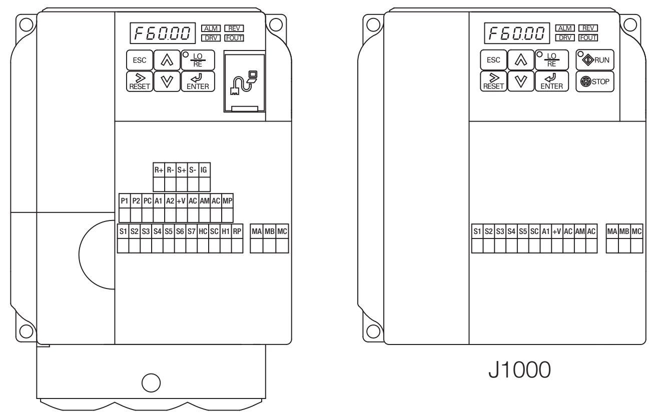
Electric Preheat

1. Remove power from unit.
2. Jumper the frost indicating wheel pressure switch in the preheat control center.
3. Jumper the temperature indicating thermodisc in the preheat control center. Thermodisc has a pre-set temperature of 5º F.
4. Apply power to unit. Preheater should turn on.

Variable Frequency Drives

Optional factory installed, wired, and programmed variable frequency drives (VFDs) may have been provided for modulating or multi-speed control of the blowers and energy recovery wheel for economizer and frost control modes. One VFD, either Yaskawa model V1000 or J1000, is provided for each blower (supply air and exhaust) and one Yaskawa model J1000 is provided for the energy recovery wheel.

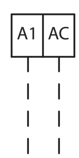
Refer to the tables in this section for factory settings and field wiring requirements. Refer to the unit control center for unit specific wiring diagram. When making adjustments outside of the factory set points, refer to Yaskawa VFD instruction manual, which can be found online at www.drives.com. For technical support, contact Yaskawa direct at 1-800-927-5292.



V1000 J1000

OPTION 1 - 0-10 VDC CONTROL

USER TO PROVIDE ISOLATION AS REQUIRED



0-10 VDC CONTROL SIGNAL (BY OTHERS)
WIRED TO A1 (+) AND AC (COMMON)
0 VDC = 30 Hz
10 VDC = 60 Hz

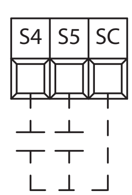
FOR ONE 0-10 SIGNAL, WIRE TO DRIVES IN PARALLEL

SEE VFD INSTALLATION MANUAL FOR MORE DETAIL

FOR CONTINUOUS 60Hz OPERATION JUMPER TERMINALS A1 AND +V.

OPTION 2 - MULTI SPEED CONTROL

USER TO PROVIDE CONTACTS AND ISOLATION AS REQUIRED



NEITHER S4 OR S5 CONTACT CLOSED
DRIVE SPEED = 60 Hz.

S4 TO SC CONTACT CLOSED (BY OTHERS)
DRIVE SPEED = 40 Hz.

S5 TO SC CONTACT CLOSED (BY OTHERS)
DRIVE SPEED = 30 Hz.

SEE VFD INSTALLATION MANUAL FOR MORE DETAIL

Factory Set Points

Variable frequency drives (VFDs) for the blowers are factory setup to operate in one of the three following modes:

- **Modulating:** 0-10 VDC signal wired in the field by others varies the speed of the blower between 30 and 60 Hz
- **Multi-speed:** Digital contact closures by others command the VFD to run at multiple speed settings:
    - Open - Drive runs at 60 Hz
    - SC to S4 - Drive runs at 40 Hz
    - SC to S5 - Drive runs at 30 Hz
- **CO_2 Sensor:**
    - **Set Point Control:** A carbon dioxide sensor is provided from the factory for field mounting OR unit mounting in the space(s) being served by the energy recovery unit. The CO_2 sensors are wired to the unit VFD's with two preset speeds of 700 PPM or less CO_2 = 50% fan speed and 800 PPM or greater CO_2 = 100% fan speed.
    - **Proportional Control:** A carbon dioxide sensor is provided from the factory for field mounting OR unit mounting in the space(s) being served by the energy recovery unit. The CO_2 sensors are wired to the unit VFD's with default factory settings of 500 PPM or less CO_2 = 50% fan speed and 1000 PPM or greater CO_2 = 100% fan speed. Modulation of VFD occurs proportional to CO_2 between 500 and 1000 PPM.

The terminal locations for modulating and multi-speed are shown on the previous page. Most of the set points in the VFDs are Yaskawa factory defaults. However, a few set points are changed at Greenheck and are shown in the tables. These settings are based on the VFD mode selected.

Change Set Points

To gain access to change set points on the V1000 and J1000 drives, parameter A1-01 needs to be set at "2". To prevent access or tampering with drive settings on either drive, change parameter A1-01 to "0".

- **Drive Operation**
    - SC to S1 contact for On/Off
    - A1 (0-10 VDC) referenced to AC. *Can use +15 VDC from +V.*

Resetting the V1000 drive to factory defaults

To reset the V1000 drive back to Greenheck factory defaults, go to parameter A1-01 and set it to "2". Then go to A1-03 and change it to "1110" and press enter. The drive is now reset back to the settings programmed at Greenheck. This option is not available on the J1000.

MODULATING CONTROL FOR FAN SPEED (0-10 VDC)			
Parameter		Setting	
		V1000	J1000
A1-01	Access Level	2	2
B1-17	VFD Start-Up Setting	1	1
C6-02	Carrier Frequency	1	1
D2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	Motor FLA	Motor FLA
H2-01	Terminal MA, MC Function	5	5
H3-04	Terminal A1 Bias	50%	50%
L4-01	H2-01 Frequency Detection	15	15
L5-01	Auto Restart Attempt	5	5
A1-01	Access Level	0	0

CO_2 SENSOR CONTROL FOR FAN SPEED (1/2 SPEED WHEN CO_2 DROPS BELOW 700 PPM) (FULL SPEED WHEN CO_2 RISES ABOVE 800 PPM)			
MULTI-SPEED CONTROL FOR FAN SPEED (1/3 OR 1/2 SPEED REDUCTION)			
Parameter		Setting	
		V1000	J1000
A1-01	Access Level	2	2
B1-01	Reference Source (Frequency)	0	0
B1-17	VFD Start-Up Setting	1	1
C6-02	Carrier Frequency	1	1
D1-01	Frequency Reference 1	60 Hz	60 Hz
D1-02	Frequency Reference 2	40 Hz	40 Hz
D1-03	Frequency Reference 3	30 Hz	30 Hz
D1-04	Frequency Reference 4	60 Hz	60 Hz
D2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	Motor FLA	Motor FLA
H1-04	Multi-Function Input Sel 4 (Terminal S4)	3	3
H1-05	Multi-Function Input Sel 5 (Terminal S5)	4	4
H1-06	Multi-Function Input Sel 6 (Terminal S6)	5	NA
H2-01	Terminal MA, MC Function	5	5
H3-10	A2 Not Used	F	NA
L4-01	H2-01 Frequency Detection	15	15
L5-01	Auto Restart Attempt	5	5
A1-01	Access Level	0	0

CO_2 PROPORTIONAL CONTROL			
Parameter		Setting	
		V1000	J1000
B1-17	VFD Start-Up Setting	1	1
C6-02	Carrier Frequency	1	1
D2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	FLA	FLA
H3-03	Analog Frequency Reference (Gain)	150%	150%
H3-04	Analog Frequency Reference (Bias)	25%	25%
L2-01	Ride Thru Power Loss	2	2
L4-05	Frequency Ref Loss	0	NA
L5-01	Auto Restart Attempt	5	5
A1-01	Access Level	0	0

VARIABLE FREQUENCY DRIVES FOR ENERGY RECOVERY WHEEL			
Parameter		Setting – J1000	
A1-01	Access Level	2	
B1-17	VFD Auto Start	1	
C1-04	Decel Time	600	
*C4-01	Torque Gain	0.6	
C6-02	Carrier Frequency	2	
D2-01	Ref Upper Limit	40 or 50*	
D2-02	Ref Lower Limit	5%	
E2-01	Motor Rated FLA	Motor FLA	
E2-03	Motor No-Load Current	Must be less than FLA	
H1-02	Multi-Function Input (Terminal S2)	6	
H2-01	Multi-Function Output (MA, MB, MC)	4	
H1-04	Multi-Function Input Sel 4 (Terminal S4)	7	
Economizer Signal Source (0-10 VDC)		Setting	
		Honeywell Module	Carel Controller
H3-03	Analog Frequency Reference (Gain)	0	40 or 50*
H3-04	Analog Frequency Reference (Bias)	40 or 50**	0
L1-01	Elect Thermal Overload	2	
L2-01	Ride Thru Power Loss	2	
L4-01	Frequency Detection Level	15	
L5-01	Auto Restart Attempt	5	
A1-01	Access Level	0	

* 208/230 volt only
**36 through 52 inch wheels are 40 (24 Hz)
58 or 74 inch wheel is 50 (30 Hz)

Routine Maintenance

DANGER

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit to OFF at disconnect switch(es). Unit may have multiple power supplies.

CAUTION

Use caution when removing access panels or other unit components, especially while standing on a ladder or other potentially unsteady base. Access panels and unit components can be heavy and serious injury may occur.

Once the unit has been put into operation, a routine maintenance program should be set up to preserve reliability and performance. Items to be included in this program are:

Lubrication
Apply lubrication where required

Dampers
Check for unobstructed operation

Fan Belts
Check for wear, tension, alignment

Motors
Check for cleanliness

Blower Wheel & Fasteners
Check for cleanliness
Check all fasteners for tightness
Check for fatigue, corrosion, wear

Bearings
Check for cleanliness
Check set screws for tightness
Lubricate as required

External Filter
Check for cleanliness - clean if required

Internal Filter
Check for cleanliness - replace if required

Door Seal
Check if intact and pliable

Energy Recovery Wheel
Check for cleanliness - clean if required
Check belt for wear
Check pulley, bearings, and motor

Maintenance Procedures: Lubrication

Check all moving components for proper lubrication. Apply lubrication where required. Any components showing excessive wear should be replaced to maintain the integrity of the unit and ensure proper operation.

Dampers

Check all dampers to ensure they open and close properly and without binding. Backdraft dampers can be checked by hand to determine if blades open and close freely. Apply power to motorized dampers to ensure the actuator opens and closes the damper as designed.

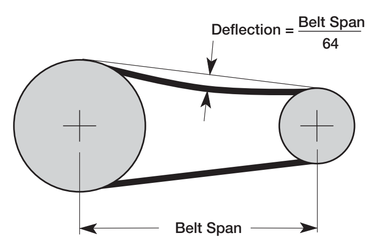
Fan Belts

Belts must be checked on a regular basis for wear, tension, alignment, and dirt accumulation. Premature or frequent belt failures can be caused by improper belt tension (either too loose or too tight) or misaligned sheaves. Abnormally high belt tension or drive misalignment will cause excessive bearing loads and may result in failure of the fan and/or motor bearings. Conversely, loose belts will cause squealing on start-up, excessive belt flutter, slippage, and overheated sheaves. Both loose and tight belts can cause fan vibration.

When replacing belts on multiple groove drives, all belts should be changed to provide uniform drive loading. Do not pry belts on or off the sheave. Loosen belt tension until belts can be removed by simply lifting the belts off the sheaves. After replacing belts, insure that slack in each belt is on the same side of the drive. Belt dressing should never be used.

Do not install new belts on worn sheaves. If the sheaves have grooves worn in them, they must be replaced before new belts are installed.

The proper belt setting is the lowest tension at which the belts will not slip under peak load operation. For initial tensioning, set the belt deflection at $\frac{1}{64}$-inch for each inch of belt span (measured half-way between sheave centers). For example, if the belt span is 64 inches, the belt deflection should be one inch (using moderate thumb pressure at mid-point of the drive). Check belt tension two times during the first 24 hours of operation and periodically thereafter.



Fan Motors

Motor maintenance is generally limited to cleaning and lubrication. Cleaning should be limited to exterior surfaces only. Removing dust and grease buildup on the motor housing assists proper motor cooling. Never wash-down motor with high pressure spray. Greasing of motors is only intended when fittings are provided. Many fractional motors are permanently lubricated for life and require no further lubrication.

Fan Wheel & Fasteners

Wheels require very little attention when moving clean air. Occasionally oil and dust may accumulate on the wheel causing imbalance. When this occurs the wheel and housing should be cleaned to assure smooth and safe operation. Inspect fan impeller and housing for fatigue, corrosion or wear.

Routinely check all fasteners, set screws and locking collars on the fan, bearings, drive, motor base and accessories for tightness. A proper maintenance program will help preserve the performance and reliability designed into the fan.

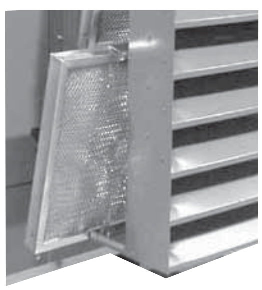
Bearings

Most bearings are permanently lubricated and require no further lubrication under normal use. Normal use being considered -20ºF to 120ºF and in a relatively clean environment. Some bearings are relubricatable and will need to be regreased depending on fan use. Check your bearings for grease zerk fittings to find out what type of bearing you have. If your fan is not being operated under normal use, bearings should be checked monthly for lubrication.

External Filter Maintenance

Aluminum mesh, 2-inch deep filters are located in the supply weatherhood (if the weatherhood option was purchased). Filters should be checked and cleaned on a regular basis for best efficiency. The frequency of cleaning depends upon the cleanliness of the incoming air. These filters should be cleaned prior to start-up.

To access these filters, remove bottom bolt in the access door on the side of the weatherhood. Slide the access door up and then pull bottom out to remove door. Then, slide the filters out (see picture at right).



Outdoor air intake hood mesh filter access

Clean filters by rinsing with a mild detergent in warm water.

Internal Filter Maintenance

The ERV units will typically be provided with 2-inch, pleated filters in the outdoor air and exhaust airstreams. These filters should be checked per a routine maintenance schedule and replaced as necessary to ensure proper airflow through the unit. See table for pleated filter size and quantity for each unit. Replacement filters shall be of same performance and quality as factory installed filters. Filter type must be pleated design with integral metal grid. Two acceptable filter replacements are Aerostar Series 400 or Farr 30/30®.

Pleated Filter Size and Quantities

Unit Size	Size	Supply Qty.	Exhaust Qty.
ERV-10	16 x 25	1	1
ERV-20	16 x 20	2	2
ERV-45	16 x 25	3	3
ERV-55	16 x 20	6	6
ERV-90	16 x 25	7	7
ERV-120	20 x 25	6	6

All dimensions in inches.

Outdoor Air Filters: Access to the outdoor air filters is through the door labeled as “Filter Access” on the outdoor air side of the unit.

Exhaust Air Filters: Access to the exhaust air filters is through the door labeled as “Filter Access” on the exhaust air side of the unit.

Refer to Access Door Descriptions section for additional information on filter locations.

Door Seal Maintenance

ERV-10, 20, 45, and 55: Closed cell foam tape is installed on the perimeter of the door. Inspect at least annually to ensure that the seal is still intact.

ERV-90 & 120: Slip-on type vinyl seal is installed on the perimeter of the door openings. Inspect at least annually to ensure that seal is still pliable and intact.

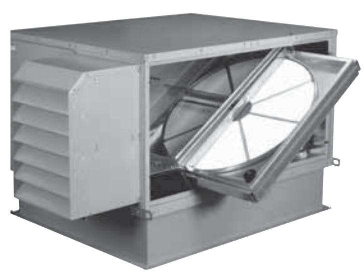
Energy Recovery Wheel Maintenance

Annual inspection of the energy recovery wheel is recommended. Units ventilating smoking lounges and other non-clean air spaces should have energy recovery wheel inspections more often based upon need. Inspections for smoke ventilation applications are recommended bimonthly to quarterly until a regular schedule can be established.

Accessing the Energy Recovery Wheel in Models ERV-10, 20, 45 and 55

Disconnect power to the ERV. Remove access panel(s) labeled “Energy Wheel Cassette Access”.

Unplug the wheel drive motor. The center channel must be removed to access the energy wheel cassette. Use a 5⁄16 inch open or closed wrench to remove the three (3) fasteners that hold the center channel in place.



Access to wheel through outdoor air filter door

Pull the cassette halfway out as shown. (Except on ERV-55, wheel is stationary).

When service is complete, reattach the center channel before putting access panels back in place.

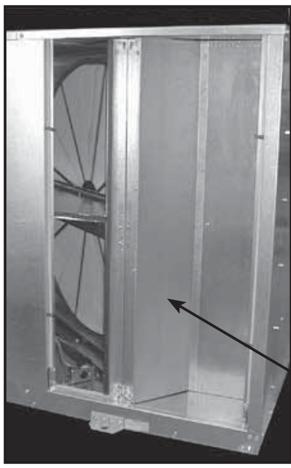
Accessing the Energy Recovery Wheel in Models ERV-90 and 120

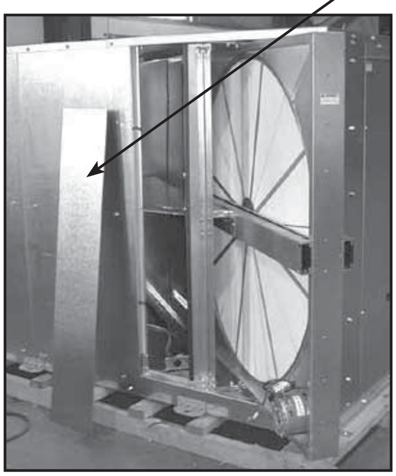
Disconnect power to the ERV. Remove access panel(s) labeled “Energy Wheel Cassette Access”, which reveals the energy wheel cassette. There are additional panels that must be removed in order to slide out the cassettes. (See pictures providing additional visual information).

Unplug the wheel drive motor and pull the cassette halfway out as shown.

NOTE: ERV-90 has two energy wheels with access panels for both wheels. Wheels slide out on opposite corners.

Energy recovery wheels for ERV-120 are hard-wired and not designed to slide out.

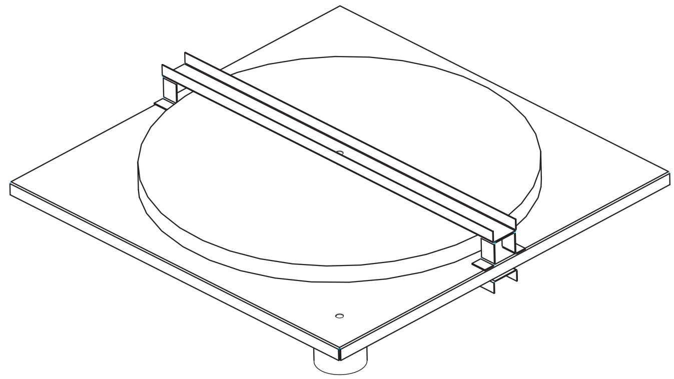




This panel must be removed before the energy wheel can slide out. (ERV-90 only)

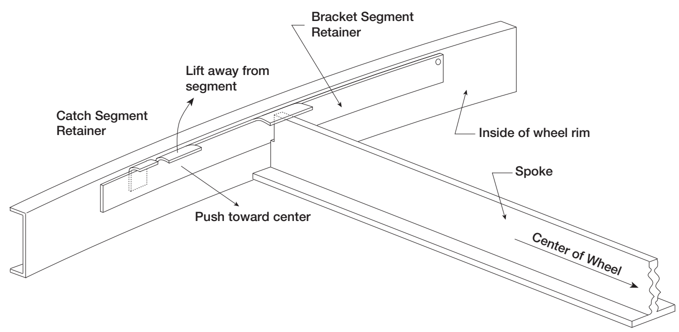
Removing the Energy Recovery Wheel in ERV-10

First, remove the drive belts and the collars in both bearings. On the pulley side of the cassette, remove the four (4) fasteners that hold the bearing support channel in place. Once the bearing support is removed the wheel can be pulled from the cassette. To replace the wheel, reverse this procedure.



Removing the Energy Recovery Wheel Segments ERV-20, 45, 55, 90 and 120 (stainless steel rim)

Steel retainers are located on the inside of the wheel rim. Push the retainer towards the center of the wheel, then lift up and away to release segments.



IMPORTANT
Place retainers back in the original position before rotating the energy recovery wheel, otherwise damage to retainer will occur.

Wheel segment removed

Cleaning the Energy Recovery Wheel

If the wheel appears excessively dirty, it should be cleaned to ensure maximum operating efficiency. Only excessive buildup of foreign material needs to be removed. Discoloration and staining of energy recovery wheel does not affect its performance.

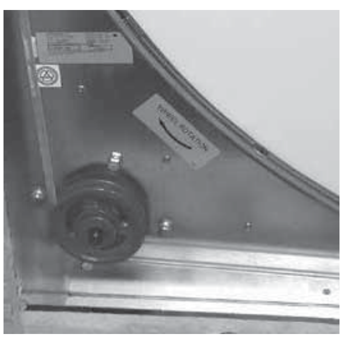
Thoroughly spray wheel matrix with household cleaner such as Fantastik® or equivalent. Gently rinse with warm water and using a soft brush remove any heavier accumulation. A detergent/water solution can also be used. Avoid aggressive organic solvents, such as acetone. The energy recovery wheel segments can be soaked in the above solution overnight for stubborn dirt or accumulation.

After cleaning is complete, shake the excess water from the wheel or segments. Dry wheel or segments before placing them back into the cassette. Place wheel or segments back into cassette by reversing removal procedures.

CAUTION
Do not clean energy recovery wheel segments with water in excess of 140ºF (60ºC).
Do not dry energy recovery wheel segments in air in excess of 140ºF (60ºC).
The use of a pressure washer to clean segments is **not recommended.** Damage could result.

Energy Recovery Wheel Belt

Inspect belts each time filters are replaced. Belts that look chewed up or are leaving belt dust near the motor pulley may indicate a problem with the wheel. Be sure to inspect wheel for smooth and unrestricted rotation. If a belt requires replacement, contact the local Greenheck representative. Instructions for replacement will ship with the new belt.



Wheel Belt & Pulley

Energy Recovery Wheel Bearing

In the unlikely event that a wheel bearing fails, the bearing is behind a removable plate on the wheel support beam which is accessible through the outdoor air filter door (and exhaust filter door on the ERV-90 and 120). Contact the local Greenheck representative for detailed instructions on how to replace the bearing.

Wheel Bearing

Troubleshooting - Economizer Alarms

Addressing Alarms

Alarms will signify a faulty sensor. When this occurs, verify all connections to the sensor and controller are secure. Press enter twice to clear the alarm. If the issue persists, consult the factory.

Clearing Alarms

Once the alarm has been identified and the cause has been removed (e.g. replaced faulty sensor), the alarm can be cleared from the display.

To clear an alarm, perform the following:

1. Navigate to the desired alarm.
2. Press the ↵ (enter).
3. ERASE? displays.
4. Press ↵ (enter).
5. ALARM ERASED displays.
6. Press ⏀ (escape) to complete the action and return to the previous menu.

NOTE
If an alarm still exists after you clear it, it redisplays within 5 seconds.

Bulletin A102-1

BRASCH

Electric Duct Heaters

© Brasch Manufacturing Co., Inc.

I n d e x

Ratings and Sizes

You specify it—we build it! Heaters described in this bulletin are custom designed at no extra charge to your exact size, wattage, voltage and phase and number of steps. Any duct size from W = 5" and H = 4" minimum to W = 480" and H = 180" maximum, wattages to 2000 KW can be furnished. Base price depends upon duct size and KW rating; base price is the same for single or three phase and does not change with number of steps.

For practical design of heater, minimum recommended KW per step is .5 KW for 208V single phase; 1.0 KW for 277V or 480V single phase and 2.0 KW for 480V or 600V three phase.

UL Listing

UL Listed by Underwriters Laboratories, Inc. under File Nos. E 39836 and E39386 for zero clearance between heater and combustible surfaces. Listing includes all built-in components unless otherwise noted. Heaters are also UL Listed for use with heat pumps and air conditioners when mounted 4 feet or more from unit and maximum inlet air temperature is 100°F.

Quality Control

Heaters are dielectrically tested for 1000V plus twice the rated voltage or 2000V, whichever is higher. The resistance of each heater is measured and recorded and must be within 5% of rated value. Electrical components are tested and inspected after installation in the heater. Every heater is checked twice; once in production and once by a trained Quality Control inspector who gives each heater a thorough inspection.

Suggested Schedule for Electric Heating Coils

Tag NO.	Inside Duct Size W' x H'	CFM (Min.)	KW	Voltage/Phase	No. of Steps	Control Volts	Type of Control	Horizontal or Vertical Airflow Direction	Special Features
EH-1 to 10	12 x 8	430	5.0	480/3	2	24	PE		Direct Acting
EH-11	18 x 12	750	21.5	480/3	1	24	SCR	HAF	Direct Acting Transducer
AH-1	—	5000	85.0	480/3	6	24	Step Control		Preheat for Carrier 39BA120-B

S a m p l e Specification-Open Coil - Finned Tubular

General: Electric duct heaters and air handling coils shall be as manufactured by Brasch Manufacturing Company, Inc. Voltage, size, KW, steps and control voltage shall be as scheduled. Three phase heaters shall have balanced phases.

1. Heaters shall be UL Listed for zero clearance an shall meet all NEC requirements.

2. Type: Heaters shall be of the following configuration:
   For Duct Mounting . . . . All Slip-in or Flanged

   For Air Handling Unit Coils . . . . All Slip-in or Flanged

   Multizone Hot Deck Coils . . . . Slip-in Type

3. Open coil heating elements shall be 80% nickel and 20% chromium; steps shall be arranged to prevent stratification when operating at less than full capacity. Elements for draw-through air handling units shall be derated to 35 watts per square inch; blow-through air handling coils and variable volume reheat coils shall be derated to 25 watts per square inch.

4. Element terminals shall be stainless steel; insulators and bracket bushings shall be nonporous ceramic and securely positioned. Terminals shall be machine crimped to elements.

5. Elements for Finned Tubular heaters shall have steel fins brazed to copper plated sheath. Element wire shall be 80/20 Nichrome. Elements shall be protected against corrosion by a high-temperature aluminum coating. Terminals shall be sealed with silicone rubber to protect against moisture.

6. Frame shall be constructed of heavy gauge galvanized steel with galvanized steel brackets, stiffening ribs and gussets spot welded to the frame.

7. Terminal box shall be spot welded construction with solid, hinged cover, totally enclosed, without louvers or grilles per the UL Standard.

8. Recessed terminal box to be provided when coils are installed in ducts with internal insulation or obstruction greater than 1".

9. Direction of airflow: heaters shall be interchangeable for horizontal left or right or vertical up airflow except when position sensitive mercury contactors or SCRs are built-in. In these cases, airflow direction shall be as scheduled.

10. Safety devices: a disc-type automatic reset thermal cutout shall be furnished for primary overtemperature protection. For secondary protection, a sufficient number of replaceable thermal cutouts in the power lines shall de-energize elements if the primary cutout fails. All safety devices shall be serviceable through the terminal box without removing the heater from the duct.

11. Wiring diagrams: a unique wiring diagram shall be furnished for each heater. Diagram shall include recommended supply wire gauges per NEC and fuse sizes. Typical wiring diagrams are not acceptable.

12. Built-in components shall include safety interlocking disconnect switch, disconnecting break magnetic contactors, transformer with primary fusing per UL, pressure-type airflow switch set at .05" WC, supplementary circuit fuses per NEC (one set of fuses per 48 amp circuit), and separate load and control terminal blocks to accept conductors as shown on the electrical plan.

13. Special features: the following special features are required as scheduled:

SPECIAL CONSTRUCTION
- Insulated Terminal Box
- Dusttight Terminal Box
- Raintight Construction (nonremovable flange)
- Bottom Insert - open coil only
- Round-duct Construction
- Stainless Steel Frame
- Aluminized Steel Frame
- Protective Screens
  - A. Inlet Side Only
  - B. Outlet Side Only
  - C. Both Sides

OVERCURRENT PROTECTION
- Automatic Circuit Breakers (in lieu of fuses)
- Fuses Per Step (in lieu of one per 48 amperes)
- Main Supply Overcurrent Protection (heaters 48 amperes or less)

OVERTEMPERATURE PROTECTION
- Manual Reset Thermal Cutout in control circuit in series with automatic
- Manual Reset Thermal Cutout in power lines (in lieu of secondary cutouts)
- Manual Reset Thermal Cutout operating back-up contactors

SWITCHING DEVICES AND CONTROLS
- Magnetic Contactors, De-energizing (in lieu of disconnecting)
- Mercury Contactors (sealed for quiet switching)
  - A. Disconnecting Break
  - B. De-energizing Break
- SCRs (solid state modulating control)
- Toggle Switch(es)
  - A. One Per Step
  - B. Interrupts Control Voltage
- Door Interlock Switch (to break control circuit)
- Step Controller(s) (specify input)
  - A. Electronic Modulating
- Time Delay Relay
- PE Switch(es) (for pneumatic control; specify close or open on pressure rise)
- Transducer (pneumatic to 135 Ohm)
- Pilot Light(s)
  - A. One Per Step (x # of steps)
  - B. Control Voltage On
  - C. Power On (Line Volts)
  - D. Normal Operation (Automatic Reset Circuit is Closed)
  - E. Airflow Switch Open
  - F. Manual Reset Thermal Cutout On
  - G. Push-To-Test Type (Not UL except with 16E)
  - J. Overtemperature (Automatic Reset Cutout Circuit is Open)
  - K. Nema - 12 or Nema - 4
  - L. Heater On

14. Manufacturer to provide two year limited warranty for heating elements; other components and accessories to be warranted for one year.

Types

Figure 1A Slip-in Heater

Figure 2A Flanged Heater

SLIP-IN HEATER—standard and by far the most widely used because of the ease of installation; see 1A and 1B. When built-in controls are specified in a slip-in heater, they are usually mounted in the left-hand overhang (S dimension in Figure 1B). If right-hand overhang is desired, specify S dimension to be 1", T dimension as required.

FLANGED HEATER—(optional) consists of a slip-in heater mounted in a flanged duct section; see Figures 2A and 2B. The slip-in portion slides out without removing flanges from duct. When built-in controls are specified in a flanged heater, they are mounted in the terminal box of the slip-in portion; the frame containing the elements stays the same. The flanged duct section is increased in depth to accommodate the larger terminal box.

Dimensions

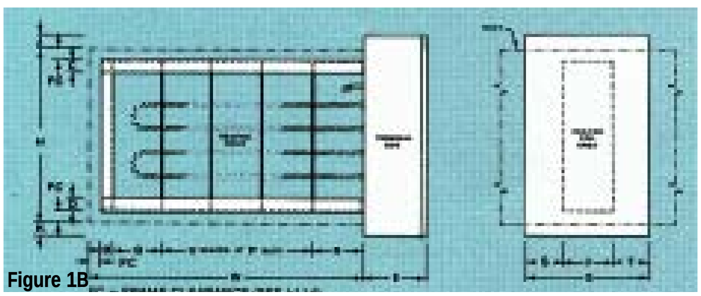


Figure 1B

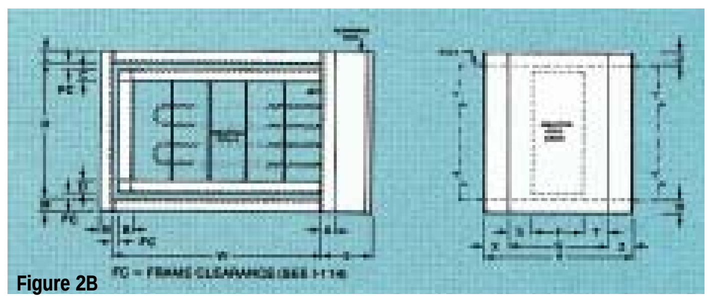


Figure 2B

H = 4" minimum, 180" maximum; W = 5" minimum, 480" maximum (for sizes over H = 90" or W = 120", consult factory). E, F, S, T, Y and G dimensions depend on KW, voltage, phase, number of steps and built-in controls; consult factory.

Installation

Bulletin I-17 or I-556-1 is included with each heater. Covers maintenance and installation warnings on how NOT to install duct heaters. Service instructions also given.

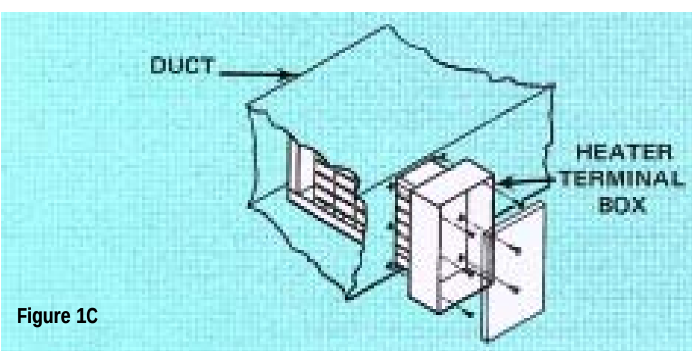


Figure 1C

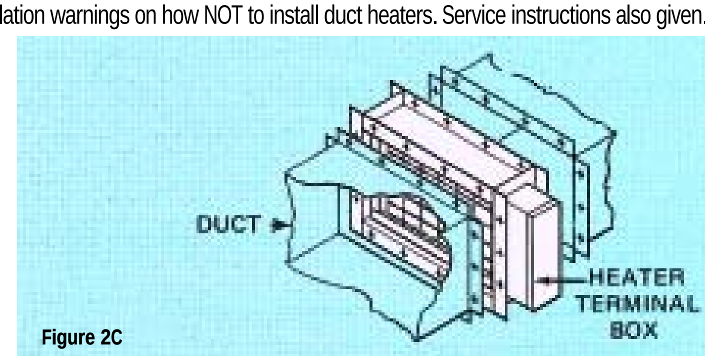


Figure 2C

Figure 1C SLIP-IN HEATER

Step 1. Cut hole in side of duct 1/8" larger than heater body.
Step 2. Insert heater until terminal box covers opening.
Step 3. Secure heater in place with sheet metal screws.

Figure 2C FLANGED HEATER

Step 1. Provide flanges on ends of duct matching heater flanges
Step 2. Secure heater flanges to duct flanges with sheet metal screws, so that mounting screws do not enter terminal box.

Construction Details

NOTE:
Central location of thermal cutout allows same heater to be used for left- or right-hand and vertical up airflow.

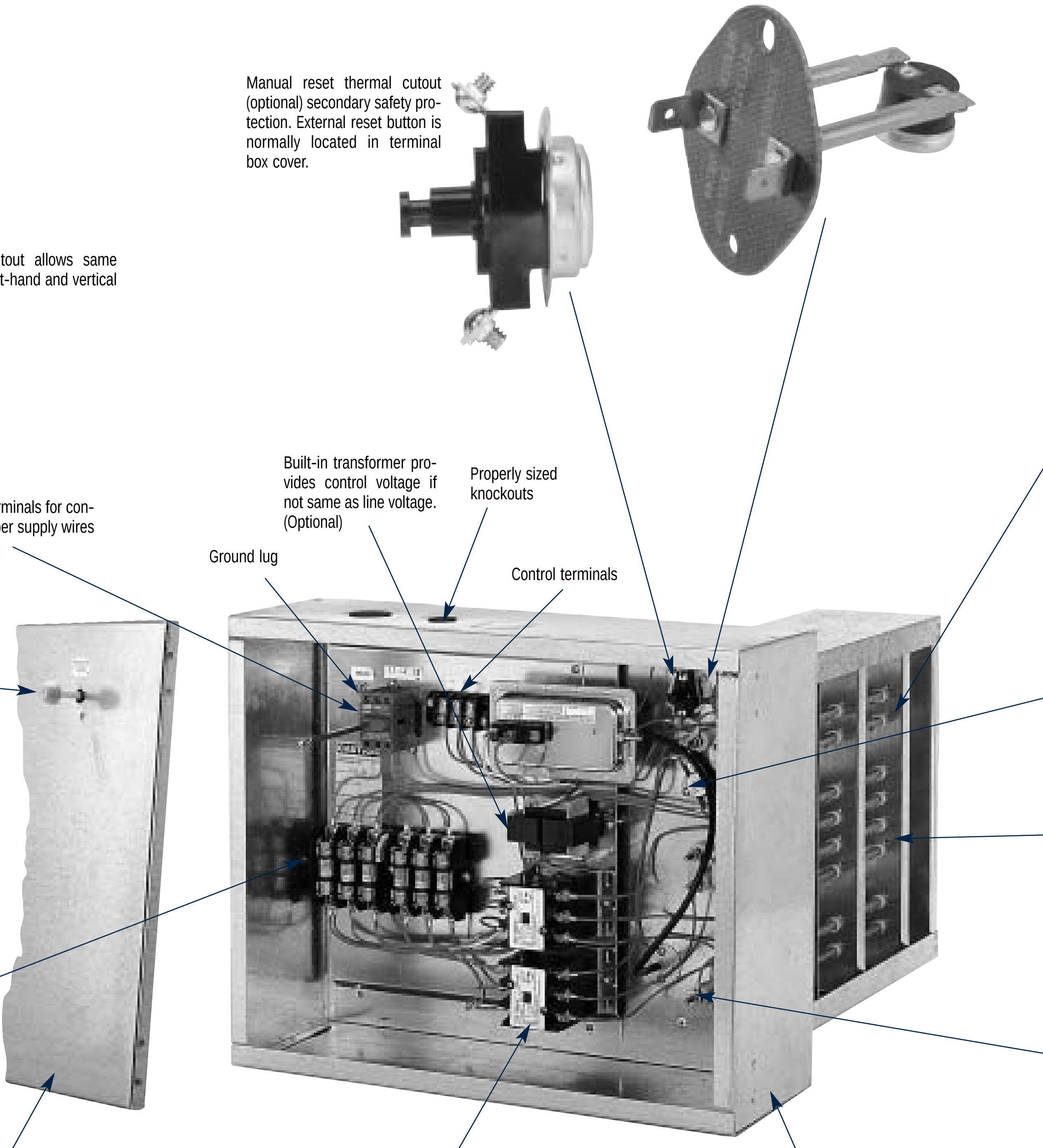
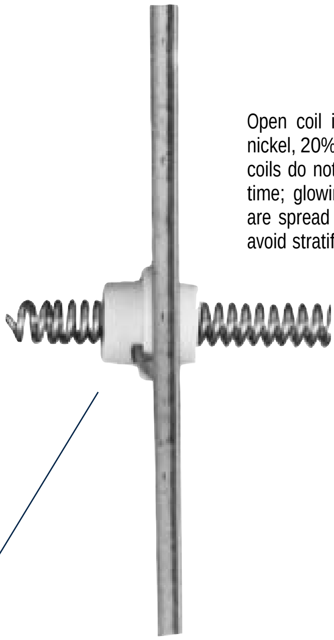
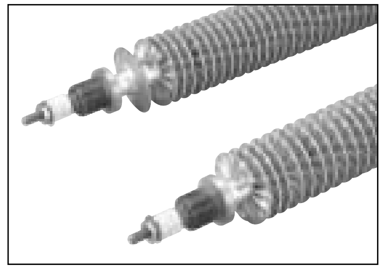


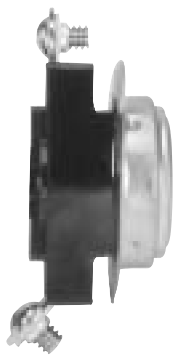
Figure 1
Typical Slip-in Heater (Features also apply to flanged heaters)



Open coil iron-free heating elements. Highest grade (80% nickel, 20% chromium) Type A resistance wire has longer life; coils do not sag or oxidize; resistance does not change with time; glowing is minimized with sufficient airflow. Elements are spread across the face of the heater, when practical, to avoid stratification.

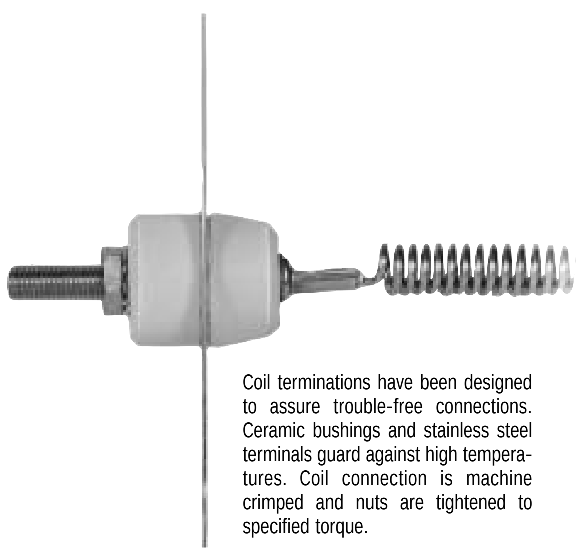


Optional finned tubular heating elements. 80/20 nickel/chromium inner coil centered in copper-plated steel tubes; magnesium oxide filler assures rapid heat transfer from coil to steel fins brazed to tube; silicone rubber double seals prevent magnesium oxide contamination. High temperature aluminum coating protects element surfaces from corrosion.



Secondary disc-type cutouts standard on every heater. Set at higher temperature than automatic reset thermal cutout. Meets UL and NEC requirements. Sufficient number of cutouts located in the power lines de-energize elements should automatic reset thermal cutout fail; easily serviced through the terminal box. No back-up contactors are required.

Support brackets with special reinforcements (ribbing along edges and gussets in top and bottom mounting flanges)



Coil terminations have been designed to assure trouble-free connections. Ceramic bushings and stainless steel terminals guard against high temperatures. Coil connection is machine crimped and nuts are tightened to specified torque.

Step Controllers

Step controllers are used to control multi-step heaters.

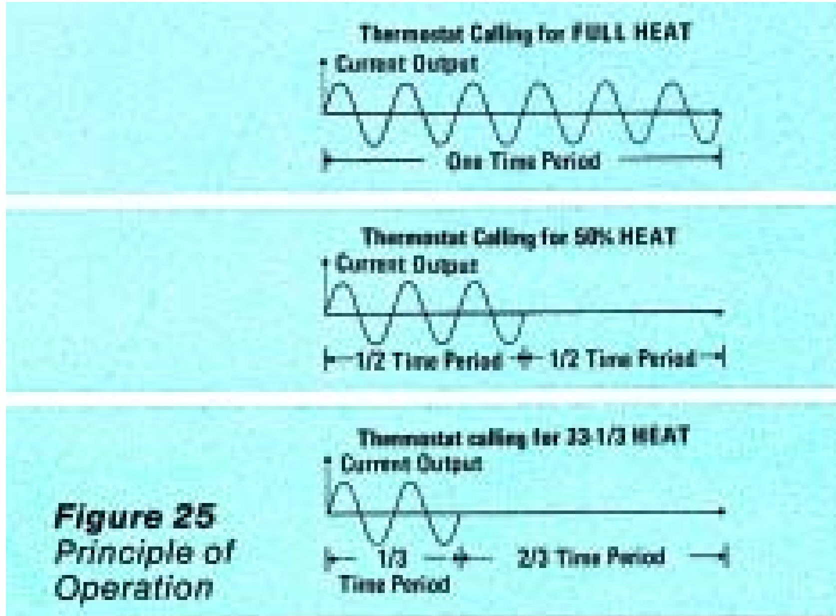


Figure 25
Principle of Operation

ELECTRONIC MODULATING

Solid state electronic step controllers will switch up to ten contactor holding coils each and may be wired in series for a maximum of 30 steps. They are available with a single input from all commonly used thermostat input signals.

The step controller automatically recycles to the full-off position in case of a power interruption.

SCRs

Silicone controlled rectifiers (SCRs) are used to provide very close heat control and/or silent operation for critical areas such as laboratories, computer rooms and executive offices. They are a solid state device with no moving parts which will provide 100% stepless and noiseless modulation through many years of trouble free service. The SCR has heat sink mounted protruding through the terminal box to maximize convection cooling. The heat sink is electrically insulated from live parts. Power and heat output are precisely controlled from zero to 100% in direct response to the modulating thermostat signal (figure 25). All commonly used thermostat input signals will be accepted by the SCR without a special interface. A safety contactor must be used.

All elements in the heater are simultaneously controlled, thus avoiding problems of air stratification. Zero angle firing interrupts the full wave AC cycle only when current passes through zero, minimizing radio frequency interference.

SCR Vernier

SCR Vernier systems are used on larger KW heaters where very close heat control is required. The SCR Vernier system employs a combination of SCR and non-SCR steps. For electric/electronic controls, a step controller energizes the non-SCR steps; for pneumatic controls, adjustable differential PE switches energize the non-SCR steps. The system is more economical for larger KW heaters than full SCR control while providing the same very close heat control as the full SCR system. This is accomplished by satisfying most of the heat requirement through the non-SCR steps and then the last portion of the heat requirement is "fine-tuned" by the modulating SCR controller. The SCR step is nominally equal to the KW of a non-SCR step to provide an even transition between steps.

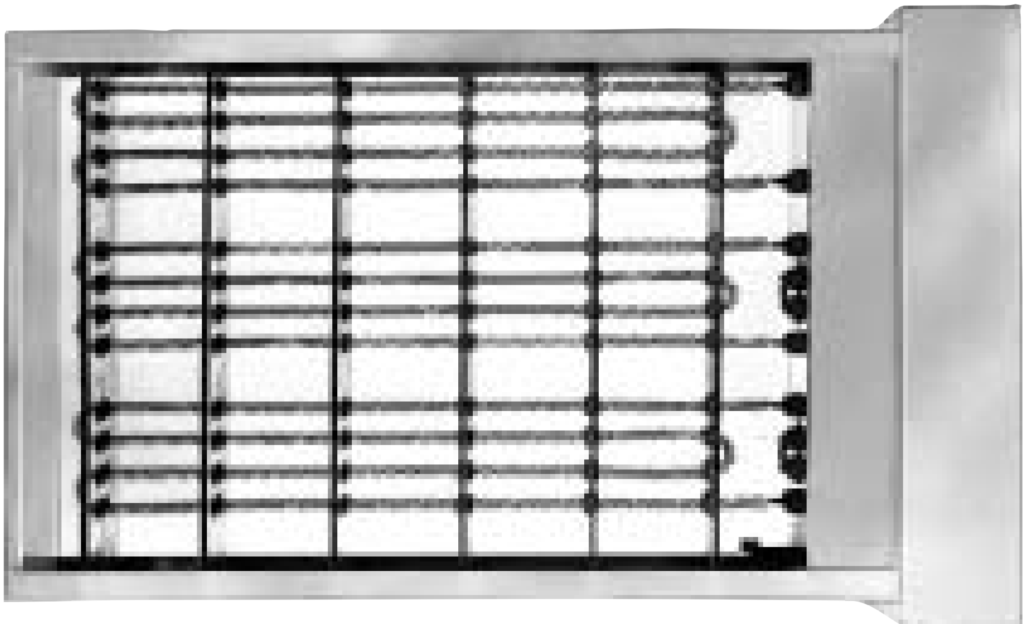
Thermostats

Table 23: Thermostats

Catalog Number	Type	Temp. Range	Ratings	Action	No. Steps
T-101	Room	40 - 90° F	120 - 240V	Pilot	1
T-102	Room	40 - 90° F	120 - 240V	Pilot	2
T-111	Room	40 - 90° F	24V	Pilot	1
T-112	Room	40 - 90° F	24V	Pilot	2
T-201	Room	40 - 90° F	120 - 277V	Line	1
T-300	Room	60 - 90° F	D.C./Resistive Output	Step Controller	Mod.
C1025	Room	60 - 90° F	D.C./Resistive Output	SCR	Mod.
T-400	Room	40 - 90° F	Pneumatic	Direct Acting	Mod.
T-401	Room	40 -90° F	Pneumatic	Reverse Acting	Mod.
T-601	Duct	60 -90° F	120 - 240V	Pilot	1
T-602	Duct	60 - 90° F	24 - 240V	Pilot	2
T-603	Duct	60 - 90° F	24 - 277V	Pilot	3
T-604	Duct	60 - 90° F	120 - 277V	Pilot	4
T-810	Duct	80 - 100°F	D.C./Resistive Output	Step Controller	Mod.
T-100-M043	Duct	0 - 180°F	D.C./Resistive Output	SCR	Mod.
TG-100M	Thermostat Guard	—	—	—	—

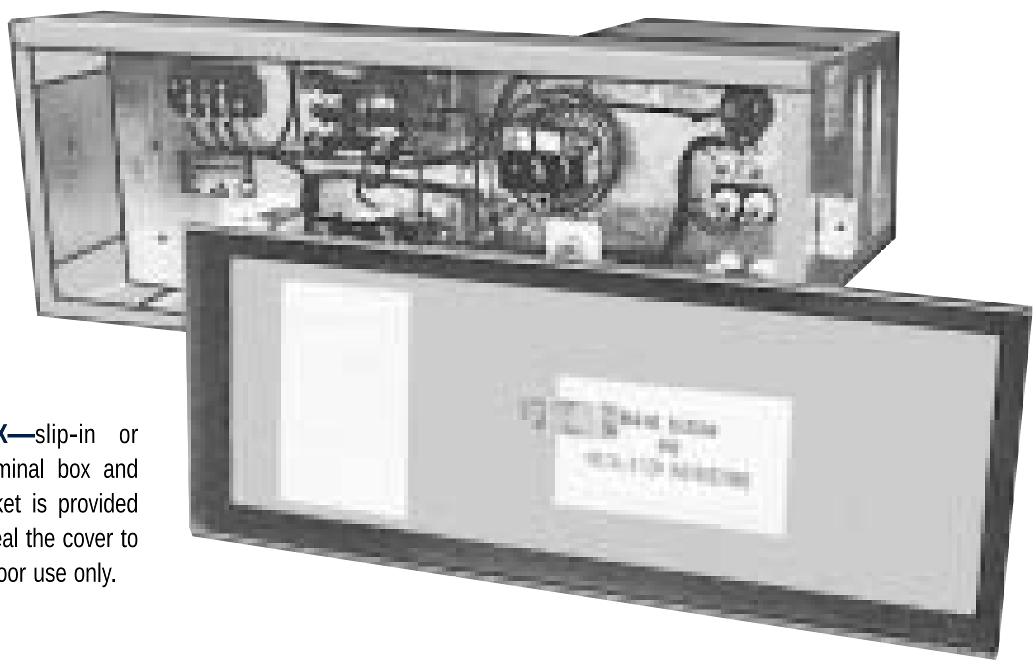
NOTE: Data subject to change without notice.

Special Constructions



Heaters for Ducts with Internal Obstructions

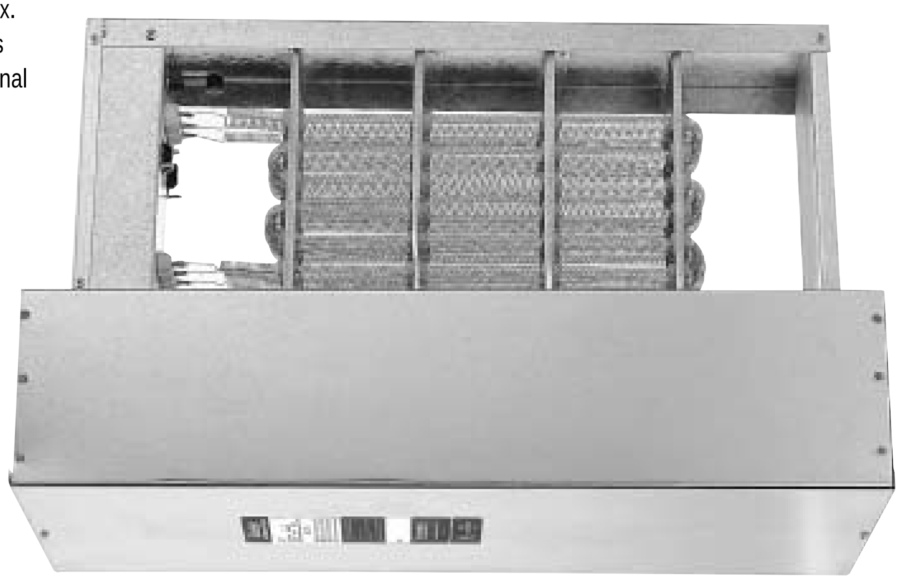
RECESSED TERMINAL BOX—for slip-in heaters; brings element terminals and thermal cutouts further into the airstream (recommended where the element terminals are blocked by an obstruction of more than 1").



DUSTTIGHT TERMINAL BOX—slip-in or flanged heaters have sturdy terminal box and cover with sealed seams. A gasket is provided inside the terminal box cover to seal the cover to the terminal box. UL Listed for indoor use only.

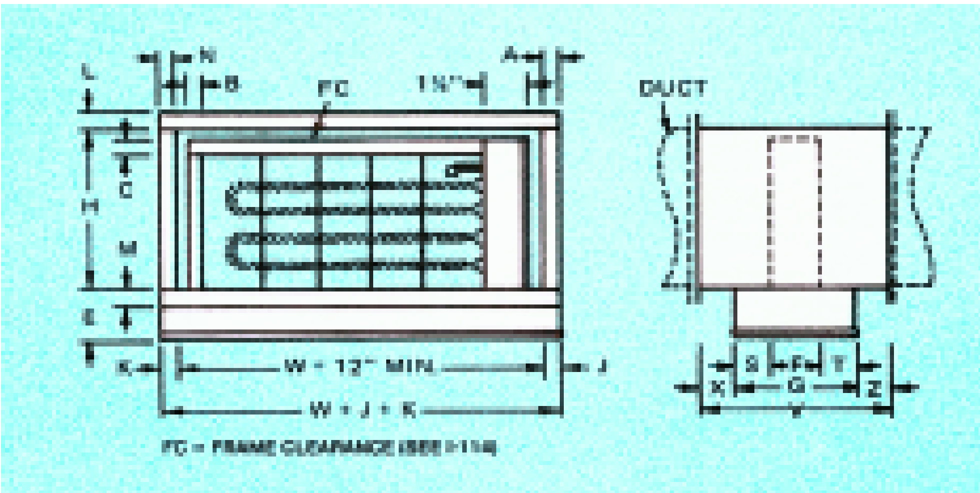
Bottom Terminal Boxes

BOTTOM INSERT—slip-in heater inserts through a hole in the bottom of a horizontal duct. Internal terminal box contains resistance coil terminations, automatic reset and secondary thermal cutouts, all prewired to terminal blocks in field terminal box. Control components such as contractors, fuses and transformers are mounted in bottom terminal box. Specify W and H dimensions (minimum W dimension is 12").



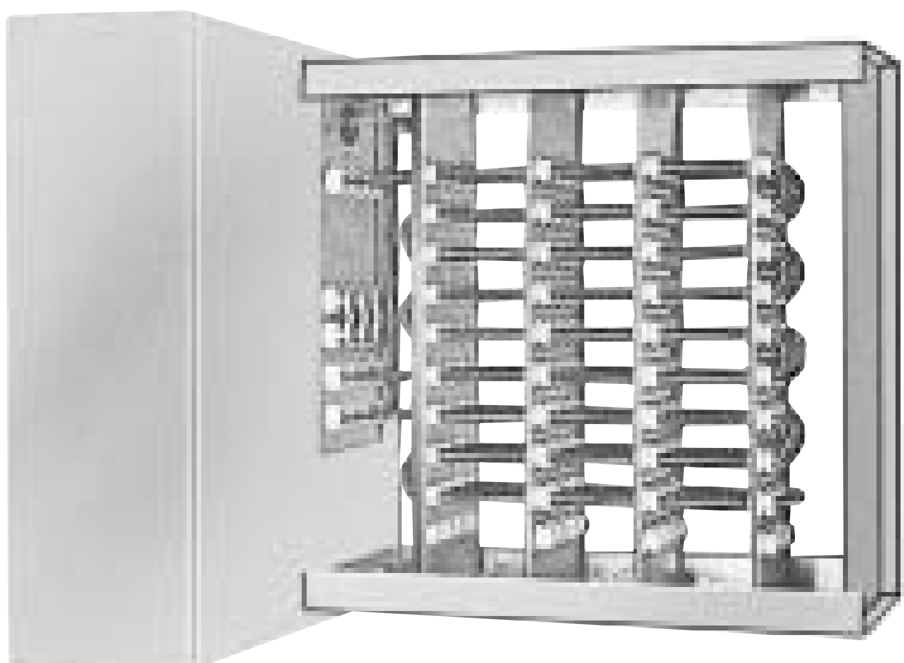
RAINTIGHT HEATER—UL Listed for outdoor use; formed of heavy gauge galvanized steel, sealed with high temperature sealant. May be supplied with recessed construction. Flanged construction fits any horizontal, rectangular duct. Available with standard built-in components that do not protrude through door such as contactors, fuses, transformers, step controller, PE switches, etc. Insulated terminal box or insulated flange are not available UL Listed. Consult local representative for additional information. Not suitable for use in salt spray environments.

Special Constructions (cont.)



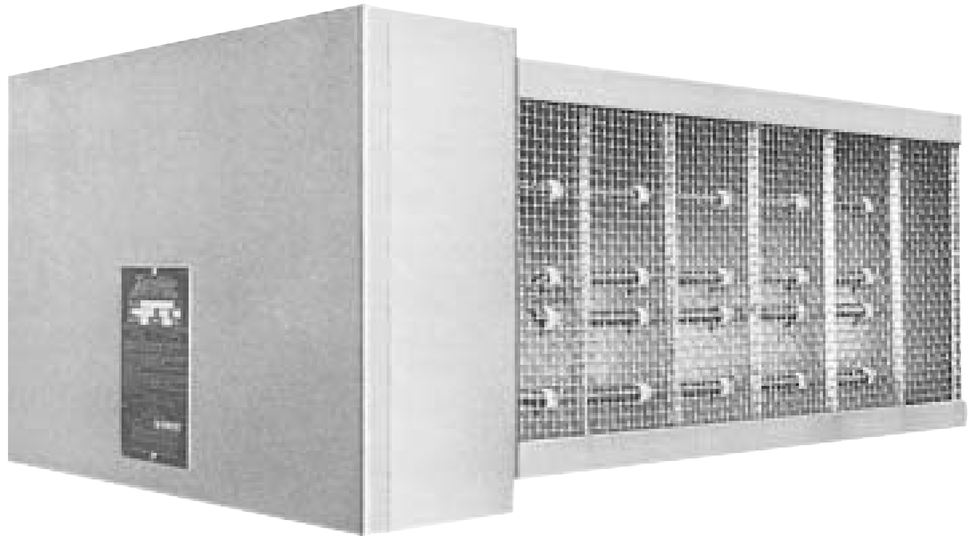
BOTTOM OUTLET—recommended where a flanged heater is desired with field terminal box at the bottom of the horizontal duct. Internal terminal box contains resistance coil terminations, automatic reset thermal cutout and secondary thermal cutouts, all prewired to terminal blocks in field terminal box. Control components such as contactors, fuses and transformers are mounted in bottom terminal box. Not available with built-in weather resistant or dusttight terminal box.

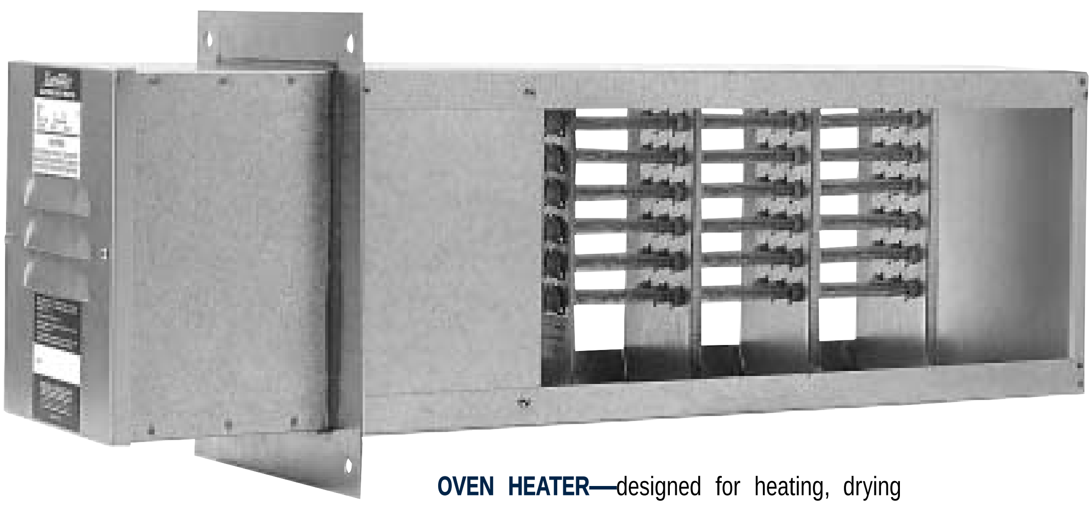
INSULATED TERMINAL BOX—recommended whenever heaters are used in air conditioning ducts in areas with high relative humidity. Slip-in or flanged heaters with insulated terminal box have insulating board fastened to the back of the terminal box, between the duct and the terminal box.



PROTECTIVE SCREENS—prevent accidental contact and possible electrical shock, especially where maintenance personnel are likely to enter the duct near the heater. Galvanized 1/2" x 1/2" hardware cloth mesh is standard. Screen also prevents debris such as loose duct insulation, etc. from contacting heater coils.

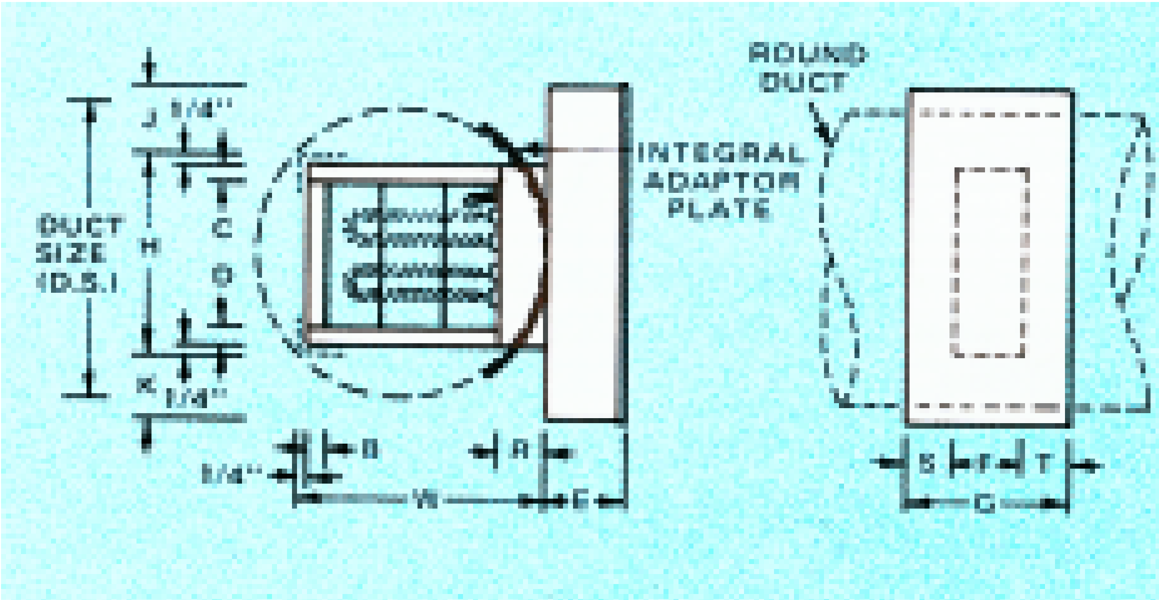
When ordering, specify:
A. Inlet Side Only
B. Outlet Side Only
C. Both Sides



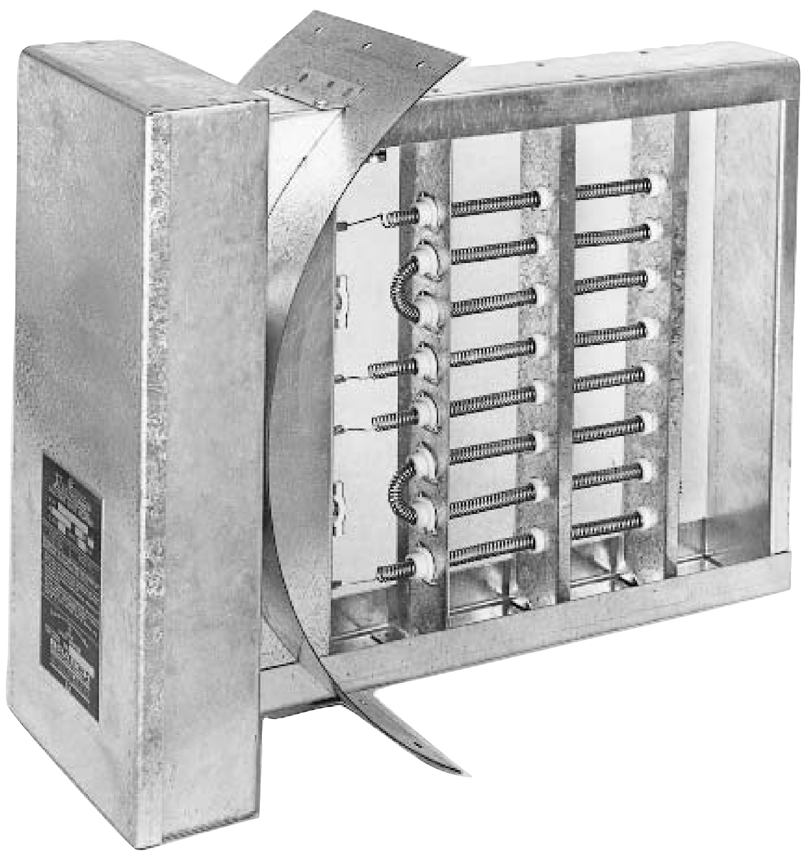


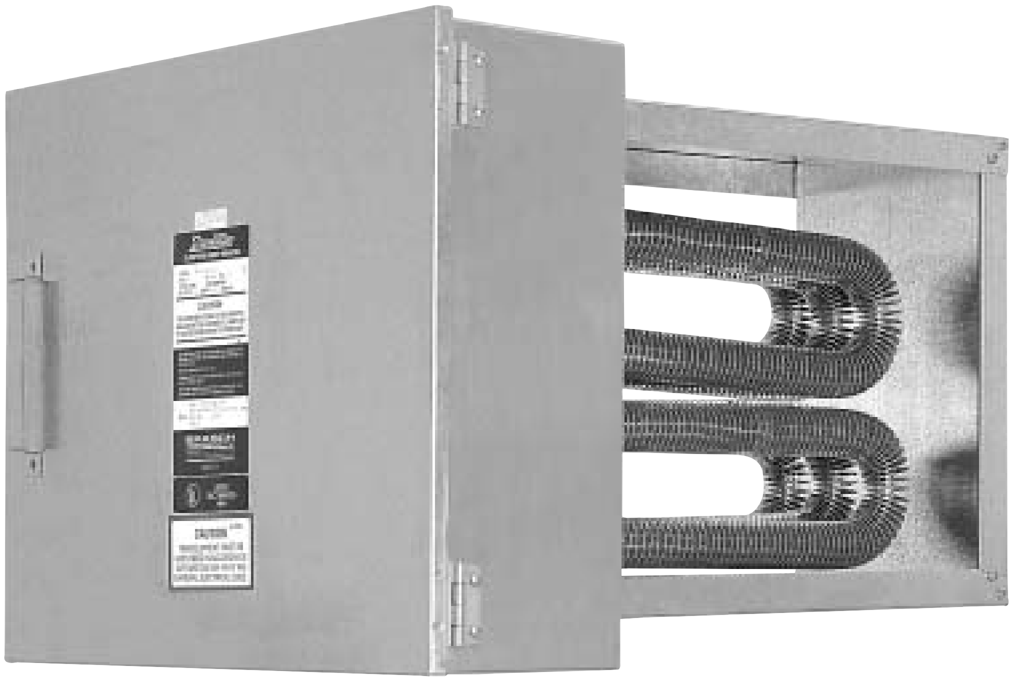
OVEN HEATER—designed for heating, drying and baking applications in industrial ovens. Air temperatures to 1200° F are maintained by forced air circulation. Highest Grade Type A (80/20) resistance wire elements minimize oxidation. Elements are derated on an increasing scale to match design temperature conditions. Frames are of galvanized, aluminized, or stainless steel, depending on outlet temperature. Optional features include control thermostat, high limit cutout, airflow switch, remote panel with built-in components. UL or not UL Listed.

Special Constructions (cont.)



ROUND-DUCT—UL Listed, designed for insertion into round ductwork. Basic slip-in style with special adapter plate to fit specified duct diameter.

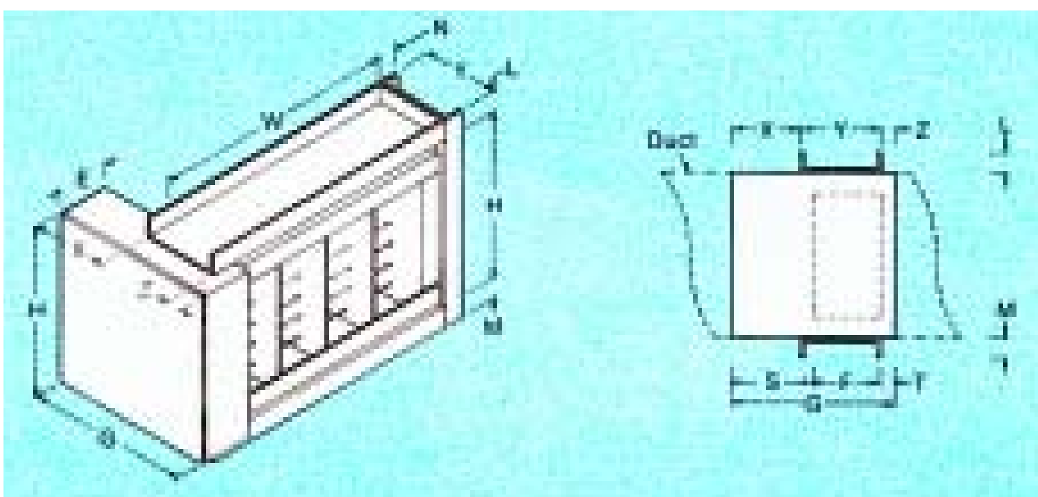




Finned Tubular

SLIP-IN AND FLANGED—UL Listed, heavy gauge galvanized steel frame (aluminized and stainless optional); solid cover; nonperforated terminal box (dust-tight NEMA 12 optional); properly sized knockouts; interchangeable airflow, horizontal in either direction or vertical up. Finned elements use 80/20 nickel/chromium resistance wire, helically wound and centered in a copper plated steel tube filled and compacted with magnesium oxide for rapid heat transfer; silicone rubber double seals prevent contamination. High temperature aluminum coating further protects element from corrosion. Also available in frit (glass-ceramic) coated.

FLANGED HEATER (Non-Removable Heater Section)—UL Listed units are designed for horizontal or vertical rectangular ducts. Units are of heavy gauge galvanized steel (standard) or aluminized steel (optional). Terminal box for control components is built in.For flanged heater with removable heater section see page 5.



MULTIZONE APPLICATIONS—where electric heaters are installed in air handling equipment with multizone dampers which constantly reposition, depending on the requirements of each zone, special precautions must be taken in the design of the heaters.

Both slip-in and flanged heaters are suitable for multizone equipment, depending upon the configuration of the unit. The frame dimensions must be carefully chosen so the heater will fit the multizone unit. We recommend the dimensions be approved by the multizone unit manufacturer. Care must be taken so that no part of the heater face area is blocked by the frame members, cooling coil headers, filter supports or blower housings. Multizone heaters should be ordered with no coils three to four inches from the top, bottom or back flanges because these areas are exposed to reduced airflow conditions. If necessary, a recessed terminal box can be used to extend element terminals into the airstream, past any obstructions. Multizone heaters must be significantly derated in terms of watt density per square inch of heating element surface; 25 watts maximum per square inch of element is recommended.

A special linear cutout must be ordered in addition to standard primary and secondary thermal cutouts. The linear cutout deenergizes the entire heater in the event of a temporary high temperature condition along any 12" section. It will automatically reset itself and the heater will resume normal function when the hot spot has cooled.

Built-in components are not recommended for multi-zone applications. Instead, a remote control panel is recommended.

HOT DECK CONTROL SYSTEMS—in addition to derating the coils and providing the heater with a linear type cutout, an averaging-type thermostat extending the entire length of the hot deck is necessary to modulate the amount of heat supplied in accordance with the actual total load requirement. For smaller loads, SCRs are recommended to control the entire heater, or a step controller can be used, as long as the number of steps is equal to at least the number of zones plus one. for larger loads, a combination step controller/SCR Vernier system is recommended. This system combines the advantage of almost infinite modulation offered by SCRs with the economy of the step controller. Combination step control/SCR Vernier systems are described in detail on page 8.

SINGLE ZONE AIR HANDLING UNITS—electric heaters can be used in place of hot water or steam coils in air handling units. Slip-in or flanged construction can be used, depending upon which is most suitable for the particular application. If a flanged heater is desired, but the maximum thickness of the heater is limited, a modified flange design can be used. Heater dimensions and construction should be carefully coordinated with the air handling unit manufacturer. Follow these guidelines:

1. Because airflow is not always uniform in an air handling unit, the watt density of the resistance wire should be reduced to a maximum of 35 watts per square inch of wire surface.

2. If face and bypass damper are used, watt density should be reduced to a maximum of 25 watts per square inch of wire surface. Heater must be interlocked with the face damper to prevent operation until damper is open.

3. If the face area directly adjacent to the terminal box will be blocked by a cooling coil header, baffles or frame members, a recessed terminal box is recommended. Amount of recess must be sufficient to clear obstructions.

4. All heaters for us with air handling equipment should be ordered with no heating elements three to four inches from the top, bottom and back flange. These areas often receive little or no airflow.

Use these formulae as rough guidelines for estimating purposes only:

Formula #1

$$KW^* = \frac{CFM \times \Delta T}{3160}$$

Formula #2

$$\Delta T = \frac{KW \times 3160}{CFM}$$

*Approximate - formulas are based on 70° F entering air and actual KWs will vary with a change of inlet temperature.

TOTAL KW REQUIRED—use Formula #1 to figure total KW needed when air volume and temperature (ΔT) are known:

NUMBER OF STEPS—for the average installation it is customary to figure the temperature rise (ΔT) provided by each heating step as follows:

COMFORT HEAT CONTROL DESIRED	ΔT PER STEP
Very Fine Control	5° or less
Average Control	6 to 14° F
Coarse Control	15° F and up

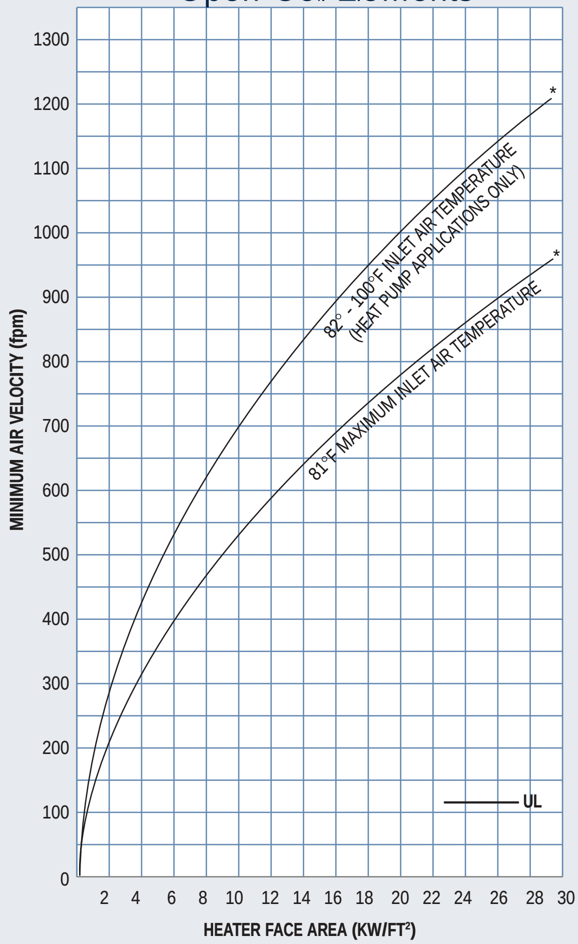
Using Formula #1, figure KW per step when temperature rise and CFM are known. When the KW per step is known, use Formula #2 as a rule of thumb to figure the temperature rise per step.

For economy, we recommend each step be limited to a maximum of 48 amperes. See page 11 for KW ratings equivalent to 48 amperes.

For practical design of heater, minimum recommended KW per step is .5 KW for 208V single phase; 1.0 KW for 277V or 480V single phase and 2.0 KW for 480V or 600V three phase.

Minimum number of steps for multizone heaters should be equal to number of zones plus one.

Minimum Air Velocity
Open Coil Elements

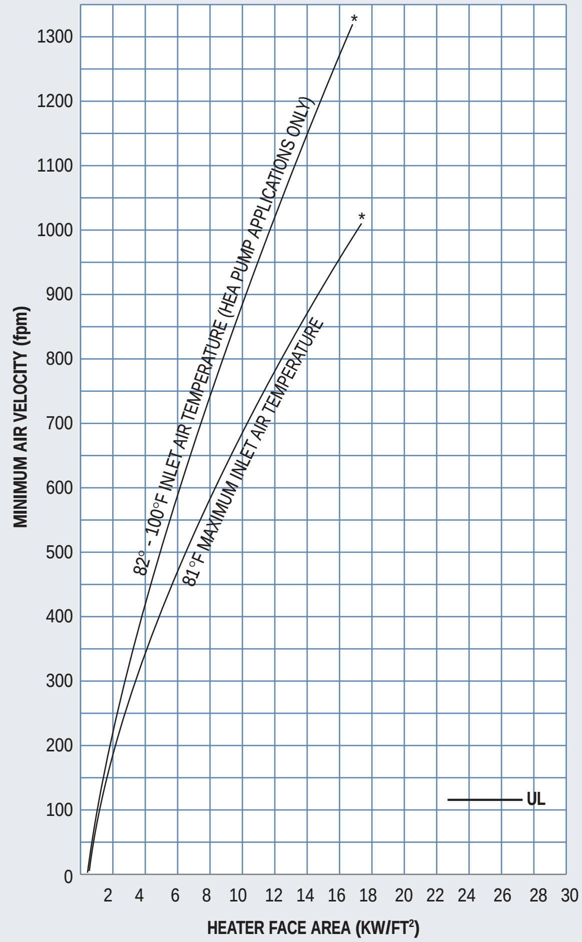


*Maximum allowed watt density: 28.9 KW/FT²)

$$\text{Face Area} = \frac{(H\text{-}2^1/_2\text{''})\ (W\text{-}^3/_4\text{''})}{144}$$

$$\text{KW/Ft}^2 = \frac{\text{KW}}{\text{Face Area}}$$

Minimum Air Velocity
Finned Tubular Elements



*Maximum allowed watt density: 17.0 KW/FT²)

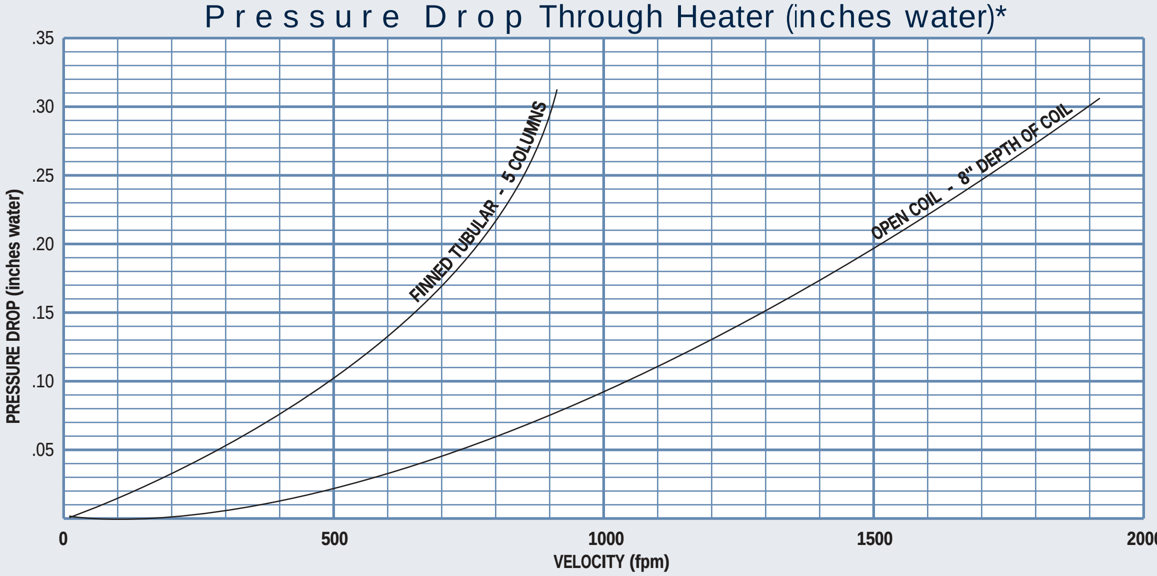
Example: 25 KW UL Heater, Inlet 75° F
12'' H x 24'' W, Open Coil Elements

$$\text{Face Area} = \frac{(12\text{-}2^1/_2\text{''})\ (24\text{-}^3/_4\text{''})}{144} = 1.53\ \text{Ft}^2$$

$$\text{KW/Ft}^2 = \frac{25}{1.53} = 16.3$$

16.3 KW/Ft² = 700 fpm

Pressure Drop Through Heater (inches water)*



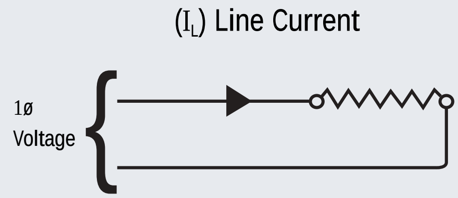
*This is an estimate ony and will vary with the specific construction of each heater. Calculations for specific heaters can be run on a computer program but are still rough approximatoions. Actual pressure drops can only be found by performing pressure drop tests on the actual duct heater after manufacture.

How to Calculate Line Currents

To determine the line current use the following formulae

Single Phase

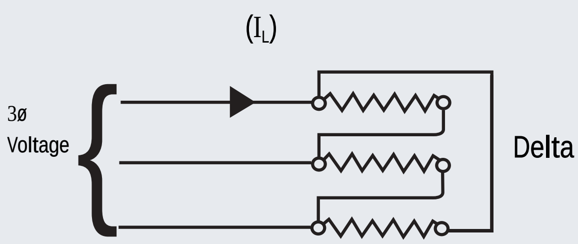
LINE CURRENT (I_L) in amperes = $\dfrac{\textbf{WATTAGE}}{\textbf{VOLTAGE}}$

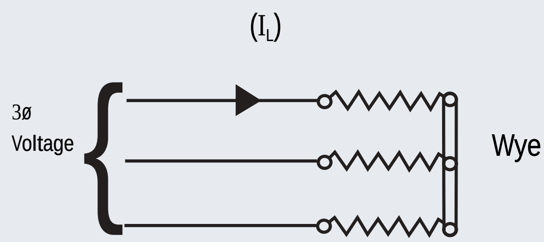


Three Phase

LINE CURRENT (I_L) in amperes = $\dfrac{\textbf{WATTAGE}}{\textbf{VOLTAGE X 1.73}}$

NOTE: This is the current which will flow in each of the three lines, regardless of whether the elements are wye or delta connected.

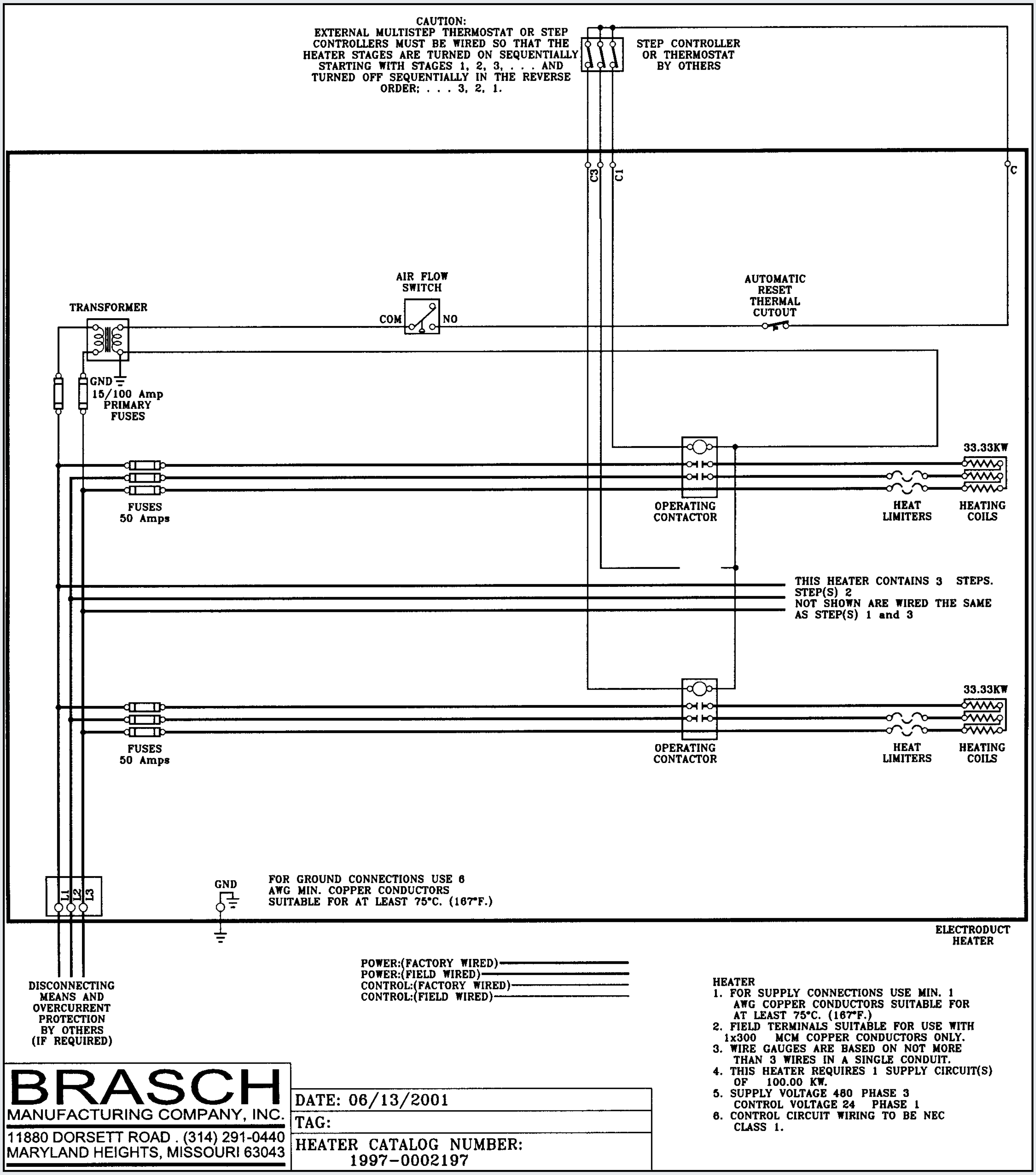




SUPPLY WIRE AND LINE TERMINALS SIZING—UL requires that the line terminals in duct heaters be sized to accept conductors which are rated to carry at least 125% of heater line current. Heaters are provided with properly sized terminals at no extra charge. Field supply wires must be sized to carry at least 125% of heater line current except when the heater is for space heating, is over 50KW and not more than 3 wires in the conduit—may be sized at 100% of heater line current.Supply conductors must have insulation rated at least 75° C (167° F).

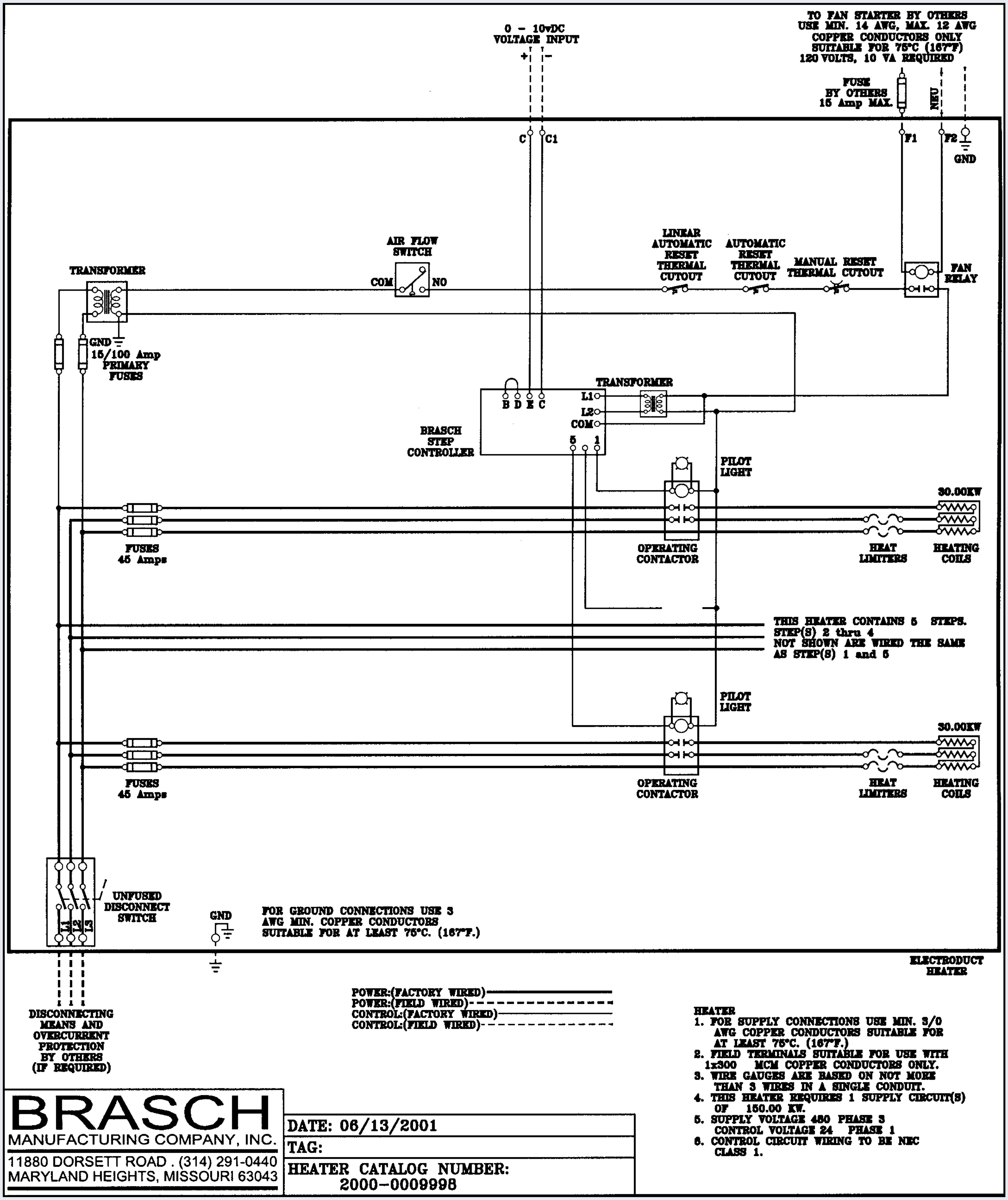
Wiring Diagram Control System 1

Single or multi-step heater with de-energizing magnetic contactors per step, fusing per NEC and 24 volt transformer. Can be controlled by a single/multiple stage room or duct thermostat, remote step controller and modulating room or duct thermostat or signal from various electronic building system controls. Standard options available include disconnecting magnetic contactors, interlocking disconnect switch and remote control panel. For other options, consult factory or the local Brasch representative.



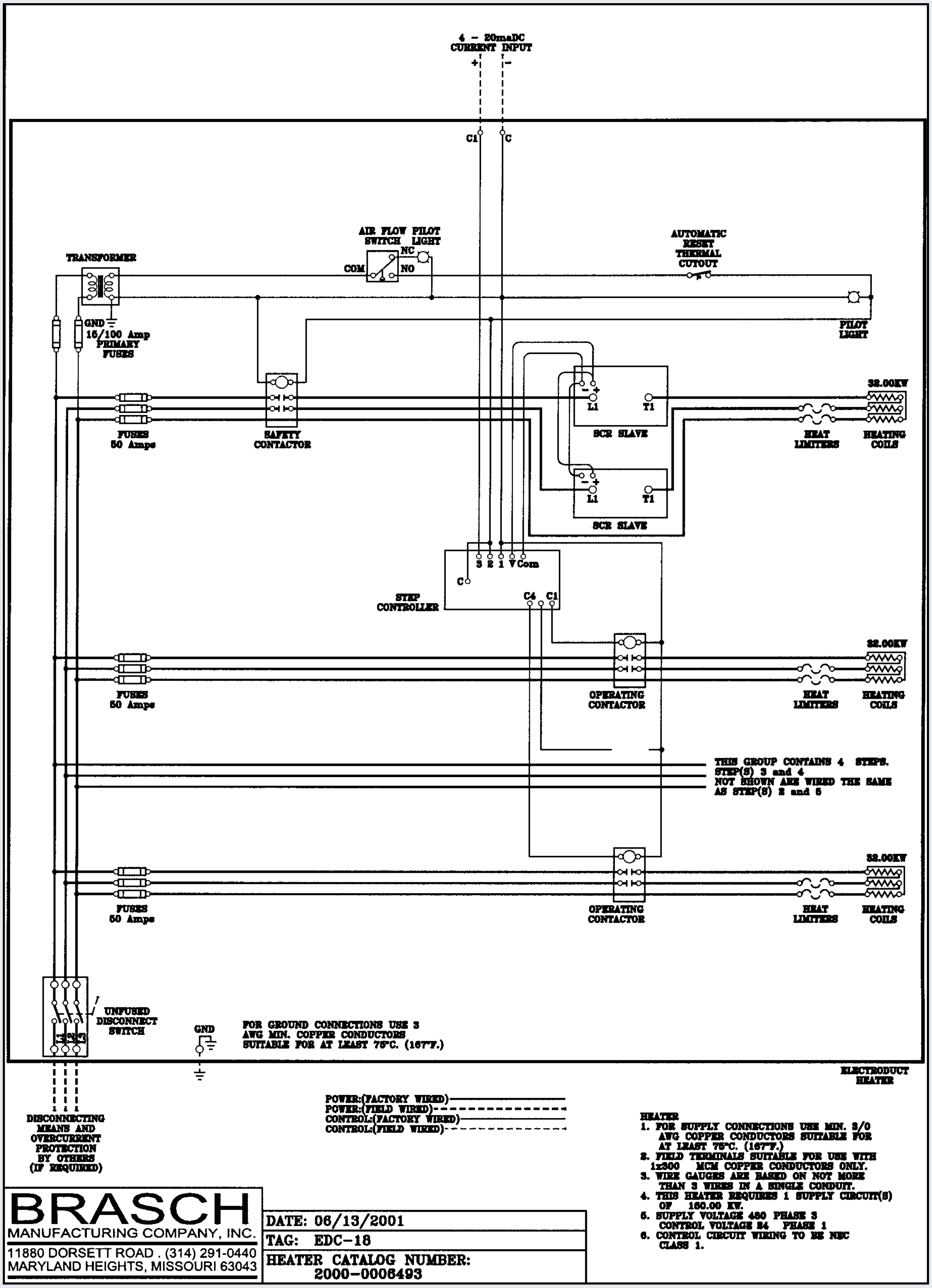
Wiring Diagram Control System 2

Multi-step heater with de-energizing magnetic contactors per step, built-in step controller, fusing per NEC and 120 bolt transformer with primary fusing. Can be controlled by a modulating room or duct thermostat or signal from various electronic building system controls. Standard options available include disconnecting magnetic contactors, interlocking disconnect switch and remote control panel. For other options, consult factory or the local Brasch representative.



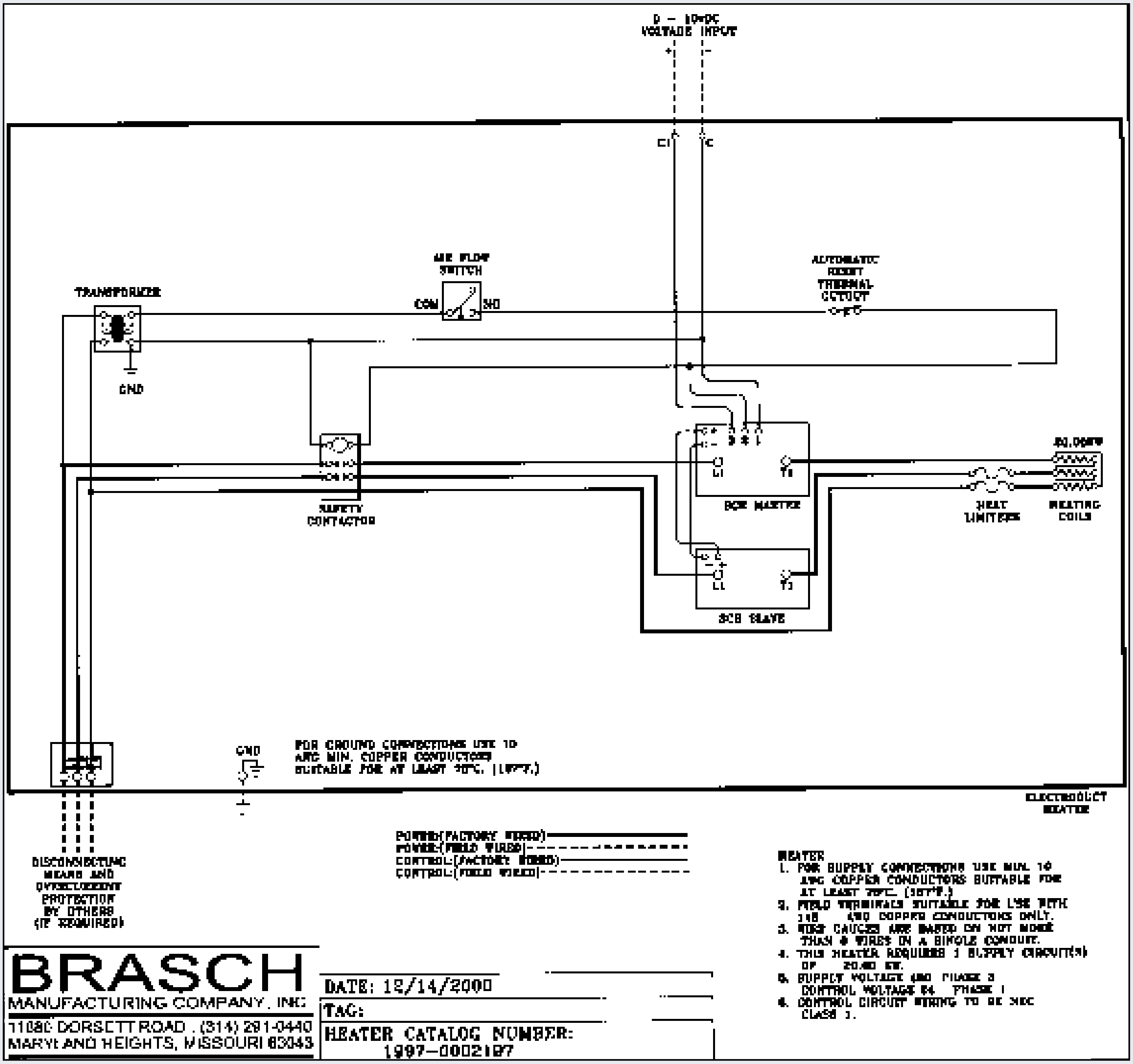
Wiring Diagram Control System 3

Multi-step heater with SCR Vernier control. Step 1 is SCR and is equal to each step on the step controller. Controls include SCR's, step controller, de-energizing magnetic operating contactors per step and safety contactor, fuses per NEC, and 120 bolt transformer with primary fusing. Can be controlled by a modulating room or duct thermostat or signal from various electronic building system controls. Standard options available include disconnecting magnetic contactors, interlocking disconnect switch and remote control panel. For other options, consult factory or the local Brasch representative



Wiring Diagram Control System 4

Total SCR controlled heater with SCR's, de-energizing magnetic safety contactors per step and safety contactor, fuses per NEC, and 24 volt transformer. (Above approximately 100 amps total heater load, the economics of System 3 should be considered). Can be controlled by a modulating room or duct thermostat or signal from various electronic building system controls. Standard options available include disconnecting magnetic contactos, interlocking disconnect switch and remote control panel. For other options, consult factory or the local Brasch representative.



U L / N E C Requirements*

REQUIREMENT

DOUBLE SAFETY PROTECTION

UL 1996, Paragraph 23.3.1:

"A duct heater shall be equipped with one or more automatically resetting temperature-limiting controls, as determined by 23.3.3, that will disconnect the heating element or elements from the supply circuit to prevent temperatures from exceeding the limits specified. These temperature-limiting controls shall be factory-installed as an integral part of the heater."

NEC Article 424-64:

"Limit Controls. Each duct heater shall be provided with an approved, integral, automatic-reset temperature-limiting control or controllers to de-energize the circuit or circuits."

Secondary Control

NEC Article 424-64 (continued):

"In addition, an integral independent supplementary control or controllers shall be provided in each duct heater that will disconnect a sufficient number of conductors to interrupt current flow. This device shall be manually resettable or replaceable."

UL 1996, Paragraph 23.3.9:

A duct heater shall be provided with one or more manually resettable or replaceable back-up protective devices of the type specified in 23.3.7, that will, with the contacts of the automatically reset limit control permanently closed, limit the temperature to comply with the requirements specified in the Back-up Protection Tests, Section 33.

Paragraph 23.3.10:

The manually resettable or replaceable protective devices specified in 23.3.9 shall be functionally independent of the automatically reset limit control. The following types of controls comply with this requirement:

A. On or more thermal cutoffs, nonresettable limit controls, or manually resettable limit controls connected to open a sufficient number of ungrounded conductors to permit the unit to comply with the specified temperture limits.

B. A combination consisting of one or more normally open magnetic contactors and thermal cutoffs, nonresettable limit controls, or manually resettable limit controls. The thermal cutoff or limit control shall be connected in the coil circuit of the contactor. The combination shall be intergral witht he product; be able to open a sufficient number of ungrounded supply conductors to permit the product to comply with the specified temperature limits; and be independent of control by an automatic cycling device with the unit.

CONTROLLERS AND DISCONNECTING MEANS

NEC article 424-20:

(a) Serving as Both Controllers and Disconnecting Means. Thermostatically controlled switching devices and combination thermostats and manually controlled switches shall be permitted to serve as both controllers and disconnecting means provided all of the following conditions are met:

(1) Provided with a marked "off" position.
(2) Directly open all ungrounded conductors when manually placed in the "off" position.
(3) Designed so that the circuit cannot be energized automatically after the device has been manually placed in the "off" position.
(4) Located as specified in Section 424-19.

* Quoted from 1999 NEC and UL Standard 1996.

HOW BRASCH MEETS REQUIREMENT

Every heater is furnished with an automatic reset thermal cutout of the bimetallic disc type This device is sol located that the airflow through the heater can be either left- or right-hand or vertical up and the device is serviceable without having to remove heater from duct. On larger heaters, where UL requires additional thermal cutouts, these are provided at no extra charge.

Brasch heaters have always had double safety protection as standard and without additional charge. To meet the requirement for a manually replaceable cutoff, a sufficient number of secondary cutouts are provided in every heater. Secondary cutouts are:

1. Factory prewired in the power lines of the heating elements and are not dependent upon back-up contactors or other devices in the control circuit which may fail to open.
2. Spread throughout the terminal box to give protection to the particular elements which they serve. Thus they will sense unsafe conditions even if they occur in th lower portion of the heater.
3. Easily replaced with locally stocked factory replacements once the unsafe condition has been corrected. Unlike the manual reset thermal cutouts which invite being reset without the cause of the unsafe condition having been determined, secondary cutouts, by requiring replacement, point out that something is seriously wrong and must first be corrected.

Brasch heaters are available with optional manual reset thermal cutout and can be wired:

1. In series with the automatic reset thermal cutout (in addition to the secondary cutout which serves as secondary protection),
2. In the power lines (in lieu of secondary cutouts), and
3. To operate back-up contactors.

A secondary cutout and back-up contactor combination is unnecessary since the secondary cutouts are rated to carry the load without need for back-up contactors. A manual reset thermal cutout and back-up contactor combination while optionally available is not recommended for Brasch heaters since secondary cutouts will be provided instead and offer better protection. Back-up contactors are an unnecessary expense.

This requirement means that as long as the thermostat with an off position is not an integral part of the duct heater, a de-energizing contactor as described on page 9 can be used. Disconnecting break contactors are recommended for all applications and some local codes may require them as in Chicago and New York City.

REQUIREMENT

(b) Thermostats That Do Not Directly Interrupt All Ungrounded Conductors.
Thermostats that do not directly interrupt all ungrounded conductors and thermostats that operate remote control circuits shall not be required to meet the requirements of (a) above. These devices shall not be permitted as the disconnecting means.

UL 1996, Paragraph 26.11
"A contactor or similar device, such as a silicone controlled rectifier required for use with a limit control, shall be provided by the manufacturer of the heater, but need not be mounted on the heater."

ZERO CLEARANCE
UL 1996, Paragraph 44.5
"A duct heater rated 50 kilowatts (kw) or less shall be tested for installation with zero spacing between the duct and combustible surfaces. A duct heater rated more than 50 kw may necessitate that such spacings be larger than zero. See Paragraph 52.2."

CONTROL TRANSFORMER CIRCUIT OVERCURRENT PROTECTION
UL 1996, Paragraphs 20.8 and 20.9
20.8 Except as indicated in paragraph 20.9, a transformer having a rated output of not more than 30 volts and 1000 volt-amperes (National Electrical Code, ANSI/NFPA 70-1984, Class 1, power-limited circuit) shall be protected by an overcurrent device located in the primary circuit. The overcurrent device shall be rated or set at not more than 167 percent of the primary current rating of the transformer. See paragraph 20.10.

20.9 A transformer that directly supplies a National Electrical Code, ANSI/NFPA 70-1984, Class 2 circuit (see paragraph 2.2) shall, in accordance with the Standard for Class 2 and Class 3 Transformers, UL 1585, either limit the output current (inherently limited transformer) or be equipped with an over current device (not inherently limited transformer), and need not comply with the requirements in paragraph 20.8.

SUBCIRCUIT OVERCURRENT PROTECTION
NEC Article 424-22 (b) and (c):
(b) Resistance Elements. Resistance-type heating elements in electric space heating equipment shall be protected at not more than 60 amperes. Equipment rated more than 48 amperes and employing such elements shall have the heating elements subdivided, and each subdivided load shall not exceed 48 amperes. Where a subdivided load is less than 48 amperes, the rating of the supplementary overcurrent protective device shall comply with Section 424-3 (b).

(c) Overcurrent Protective Devices. The supplementary overcurrent protective devices for the subdivided loads specified in (b) above shall be: (1) factory installed within or on the heater enclosure or supplied for use with the heater as a separate assembly by the heater manufacturer; (2) accessible, but shall not be required to be readily accessible; and (3) suitable for branch-circuit protection.

Where cartridge fuses are used to provide this overcurrent protection, a single disconnecting means shall be permitted to be used for the several subdivided loads"

"The overcurrent protective devices required by Paragraph 18.1 shall be provided as an integral part of the heater or shall be provided by the heater manufacturer as a separate assembly, for independent mounting, for use with the heater. See Paragraph 42.15."

AIRFLOW
NEC Article 424-59:
"Air Flow. Means shall be provided to assure uniform and adequate air flow over the face of the heater in accordance with the manufacturer's instructions.

Heaters installed with 4 feet (1.22m) of the outlet of an air-moving device, heat pump, air conditioner, elbows, baffle plates, or other obstruction in duct work may require turning vanes, pressure plates, or other devices on the inlet side of the duct heater to assure an even distribution of airover the face of the heater."

HOW BRASCH MEETS REQUIREMENT

This paragraph requires that the duct heater manufacturer furnish control, back-up and safety contactors or an SCR controller as part of the heater (either built-in or in a remote control panel) whenever the thermal cutout is incapable of carrying the heater load directly.

Brasch heaters, both slip-in and flanged types, are UL Listed for zero clearance, including those rated over 50 KW (up to 2000 KW maximum). However, it is not recommended that any combustible material be allowed to touch any electric duct heater or immediate surrounding areas.

These requirements mean that when a built-in 120 volt secondary transformer is supplied, it must be provided with primary fusing: when a built-in 24 volt secondary transformer is supplied, it does not require primary fusing unless it is above 100 VA.

To meet this requirement, Brasch heaters were one of the first to offer UL Listed heaters with built-in fuses. Note: NEC requires overcurrent protection only on heaters exceeding 48 amperes total line current. Automatic circuit breakers also meet this requirement.

If overcurrent protection is not ordered built-in, all heaters exceeding 48 amperes total line current must be divided into a sufficient number of subcircuits, each provided with the line terminals for connection to remote overcurrent protection and this remote overcurrent protection must be supplied by the heater manufacturer.

This paragraph requires that the duct heater manufacturer furnish as an integral part of each heater an acceptable means of interlocking the heater with the fan.

UL/NEC Requirements* (cont.)

REQUIREMENT

HOW BRASCH MEETS REQUIREMENT

HEAT PUMPS AND AIR CONDITIONERS

NEC Article 424-61:

"Installation of Duct Heaters with Heat Pumps and Air Conditioners. Heat pumps and air conditioners having duct heaters closer than 4 feet (1.22m) to the heat pump or air conditioner shall have both the duct heater and the heat pump or air conditioner identified as suitable for such installation and so marked."

Any UL Listed duct heater must be spaced at least 4 feet from a heat pump or air conditioner unless the combination (i.e., air conditioner with built-in heater) has been Listed by UL.

UL (Excerpt form Electrical Appliance and Utilization Equipment List Preface)

Tests have indicated that no adverse thermal effects are obtained when duct heaters marked to indicated that they are suitable for use with heat pumps, or central cooling air conditioners and/or fan-coil units are installed with certain of these units (See Heat Pumps, Central Cooling Air Conditioners and Fan-Coil Units). provided the duct heater is used only in horizontal or upflow systems, and the duct heater is located downstream at least 4 ft. from the nearest surfaces of the heat pump, central cooling air conditioner, or fan-coil unit.

Heaters are UL Listed for use with heat pumps or air conditioners (no closer than 4 feet between the two).

FAN CIRCUIT INTERLOCK

UL 1996, Paragraph 21.3

"A heater that does not include a fan or blower motor but is intended to be used in conjunction with such motor, such as duct heater, shall be provided with terminals or leads for field connection of an interlock circuit for such motor unless an airflow interlock is provided as an integral part of the heater. The heater shall include the interlocking contacts or the power supply. It shall be so arranged that no heating element circuit can be energized unless the interlocking contacts are closed or the interlocking power supply energized."

NEC Article 424-63:

"Fan Circuit Interlock. Means shall be provided to ensure that the fan circuit is energized when any heater circuit is energized. However, time- or temperature-controlled delay in energizing the fan motor shall be permitted."

Any one of the following methods of interlocking the heater with the fan will be provided in Brasch heaters:

1. Built-in airflow switch (wired in series with elements or holding coils of contractors).
2. Built-in fan relay to provide the interlocking contacts mentioned in Paragraph 18.3.
3. Built-in power supply with control transformer primary wired to load size of fan starter.
4. Built-in pneumatic-electric (PE) switch with fan interlocking contacts.

NOTE: We recommend a built-in pressure differential airflow switch wherever practical (minimum total pressure differential in duct must be at least .05" WC). If a built-in airflow switch cannot be used, we recommend a built-in fan relay or transformer interlock.

LOCATION OF DISCONNECTING MEANS

NEC Article 424-19:

"Disconnecting Means. Means shall be provided to disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed electric space heating equipment from all ungrounded conductors. Where heating equipment is supplied by more than one source, the disconnecting means shall be grouped and identified.

(a) Heating Equipment with Supplementary Overcurrent Protection. The disconnecting means for fixed electric space heating equipment with supplementary overcurrent protection shall be within sight from the supplementary overcurrent protective device(s), on the supply side of these devices, if fuses, and in addition shall comply with…

(1) Heater Containing No Motor Rated Over 1/8 Horsepower. The above disconnecting means or unit switches complying with section 424-19(c) shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater under either (a) or (b) below.

a. The disconnecting means provided is also within sight from the motor controller(s) and the heater; or
b. The disconnecting means provided shall be capable of being locked in the open position."

NEC Article 424-64:

"Location of Disconnecting Means. Duct heater controller equipment shall be accessible with the disconnecting means installed at or within sight from the controller."

NEC Article 4234-21:

"Switch and Circuit Breaker to Be Indicating. Switches and circuit breakers used as disconnecting means shall be of the indicating type."

To meet this requirement, Brasch heaters are available with built-in safety disconnect switches (fused or unfused). These disconnects offer the additional advantage of having an interlocking door handle which prevents terminal box door from being opened unless switch is in the off position. Additionally, switches installed in Brasch remote control panels can be locked in the open position.

NOTE: A combination door interlock switch and contactor can not serve as a disconnecting means since door interlock switches are nonindicating.

Express Duct Heaters 14 Day Shipment

BRASCH OFFERS 14 DAY DELIVERY ON A WIDE VARIETY OF SPECIFIC SIZES, CAPACITIES AND CONTROL COMPONENTS OF SLIP-IN OPEN COIL DUCT HEATERS. DETAILS OF WHAT IS AVAILABLE UNDER THE *EXPRESS HEATER PROGRAM* ARE COVERED IN BULLETIN A-103.

PLEASE REQUEST A COPY OF BULLETIN A-103 FROM BRASCH CUSTOMER SERVICE DEPARTMENT OR GO TO OUR WEBSITE: www.braschmfg.com. CLICK “PRODUCTS” AND “ELECTRIC HEATING CAPABILITIES”. UNDER “PRODUCT LITERATURE” CLICK “BROCHURE A-103”.

OPEN COIL HEATERS NOT COVERED IN A-103 ARE NORMALLY AVAILABLE IN 4 TO 5 WEEKS. HOWEVER, HEATERS NOT COVERED IN A-103, INCLUDING FINNED TUBULAR HEATERS MAY BE AVAILABLE ON AN EXPEDITED BASIS AT MODEST ADDITIONAL CHARGE. CONTACT BRASCH SALES DEPARTMENT.

Limited Warranty

All Brasch Manufacturing Company, Inc. products covered in this bulletin are warranted against defects in material and workmanship for one year from date of purchase. This warranty does not apply to damage from accident, misuse, alteration; nor where the connected voltage is more than 5% above product nameplate voltage; nor to equipment improperly installed or wired or maintained in violation of installation instructions. This warranty is valid only in the fifty states of the United States. No other written or oral warranty applies. No employee, agent, dealer or other person is authorized to extend the warranty on behalf of Brasch Manufacturing Company.

The customer shall be responsible for all costs incurred in the removal or reinstallation and shipping of the product for repairs. Inoperative units should be returned to Brasch, to the attention of Service Manager for replacement at our option. Product will be returned freight prepaid. Repair of replacement is the exclusive remedy available from Brasch who is not liable for damages of any kind, including incident or consequential damage.

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Geothermal Indoor Split Heat Pump Product Data

- R-410A Refrigerant
- 2 to 6 Tons Single Capacity
- 2 to 6 Tons Dual Capacity

XL Series T1GN, T2GN

022-1855-01

T1GN, T2GN Series Indoor Split

General Introduction

T1GN, T2GN Series splits are designed for indoor installations, and are connected to an indoor air handler via refrigerant lines and control wiring. T1GN, T2GN Series units utilize the ozone-safe R-410A refrigerant to meet the most stringent EPA requirements now and for many years to come. Easily accessible controls and connections for refrigerant piping and water piping make this unit simple to install in a wide variety of applications. Heavy gauge metal cabinets are coated with durable polyester powder coat paint for long lasting beauty and protection. The T1GN, T2GN Series split will provide exceptional performance and comfort for many years. And because there is no outdoor blower like ordinary air conditioners or heat pumps, the T1GN, T2GN Series is “whisper quiet”.

T1GN, T2GN Series units are performance-certified to AHRI ISO 13256-1 standards, are ETL safety listed, and are ENERGYSTAR® qualified.

As a leader in the industry, we are dedicated to innovation, quality and customer satisfaction. In fact, every unit built is exposed to a wide range of quality control procedures throughout the assembly process and is then subjected to a rigorous battery of computerized run tests to certify that it meets or exceeds performance standards for efficiency and safety, and will perform flawlessly at startup. As further affirmation of our quality standards, each unit carries our exclusive Quality Assurance emblem, signed by the final test technician.

Table of Contents

AHRI Data

AHRI/ASHRAE/ISO 13256-1

English (IP) Units

Model	Capacity Modulation	Flow Rate		Water Loop Heat Pump				Ground Water Heat Pump				Ground Loop Heat Pump			
				Cooling Brine EWT 86°F		Heating Brine EWT 68°F		Cooling EWT 59°F		Heating EWT 50°F		Cooling Brine Full Load 77°F Part Load 68°F		Heating Brine Full Load 32°F Part Load 41°F	
		GPM	CFM	Capacity Btuh	EER Btuh/W	Capacity Btuh	COP	Capacity Btuh	EER Btuh/W	Capacity Btuh	COP	Capacity Btuh	EER Btuh/W	Capacity Btuh	COP
026	Full	8	900	25,000	14.6	30,500	5.1	27,800	21.8	25,000	4.6	26,200	17.0	19,500	3.9
	Part	7	700	18,500	16.6	22,000	5.6	21,300	28.4	17,700	4.8	21,000	24.5	16,200	4.4
038	Full	9	1200	34,000	14.6	40,100	5.0	34,300	20.4	33,100	4.5	35,000	17.1	25,700	3.8
	Part	8	800	25,000	16.6	30,000	5.3	25,200	27.0	24,400	4.4	27,000	25.3	22,100	4.2
049	Full	12	1500	45,900	14.0	56,800	4.7	50,500	20.2	46,700	4.4	47,700	16.1	37,000	3.8
	Part	11	1300	35,000	16.2	43,000	5.5	37,300	25.8	33,000	4.7	38,000	22.9	30,500	4.3
064	Full	16	1800	56,300	14.7	67,100	4.6	63,800	19.2	55,800	4.3	59,100	15.5	43,200	3.6
	Part	14	1500	42,900	15.7	49,500	5.1	50,000	24.9	41,000	4.3	47,900	22.2	36,800	3.9
072	Full	18	1800	60,400	13.3	80,600	4.6	67,900	17.8	63,100	3.9	62,700	15.0	50,300	3.4
	Part	16	1600	49,700	14.6	60,200	4.8	57,200	22.8	48,400	4.0	53,800	20.0	42,800	3.8
022	Single	8	800	19,700	16.3	23,500	5.3	23,300	27.9	18,900	4.5	21,800	19.5	14,000	3.7
030	Single	8	1000	25,800	17.3	32,000	5.5	28,500	24.9	25,300	4.9	26,800	19.8	19,700	4.0
036	Single	9	1200	31,400	17.6	37,600	5.5	33,900	27.0	30,000	4.7	31,900	19.8	24,000	4.0
042	Single	10	1400	39,000	17.3	41,400	5.3	42,900	25.3	33,000	4.5	39,900	19.9	25,300	3.7
048	Single	12	1500	44,200	15.5	55,400	5.2	48,900	23.8	45,100	4.5	46,200	18.1	35,300	3.8
060	Single	15	1800	54,600	14.4	66,300	4.6	62,300	21.1	52,900	4.1	57,000	17.0	44,500	3.6
070	Single	18	1800	60,200	13.2	76,000	4.2	68,500	19.2	63,000	3.7	63,200	15.1	50,800	3.3

11/12/10

Cooling capacities based upon 80.6°F DB, 66.2°F WB entering air temperature
Heating capacities based upon 68°F DB, 59°F WB entering air temperature
All ratings based upon operation at the lower voltage of dual voltage rated models.
Refer to the air handler compatibility table for matching air handler.

Energy Star Compliance Table

Model	Tier 3	
	Ground Water	Ground Loop
026	Yes	Yes
038	Yes	Yes
049	Yes	Yes
064	Yes	Yes
072	No	Yes
022	Yes	Yes
030	Yes	Yes
036	Yes	Yes
042	Yes	Yes
048	Yes	Yes
060	Yes	Yes
070	No	No

11/12/10

Energy Star Rating Criteria

In order for water-source heat pumps to be Energy Star rated they must meet or exceed the minimum efficiency requirements listed below. Please note there are 3 Tier levels that dictate minimum efficiency for water source pumps. Only one tier level is active at a given moment.

Tier 3: 1/1/2012 – No Effective End Date Published	**EER**	**COP**
Closed loop water-to-air	17.1	3.6
Open loop water-to-air	21.1	4.1
Closed loop water-to-water	16.1	3.1
Open loop water-to-water	20.1	3.5

AHRI Data cont.

The performance standard AHRI/ASHRAE/ISO 13256-1 became effective January 1, 2000 and replaces AHRI Standards 320, 325, and 330. This new standard has three major categories: Water Loop (comparable to ARI 320), Ground Water (ARI 325), and Ground Loop (ARI 330). Although these standards are similar there are some differences:

Unit of Measure: The Cooling COP

The cooling efficiency is measured in EER (US version measured in Btuh per Watt. The Metric version is measured in a cooling COP (Watt per Watt) similar to the traditional COP measurement.

Water Conditions Differences

Entering water temperatures have changed to reflect the centigrade temperature scale. For instance the water loop heating test is performed with 68°F (20°C) water rounded down from the old 70°F (21.1°C).

Air Conditions Differences

Entering air temperatures have also changed (rounded down) to reflect the centigrade temperature scale. For instance the cooling tests are performed with 80.6°F (27°C) dry bulb and 66.2°F (19°C) wet bulb entering air instead of the traditional 80°F (26.7°C) DB and 67°F (19.4°C) WB entering air temperatures. 80.6/66.2 data may be converted to 80/67 using the entering air correction table. This represents a significantly lower relative humidity than the old 80/67 of 50% and will result in lower latent capacities.

Pump Power Correction Calculation

Within each model, only one water flow rate is specified for all three groups and pumping Watts are calculated using the following formula. This additional power is added onto the existing power consumption.

- Pump power correction = (gpm x 0.0631) x (Press Drop x 2990) / 300 where ‘gpm’ is waterflow in gpm and ‘Press Drop’ is the pressure drop through the unit heat exchanger at rated water flow in feet of head.

Blower Power Correction Calculation

Blower power is corrected to zero external static pressure using the following equation. The nominal airflow is rated at a specific external static pressure. This effectively reduces the power consumption of the unit and increases cooling capacity but decreases heating capacity. These Watts are significant enough in most cases to increase EER and COPs fairly dramatically over ARI 320, 325, and 330 ratings.

- Blower Power Correction = (cfm x 0.472) x (esp x 249) / 300 where ‘cfm’ is airflow in cfm and ‘esp’ is the external static pressure at rated airflow in inches of water gauge.

ISO Capacity and Efficiency Calculations

The following equations illustrate cooling calculations:

- ISO Cooling Capacity = Cooling Capacity (Btuh) + (Blower Power Correction (Watts) x 3.412)
- ISO EER Efficiency (W/W) = ISO Cooling Capacity (Btuh) x 3.412 / [Power Input (Watts) - Blower Power Correction (Watts) + Pump Power Correction (Watt)]
  The following equations illustrate heating calculations:
- ISO Heating Capacity = Heating Capacity (Btuh) - (Blower Power Correction (Watts) x 3.412)
- ISO COP Efficiency (W/W) = ISO Heating Capacity (Btuh) x 3.412 / [Power Input (Watts) - Blower Power Correction (Watts) + Pump Power Correction (Watt)]

Comparison of Test Conditions

	ARI 320	ISO/AHRI 13256-1 WLHP	ARI 325	ISO/AHRI 13256-1 GWHP	ARI 330	ISO/AHRI 13256-1 GLHP
Cooling						
Entering Air - DB/WB °F	80/67	80.6/66.2	80/67	80.6/66.2	80/67	80.6/66.2
Entering Water - °F	85	86	50/70	59	77	77
Fluid Flow Rate	*	**	**	**	**	**
Heating						
Entering Air - DB/WB °F	70	68	70	68	70	68
Entering Water - °F	70	68	50/70	50	32	32
Fluid Flow Rate	*	**	**	**	**	**

Note *: Flow rate is set by 10°F rise in standard cooling test
Note **: Flow rate is specified by the manufacturer
Part load entering water conditions not shown.
WLHP = Water Loop Heat Pump; GWHP = Ground Water Heat Pump; GLHP = Ground Loop Heat Pump

Conversions:

Airflow (lps) = CFM x 0.472;
ESP (Pascals) = ESP (in wg) x 249;
Water Flow (lps) = GPM x 0.0631;
Press Drop (Pascals) = Press Drop (ft hd) x 2990

Design Features

Application Flexibility

- Safe, efficient operation in a wide range of liquid temperatures (25°F to 110°F) and flow rates (as low as 1.5 GPM/ton in open loop applications when EWT >50°F).
- Easily accessible loop pump wiring.

Operating Efficiencies

- Environmentally friendly R-410A refrigerant.
- LED fault and status lights with memory for easy diagnostics.
- Accumulator on all models for compressor reliability.
- AHRI 13256-1 rating for heating COPs, cooling EERs and low water flow requirements.
- Optional hot water generator creates hot water at considerable savings while improving overall system efficiency.
- High-stability expansion valve delivers optimum refrigerant flow over a wide range of conditions.
- Efficient Copeland scroll compressors in all units.
- Oversized coaxial tube water-to-refrigerant heat exchanger operates at low liquid pressure drops.
- Optional convoluted copper water tube functions efficiently at low flow rates, and provides freeze-damage resistance.

Service Advantages

- Easily removable top, front and side access panels.
- Easily accessible thermal expansion valve.
- Brass, swivel-type water connections for ease of installation.
- High- and low-pressure service ports in refrigerant circuit.

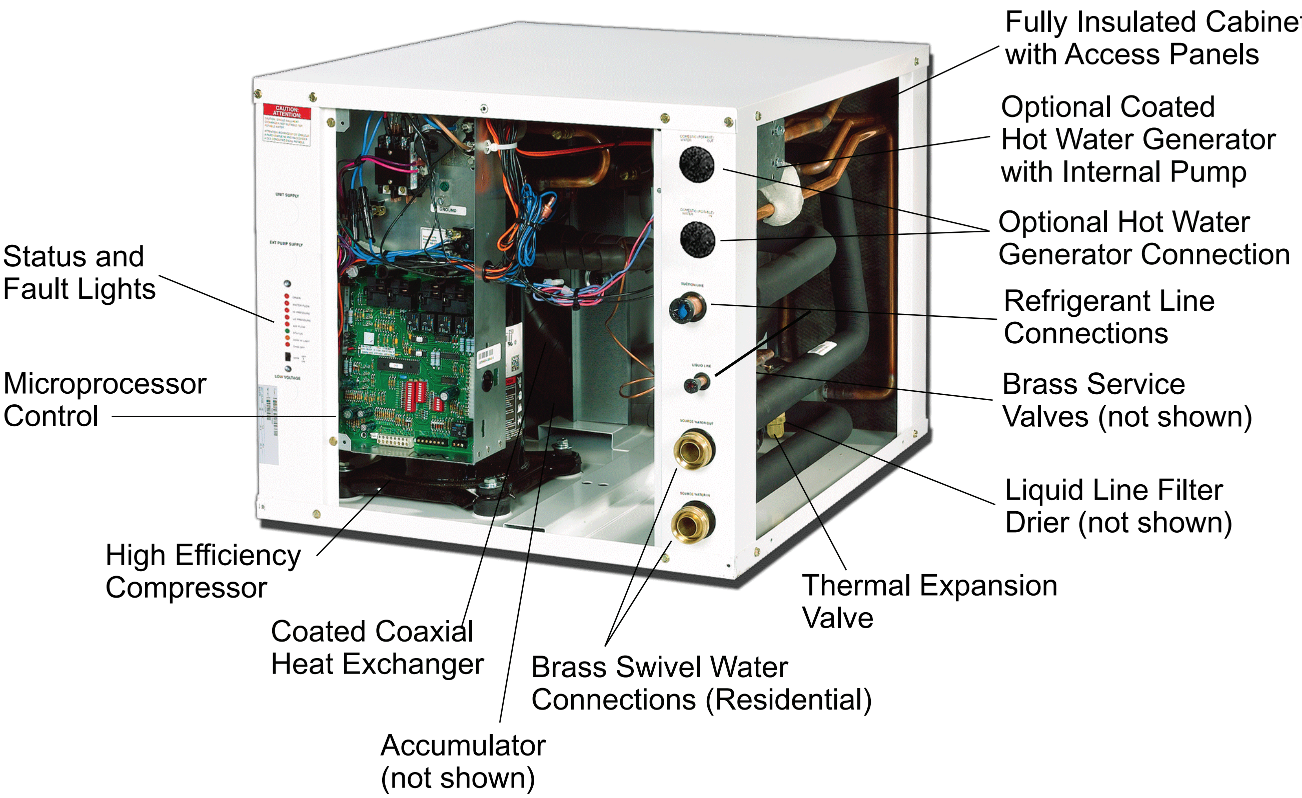
Factory Quality

- All units are manufactured on an automated testing assembly line. This assembly line features monitoring and assembly processes that lead the industry such as:
  - Component verification through bar codes.
  - Multiple automatic leak and pressure tests.
  - Performance of a water-based run test measuring
  - both functionality and performance of the unit.
  - Database management of all run test parameters
  - for service analysis.
  - Integrated fail safe system that prevents packaging of a failed unit.
- Heavy-gauge steel cabinets are painted with durable polyester powder coat paint for long lasting beauty and service.
- All refrigerant brazing is performed in a nitrogen atmosphere.
- All units are deep evacuated to less than 150 microns prior to refrigerant charging.
- All joints are helium leak-tested to ensure an annual leak rate of less than 1/4 ounce.
- Refrigerant suction lines, hot water generator coil, and all water pipes are fully insulated to reduce condensation problems in low temperature operation.
- Noise reduction features: Double isolation mounted compressors, insulated cabinet using 1/2-inch coated glass fiber.
- Compressor sound blanket.
- Safety features include high- and low-pressure refrigerant controls to protect the compressor.
- Coaxial heat exchanger and optional hot water generator are coated.

Options and Accessories

- Optional coated hot water generator with internally mounted pump and water heater plumbing connector
- Electronic auto-changeover thermostat with 3-stage heat/2-stage cool and indicator LEDs
- Closed loop flow center and loop circulating kits
- Hose kits
- Additional accessory relay
- Mounting pad
- Well water kits
- GeoStart soft starter

Indoor Split Features



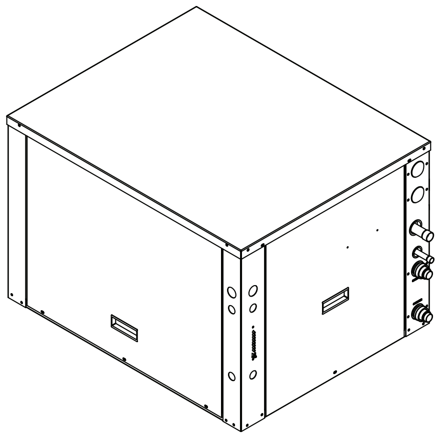
Physical Data

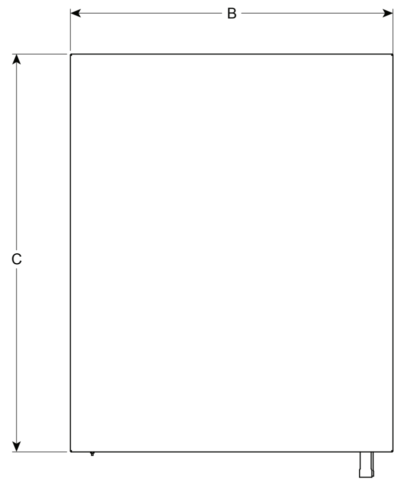
Model	022	030	036	042	048	060	070	026	038	049	064	72
Compressor (1 each)	Single Speed Scroll							Dual Capacity Scroll				
Factory Charge R410a, oz [kg]	56 [1.59]	56 [1.59]	56 [1.59]	74 [2.1]	90 [2.55]	92 [2.61]	108 [3.06]	52 [1.47]	56 [1.59]	90 [2.55]	92 [2.61]	104 [2.95]
Coax and Water Piping												
Water Connections Size - Swivel- in [mm]	1 [25.4]							1 [25.4]				
HWG Connection Size - Sweat (I.D.) - in [mm]	1/2 [12.7]							1/2 [12.7]				
Brass Service Valve - Liquid Line - in [mm]	3/8” [9.525]					1/2” [12.7]		3/8” [9.525]			1/2” [12.7]	
Brass Service Valve - Suction Line - in [mm]	5/8” [15.875]			3/4” [19.05]		7/8” [22.225]		5/8” [15.875]	3/4” [19.05]		7/8” [22.225]	
Coax & Piping Water Volume - gal [l]	0.7 [2.6]	1.0 [3.8]	1.3 [4.9]	1.3 [4.9]	1.6 [6.1]	1.6 [6.1]	2.3 [8.7]	0.7 [2.6]	1.3 [4.9]	1.6 [6.1]	1.6 [6.1]	2.3 [8.7]
Weight - Operating, lb [kg]	164 [74]	174 [79]	212 [96]	213 [97]	246 [112]	251 [114]	292 [132]	189 [186]	236 [107]	250 [113]	271 [123]	290 [132]
Weight - Packaged, lb [kg]	184 [83]	194 [88]	232 [105]	233 [106]	266 [121]	271 [123]	312 [142]	209 [95]	256 [116]	270 [122]	291 [132]	310 [141]

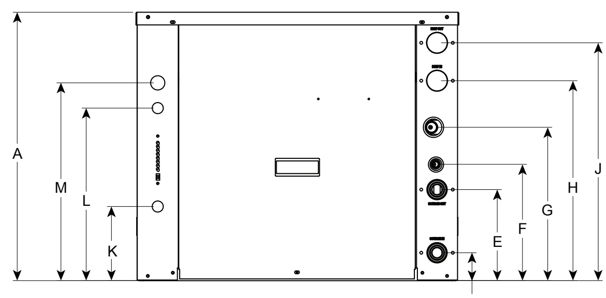
NOTES: All units have TXV expansion devices, and 1/2 in. [12.2 mm] and 3/4 in. [19.1 mm] electrical knockouts. Brass service valves are sweat type valves.

1/19/11

Dimensional Data







MODELS		HEIGHT	WIDTH	DEPTH	WATER IN	WATER OUT	SERVICE VALVE		HWG IN	HWG OUT	LOW VOLTAGE	EXTRNL PUMP	LINE VOLTAGE
							LIQUID	GAS					
		A	B	C	D	E	F	G	H	J	K	L	M
022-030	IN.	19.50	22.50	26.50	1.93	6.93	8.44	11.55	13.43	16.43	5.87	13.66	15.66
	CM.	48.90	57.15	67.31	4.90	17.60	21.44	29.34	34.11	41.73	14.91	34.70	39.78
038-072	IN.	21.25	25.50	31.50	2.21	7.21	9.21	12.14	15.83	18.83	5.87	13.66	15.66
	CM.	54.00	57.15	80.01	5.61	18.31	23.39	30.84	40.21	47.83	14.91	34.70	39.78

Dimensions are in inches.
7/27/10

Refrigerant line connections extend 2 in. [50.8 mm] beyond the front of the cabinet.
Water lines extend 1.2 in. [30.5 mm] beyond the front of the cabinet.

Electrical Data

MODEL	RATED VOLTAGE	VOLTAGE MIN/MAX	COMPRESSOR				HWA PUMP FLA	EXT LOOP FLA	TOTAL UNIT FLA	MIN CIRC AMP	MAX FUSE/ HACR
			MCC	RLA	LRA	LRA*					
022	208-230/60/1	197/253	14.0	9.0	48.0	17.0	0.4	5.4	14.8	17.1	25
030	208-230/60/1	197/253	20.0	12.8	58.3	21.0	0.4	5.4	18.6	21.8	30
036	208-230/60/1	197/253	22.0	14.1	73.0	26.0	0.4	5.4	19.9	23.4	35
042	208-230/60/1	197/253	26.0	16.6	79.0	28.0	0.4	5.4	22.4	26.6	40
048	208-230/60/1	197/253	31.0	19.8	109.0	38.0	0.4	5.4	25.6	30.6	50
060	208-230/60/1	197/253	41.2	26.4	134.0	47.0	0.4	5.4	32.2	38.8	60
070	208-230/60/1	197/253	47.0	30.1	158.0	55.0	0.4	5.4	35.9	43.4	70
026	208-230/60/1	197/253	16.0	10.2	52.0	18.0	0.4	5.4	16.0	18.6	25
038	208-230/60/1	197/253	26.0	16.6	82.0	29.0	0.4	5.4	22.4	26.6	40
049	208-230/60/1	197/253	33.0	21.1	96.0	34.0	0.4	5.4	26.9	32.2	50
064	208-230/60/1	197/253	40.0	25.6	118.0	41.0	0.4	5.4	31.4	37.8	60
072	208-230/60/1	197/253	42.5	27.2	150.0	53.0	0.4	5.4	33.0	39.8	60

Rated voltage of 208-230/60/1
5/6/09

HACR circuit breaker in USA only
Min/Max Voltage of 197/253
All fuses Class RK-5
* With optional GeoStart

GA Series Coil Nomenclature

1	2	3	4	5	6	7-9	10	11	12	13	14
A	G	C	X	C	R	026	A	M	A	A	X

Brand (either A or T)
A = Amercian Standard
T = Trane

Product Categoty
G = Geothermal

Product Type
C = Split System Dual Fuel Coil

Coil Design
X = Direct Expansion
Evaporator Coil TXV Included

Coil Cabinet
C = Cabinet Encased
U = Uncased

Model Type
R = Refrigerant Coil
H = Hydronic Coil

Minor Design Change - not orderable

Vintage
A = Current

Series
A = Current

Airflow Configuration
Cased = Multi-poise
Uncased = Multi-poise

Cloil Width
A = 20.8" / 20.0"

Nominal Coil Capacity

Refrigerant Models	Recommended Airflow (CFM)
026 Mbtuh	800-980
036 Mbtuh	1225
048 Mbtuh	1425-1625
060 Mbtuh	1760
Hydronic Models	
060 Mbtuh	1760

REFRIGERANT COIL COMPATIBILITY

ENCASED/UNCASED COIL	INDOOR SPLIT MODEL (SINGLE)	INDOOR SPLIT MODEL (DUAL CAPACITY)	OUTDOOR SPLIT MODEL (DUAL CAPACITY)	RECOMMENDED AIRFLOW (CFM)
GCXC026*	1GN022	-		800
GCXC026*	-	2GN026	2GE026	925
GCXC026*	1GN030	-	-	980
GCXC036*	1GN036	-	-	1225
GCXC036*	-	2GN038	2GE038	1225
GCXC048*	1GN042	-	-	1425
GCXC048*	1GN048	-	-	1625
GCXC048*	-	2GN049	2GE049	1625
GCXC060*	1GN060	-	-	1760
GCXC060*	-	2GN064	2GE064	1760
GCXC060*	1GN070	-	-	1760
GCXC060*	-	2GN072	2GE072	1760

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COIL PHYSICAL DATA

AIR COIL MODEL NUMBER (REFRIGERANT)		GCXC026	GCXC036	GCXC048	GCXC060
EVAPORATOR COIL	AIR COIL TOTAL FACE AREA, FT2 [M2]	5.83 [0.54]			
	TUBE OUTSIDE DIAMETER - IN. [MM]	3/8 [9.52]			
	NUMBER OF ROWS	2		3	
	FINS PER INCH	12			
	SUCTION LINE CONNECTION - IN. [MM] SWEAT	5/8 [15.87]		7/8 [22.22]	
	LIQUID LINE CONNECTION - IN. [MM] SWEAT	3/8 [9.52]			
REFRIGERANT		R-410A			
NOMINAL COOLING CAPACITY - TONS [KW]		2.1 [7.59]	3 [10.55]	4 [14.06]	5 [17.58]
CONDENSATE DRAIN CONNECTION - (FPT) IN. [MM]		3/4 [19.05]			

AIR COIL MODEL NUMBER (HYDRONIC)		GHAC060
HYDRONIC COIL	AIR COIL TOTAL FACE AREA, FT2 [M2]	6.94 [0.64]
	TUBE OUTSIDE DIAMETER - IN. [MM]	3/8 [9.52]
	NUMBER OF ROWS	3
	FINS PER INCH	13
	WATER IN CONNECTION - IN. [MM] SWEAT	7/8 [22.22]
	WATER OUT CONNECTION - IN. [MM] SWEAT	7/8 [22.22]
NOMINAL COOLING CAPACITY - TONS [KW]		5 [17.58]
CONDENSATE DRAIN CONNECTION - (FPT) IN. [MM]		3/4 [19.05]

NOTE: Water connection dimensions are O.D.

Reference Calculations

Heating Calculations:	Cooling Calculations:
$LWT = EWT - \frac{HE}{GPM \times 500}$	$LWT = EWT + \frac{HR}{GPM \times 500}$
$LAT = EAT + \frac{HC}{CFM \times 1.08}$	$LAT\ (DB) = EAT\ (DB) - \frac{SC}{CFM \times 1.08}$
$TH = HC + HW$	$LC = TC - SC$
	$S/T = \frac{SC}{TC}$

Legend and Notes

ABBREVIATIONS AND DEFINITIONS:

CFM = airflow, cubic feet/minute
EWT = entering water temperature, Fahrenheit
GPM = water flow in gallons/minute
WPD = water pressure drop, PSI and feet of water
EAT = entering air temperature, Fahrenheit (dry bulb/wet bulb)
HC = air heating capacity, MBTUH
TC = total cooling capacity, MBTUH
SC = sensible cooling capacity, MBTUH
kW = total power unit input, kilowatts
HR = total heat of rejection, MBTUH
HE = total heat of extraction, MBTUH
HWC = hot water generator capacity, MBTUH
EER = Energy Efficient Ratio = BTU output/Watt input
COP = Coefficient of Performance = BTU output/BTU input
LWT = leaving water temperature, °F
LAT = leaving air temperature, °F
TH = total heating capacity, MBTUH
LC = latent cooling capacity, MBTUH
S/T = sensible to total cooling ratio

Hot water generator performance based on 0.4 GPM flow per nominal unit ton at 90°F entering hot water temperature. Performance data does not include water pumping watts and are based upon 15% (by volume) methanol antifreeze solution. Multiple Flow Rates (for EWT) are shown in the capacity data tables. The lowest flow rate shown is used for geothermal open loop/well water systems with a minimum 50°F. The second flow rate shown is the minimum geothermal closed loop flow rate. The third flow rate shown is optimum for geothermal closed loop and the suggested flow rate for boiler tower applications. Interpolation between EWT, GPM and CFM data is permissible. Extrapolation for heating data down to 25°F is permissible. Catalog illustrations cover the general appearance of products at time of publication. We reserve the right to make changes in design and construction at any time without notice.

Operating Limits

OPERATING LIMITS	COOLING		HEATING	
	(°F)	(°C)	(°F)	(°C)
Air Limits				
Min. Ambient Air	45	7.2	45	7.2
Rated Ambient Air	80	26.7	70	21.1
Max. Ambient Air	100	37.8	85	29.4
Min. Entering Air	50	10.0	40	4.4
Rated Entering Air db/wb	80.6/66.2	27/19	68	20.0
Max. Entering Air db/wb	110/83	43/28.3	80	26.7
Water Limits				
Min. Entering Water	30	-1.1	20	-6.7
Normal Entering Water	50-110	10-43.3	30-70	-1.1
Max. Entering Water	120	48.9	90	32.2

NOTE: Minimum/maximum limits are only for start-up conditions, and are meant for bringing the space up to occupancy temperature. Units are not designed to operate at the minimum/maximum conditions on a regular basis. The operating limits are dependent upon three primary factors: 1) water temperature, 2) return air temperature, and 3) ambient temperature. When any of the factors are at the minimum or maximum levels, the other two factors must be at the normal level for proper and reliable unit operation.

Pressure Drop

Single Speed

Model	GPM	Pressure Drop (psi)				
		30°F	50°F	70°F	90°F	110°F
022	3	0.9	0.9	0.8	0.7	0.7
	4.5	1.7	1.6	1.5	1.4	1.3
	6	2.8	2.7	2.5	2.3	2.2
	8	4.7	4.4	4.1	3.9	3.6
030	4	1.5	1.4	1.3	1.2	1.1
	6	3.0	2.8	2.7	2.5	2.3
	8	5.1	4.8	4.5	4.2	3.9
	10	7.7	7.2	6.8	6.3	5.8
036	5	1.0	1.0	0.9	0.8	0.8
	7	2.1	1.9	1.8	1.7	1.6
	9	3.6	3.3	3.0	2.8	2.6
	12	6.3	5.9	5.5	5.1	4.8
042	5	0.8	0.7	0.7	0.7	0.6
	8	2.1	2.1	1.9	1.8	1.7
	11	4.2	4.1	3.8	3.5	3.3
	14	7.6	6.7	6.3	5.8	5.4
048	6	1.1	1.0	1.0	0.9	0.8
	9	2.3	2.1	2.0	1.9	1.7
	12	3.9	3.7	3.4	3.2	3.0
	16	6.7	6.3	5.9	5.5	5.1
060	9	2.4	2.2	2.1	2.0	1.8
	12	3.9	3.6	3.4	3.2	2.9
	15	5.7	5.3	5.0	4.7	4.3
	20	9.5	8.9	8.3	7.8	7.2
070	12	3.0	2.8	2.6	2.4	2.2
	15	4.4	4.0	3.8	3.5	3.3
	18	6.0	5.5	5.1	4.8	4.4
	24	9.7	9.1	8.5	7.9	7.3

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Dual Capacity

Model	GPM	Pressure Drop (psi)				
		30°F	50°F	70°F	90°F	110°F
026 full load	4	1.4	1.3	1.2	1.1	1.0
	6	2.8	2.6	2.4	2.3	2.1
	8	4.7	4.4	4.1	3.8	3.5
	10	7.0	6.6	6.2	5.8	5.3
026 part load	3	0.8	0.7	0.7	0.7	0.6
	5	2.0	1.8	1.7	1.6	1.5
	7	3.6	3.4	3.2	3.0	2.8
	9	5.8	5.5	5.1	4.8	4.4
038 full load	5	1.2	1.2	1.1	1.0	1.0
	7	2.2	2.1	1.9	1.8	1.7
	9	3.4	3.2	3.0	2.8	2.6
	11	4.9	4.6	4.3	4	3.7
038 part load	4	0.9	0.8	0.8	0.7	0.7
	6	1.7	1.6	1.5	1.4	1.3
	8	2.8	2.6	2.5	2.3	2.1
	10	4.2	3.9	3.7	3.4	3.2
049 full load	6	1.2	1.2	1.1	1.0	1.0
	9	2.4	2.2	2.1	2.0	1.8
	12	3.9	3.6	3.4	3.2	2.9
	15	5.7	5.3	5	4.7	4.3
049 part load	5	0.9	0.9	0.8	0.8	0.7
	8	2.0	1.8	1.7	1.6	1.5
	11	3.4	3.1	2.9	2.8	2.5
	14	5.0	4.7	4.4	4.1	3.8
064 full load	8	1.8	1.7	1.6	1.4	1.3
	12	3.8	3.5	3.3	3.0	2.8
	16	6.5	6.0	5.6	5.2	4.8
	20	9.7	9.1	8.5	8.0	7.4
064 part load	6	1.0	0.9	0.9	0.8	0.8
	10	2.6	2.5	2.3	2.1	2.0
	14	5.0	4.7	4.4	4.1	3.8
	18	8.1	7.6	7.1	6.6	6.1
072 full load	12	3.2	3.0	2.8	2.6	2.4
	15	4.5	4.2	4.0	3.7	3.4
	18	6.0	5.7	5.3	4.9	4.6
	21	7.8	7.3	6.8	6.4	5.9
072 part load	10	2.3	2.1	2.0	1.9	1.7
	13	3.6	3.3	3.0	2.8	2.6
	16	5.0	4.6	4.3	4.0	3.7
	19	6.5	6.2	5.8	5.4	5.0

5/30/06

Microprocessor Control

Startup
The unit will not operate until all the inputs and safety controls are checked for normal conditions. At first power-up, a four-minute delay is employed before the compressor is energized.

Component Sequencing Delays
Components are sequenced and delayed for optimum space conditioning performance.

Accessory Relay
An accessory relay on the control board allows for field connection of solenoid valves, electronic air cleaners, etc. The accessory relay has a normally open output and a normally closed output.

Short Cycle Protection
The control employs a minimum "off" time of four minutes to provide for short cycle protection of the compressor.

Shutdown Mode
A 24VAC common signal to the “shutdown” input on the control board puts the unit into shutdown mode. Compressor, hot water pump and blower operation are suspended.

Safety Controls
The XL Series control receives separate signals for a high pressure switch for safety, a low pressure switch to prevent loss of charge damage, and a low suction temperature thermistor for low source water temperature sensing.
Upon a continuous 30-second measurement of the fault (immediate for high pressure), compressor operation is suspended, the appropriate lockout LED begins flashing. (Refer to the "Fault Retry" section below.)

Testing
The XL Series control allows service personnel to shorten most timing delays for faster diagnostics.

Fault Retry
All faults are retried twice before finally locking the unit out. An output signal is made available for a fault LED at the thermostat. The “fault retry” feature is designed to prevent nuisance service calls.

Diagnostics
The XL Series control board allows all inputs and outputs to be displayed on the LEDs for fast and simple control board diagnosis.

Hot Water High Limit (Domestic Hot Water Option)
This mode occurs when the hot water input temperature is at or above 130°F for 30 continuous seconds. The DHW limit status LED on the unit illuminates and the hot water pump de-energizes. Hot water pump operations resume on the next compressor cycle or after 15 minutes of continuous compressor operation during the current thermostat demand cycle.

Hot Water Justification
Since compressor hot gas temperature is dependant on loop temperature in cooling mode, loop temperatures may be too low to allow proper heating of water. The control will monitor water and refrigerant temperatures to determine if conditions are satisfactory for heating water. The DHW limit status LED on the unit illuminates when conditions are not favorable for heating water.

Heating Operation

Heat, 1st Stage (Y1)
The blower motor is started immediately, the loop pump is energized 5 seconds after the “Y1” input is received, and the compressor is energized on low capacity 10 seconds after the “Y1” input. The hot water pump is cycled 30 seconds after the “Y1” input.

Heat, 2nd Stage (Y1,Y2) Single-Speed Units
The hot water pump is de-energized, which directs all heat to satisfying the thermostat, and the blower changes to high speed 15 seconds after the “Y2” input (ECM only).

Heat, 2nd Stage (Y1,Y2) Dual Capacity Units
The second stage compressor will be activated 5 seconds after receiving a “Y2” input as long as the minimum first stage compressor run time of 1 minute has expired. The ECM blower changes from medium to high speed 15 seconds after the “Y2” input.
The Comfort Alert will delay the second stage compressor until 5 seconds after it receives a “Y2” from the board.

Heat, 3rd Stage (Y1,Y2,W) Single-Speed Units
The first stage of resistance heat is energized 10 seconds after “W” input, and with continuous 3rd stage demand, the additional stages of resistance heat engage 90 seconds after the first stage.

Heat, 3rd Stage (Y1,Y2,W) Dual Capacity Units
The hot water pump is de-energized which directs all heat to satisfy the thermostat. The 1st stage of resistance heat is energized 10 seconds after “W” input, and with continuous 3rd stage demand, the additional stages of resistance heat engage 90 seconds after the first stage.

Emergency Heat (W only)
The blower is started on high speed, and the first stage of resistance heat is energized 10 seconds after the "W" input. Continuing demand will engage the additional stages of resistance heat 90 seconds after the first stage.

Cooling Operation

In all cooling operations, the reversing valve directly tracks the “O” input. Thus, anytime the “O” input is present, the reversing valve will be energized.

Cool, 1st Stage (Y1,O)
The blower motor and hot water pump are started immediately, the loop pump(s) is energized 5 seconds after the “Y1” input is received. The compressor will be energized (on low capacity for Dual Capacity units) 10 seconds after the “Y1” input. The ECM blower will operate at 85% of medium speed if in dehumidification mode.

Cool, 2nd Stage (Y1, Y2, O) Single Speed Units
The blower changes to high speed (85% of high speed if in dehumidification mode) 15 seconds after the “Y2” input (ECM only).

Cool, 2nd Stage (Y1, Y2, O) Dual Capacity Units
The second stage compressor will be activated 5 seconds after receiving a “Y2” input as long as the minimum first stage compressor run time of 1 minute has expired. The ECM blower changes to high speed 15 seconds after the “Y2” input (85% of high speed if in dehumidification mode). The Comfort Alert will delay the second stage compressor until 5 seconds after it receives a “Y2” from the board.

Blower (G only)

The blower starts and operates on low speed.

The following table shows the codes that will be displayed when the System Monitor (L) is connected to the F terminal of an A/TCONT802 or 803 Comfort Control.

A/TCONT802 or 803 Thermostats	
Thermostat Display Lockout Code	Lockout Description
2 Flashes	High Pressure Fault
3 Flashes	Low Pressure Fault
4 Flashes	Not Applicable
5 Flashes	Water Flow Fault
6 Flashes	Not Applicable
7 Flashes	Condensate Fault
8 Flashes	Voltage out of Range
9 Flashes	RPM Fault
10 Flashes	Comfort Alert Compressor Module Fault

Lockout code 10 - see Comfort Alert module to determine the specific flash code for compressor abnormalities.

Lockout Conditions

During lockout mode, the appropriate unit and thermostat lockout LEDs will illuminate. The compressor, loop pump, hot water pump, and accessory outputs are de-energized. The blower will continue to run on low speed. If the thermostat calls for heating, emergency heat operation will occur.
Comfort Alert lockouts cannot be reset at the thermostat. All other lockout modes can be reset at the thermostat after turning the unit off, then on, which restores normal operation but keeps the unit lockout LED illuminated. Interruption of power to the unit will reset a lockout without a waiting period and clear all lockout LEDs.

High Pressure
This lockout mode occurs when the normally closed safety switch is opened momentarily (set at 600 PSI).

Low Pressure
This lockout mode occurs when the normally closed low pressure switch is opened for 30 continuous seconds (set at 40 PSI). A low pressure fault may also be indicated when a Comfort Alert lockout has occurred.

Freeze Detection (Water Flow)
This lockout mode occurs when the freeze detection thermistor temperature is at or below the selected point (well 30°F or loop 15°F) for 30 continuous seconds.

Thermostat Displays

When using a fault monitor thermostat and SW2-8 is in the pulsing “L” position (off), the system monitor will enable a user to view the thermostat and count the fault indicator flashes to determine the lockout condition the unit is experiencing.
When using an A/TCONT802 or 803 thermostat and SW2-8 is in the pulsing “L” position (off), the system monitor will enable the user to view the thermostat and determine the fault. SW2-8 in the "on" position will send a constant signal to the fault indicator in the event of a system lockout condition. The LED board on the front of the unit will display all lockouts. The Low Pressure LED will flash for a low pressure condition or a Comfort Alert fault. If the low pressure lockout was caused by Comfort Alert codes 4, 6 or 7, then the Comfort Alert will be flashing. If no Comfort Alert code is visible, then it is a low pressure lockout.

Thermostat Wiring

Indoor Split Single and Dual Capacity Wiring Diagram

Field low voltage point to point wiring:

From Thermostat	To Air Handler	To Compressor Section
C	C	C
R	R	R
G	G	
O	O	O
Y1	Y1	Y1
Y2	Y2	Y2
W2	W	
L		L

Air Handler transformer must be 75VA.

5/29/08

Engineering Guide Specifications

General

The geothermal heating/cooling units shall be reverse cycle split system configuration designed for use with DX heating and cooling coils. Units shall be AHRI/ISO Standard 13256-1 performance certified and listed by a nationally recognized safety-testing laboratory or agency, such as ETL Testing Laboratory. Each unit shall be computer run-tested at the factory using water and performance verified. Each unit shall be mounted on a pallet and stretch-wrapped for shipping protection. The geothermal units shall be designed to operate with entering liquid temperature between 25°F and 110°F as manufactured.

Casing and Cabinet

The cabinet shall be fabricated from heavy-gauge steel and finished with corrosion-resistant epoxy/polyester powder coating. The interior shall be insulated with 1/2-inch thick, multi-density, coated glass fiber. The cabinet shall have three access panels for ease of installation and servicing. The internal layout shall provide for major component servicing through front service panel in restricted access installations.

Refrigerant Circuit

All units shall contain an environmentally friendly R410A sealed refrigerant circuit including a hermetic motor-compressor, thermostatic expansion valve, reversing valve, coaxial tube water-to-refrigerant heat exchanger, and service ports. Compressors shall be high-efficiency scroll dual capacity or single speed type designed for heat pump duty and mounted on double, rubber vibration isolators on a metal core. Compressor motors shall be heat pump rated single-phase PSC with internal overload protection. The coaxial water-to-refrigerant heat exchanger shall be designed for low water pressure drop and constructed of a convoluted copper (cupronickel optional) inner tube and a steel outer tube.
The bidirectional thermostatic expansion valve shall provide proper superheat over the entire liquid temperature range with minimal “hunting”. The refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures. An optional coated hot water generator coil shall be provided with integral internal pump and limit controls. All units shall have the source coaxial tube refrigerant-to-water heat exchanger coated.

Electrical

The microprocessor control shall provide operational sequencing, high and low-pressure switch monitoring, thermistor based freeze detection temperature limit, current sensing compressor monitoring, compressor lockout mode control and hot water generator and loop pump control. A removable terminal connector with screw terminals shall be provided for field control wiring on the board. The control shall provide water valve control, test mode, diagnostic mode, short cycle protection, random startup, pump slaving, fault LEDs, status LEDs, and intelligent fault retry.
Quick attach wiring harnesses shall be employed throughout to aid in troubleshooting or parts replacement. Line voltage box lugs shall be provided for both field power wiring connections for unit and the fused external loop pumps.
All units shall have knockouts for entrance of low and line voltage wiring.

Optional GeoStartTM

GeoStart is a single phase soft starter which reduces the normal start current (LRA) by 60%. This allows the heat pump to more easily go "off grid." Using GeoStart will also provide a substantial reduction in light flicker, reduce start-up noise, and improve the compressor's start behavior. GeoStart is available as a factory option or field retrofit kit for all XL Series split units.

Piping

Supply and return water connections shall be 1” FPT brass swivel fittings which provide a union and eliminate the need for backup wrenches or sealants when making field connections. All water piping shall be insulated to prevent condensation at low entering liquid temperatures. Hot water generator connections shall be 1/2" sweat type.

Accessories and Options

Hot Water Generator

An optional hot water assist generator coil shall be provided with integral factory-mounted internal pump. The coil shall be of convoluted double construction and suitable for potable water. Limit controls shall monitor the compressor hot gas temperature and hot water temperature and disable operation during low compressor hot gas temperatures to prevent thermosiphoning from the water heater and limit high water temperatures to prevent scalding.

Thermostat (field-installed)

A multi-stage auto-changeover electronic digital thermostat shall be provided. The thermostat shall offer three heating and two cooling stages with precise temperature control. An OFF-HEAT-AUTO-COOL-EMERG system switch, OFF-AUTO blower switch, and indicating LEDs shall be provided. The thermostat shall display in °F or °C. An optional remote outdoor sensor shall be available.

Flow Center (field installed)

A self contained Flow Center shall provide all pumping, flushing and filling operations needed for residential geothermal earth loops up to 20 gpm. Two corrosion resistant composite 3-way valves shall be employed for loop valving. The flow center shall provide 1˝ FPT or special 'GL' composite union fittings for easy adaptation to connection options. The GL flow controller shall be encased in a corrosion proof polystyrene case (FPT case is powder coated metal) and fully insulated with urethane foam to prevent condensation.

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Water Source HP
ANSI/AHRI/ASHRAE/ISO13256-1

ENERGY STAR

C ETL LISTED US
Intertek

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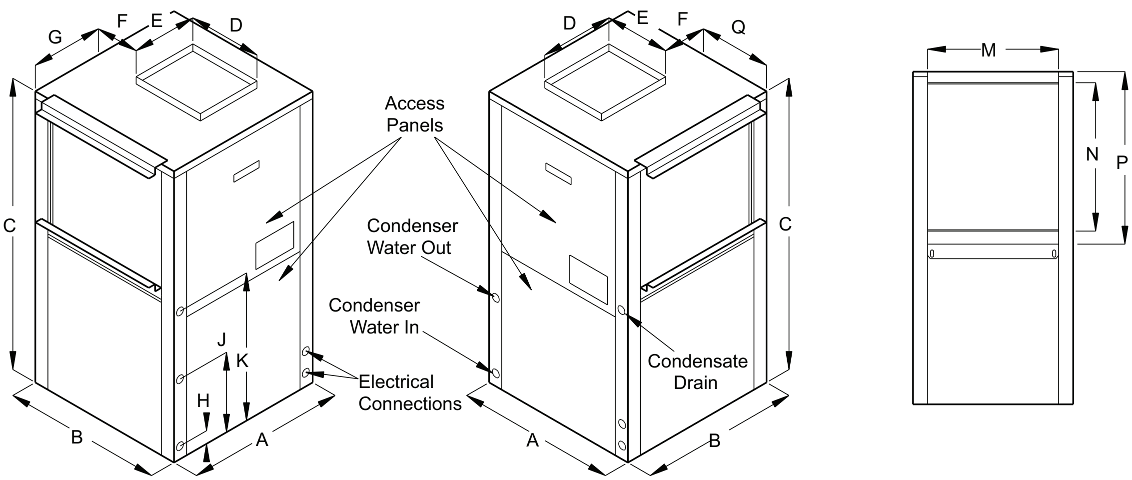
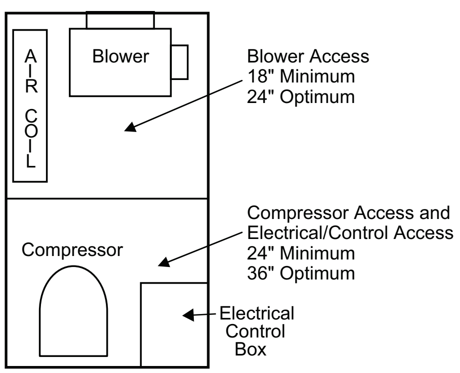
02/12

The Manufacturer has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.

50PCV UNIT



Left Hand Return **Right Hand Return** **Return Air (Filter) View**



Front of Unit
Service Clearances

LEGEND
R/A — Return Air

→ **50PCV007-070 UNITS**

50PCV UNIT SIZE	A WIDTH *	B DEPTH †	C HEIGHT	D DISC. DEPTH	E DISC. WIDTH	F CABINET EDGE TO DISC.	G LEFT SIDE TO DISC.	H WATER INLET	J WATER OUTLET	K CONDEN-SATE DRAIN	M R/A DUCT WIDTH	N R/A DUCT FLANGE HEIGHT	P FILTER RACK HEIGHT	Q	CONDENSER WATER CONNECTIONS FPT	RECOMMENEDED REPLACEMENT NOMINAL FILTER SIZE
007	19.0	19.00	24.25	10.0	8.0	4.5	9.3	2.44	9.68	13.87	16.0	8.0	10.0	5.4	3/4	10x16x1
009	19.0	19.00	24.25	10.0	8.0	4.5	9.3	2.44	9.68	13.87	16.0	8.0	10.0	5.4	3/4	10x16x1
012	19.0	19.00	24.25	10.0	8.0	4.5	9.3	2.44	9.68	13.87	16.0	8.0	10.0	5.4	3/4	10x16x1
015	21.5	21.50	32.25	10.0	8.0	5.8	10.0	2.85	8.45	15.87	20.0	14.0	16.0	3.5	3/4	16x20x1
018	21.5	21.50	32.25	14.0	14.0	3.1	5.2	2.85	8.45	15.87	20.0	14.0	16.0	5.2	3/4	16x20x1
024	21.5	21.50	39.25	14.0	14.0	3.1	5.2	2.80	8.45	18.87	20.0	18.0	20.0	5.2	3/4	20x20x1
030	21.5	21.50	39.25	14.0	14.0	3.1	5.2	2.80	8.45	18.87	20.0	18.0	20.0	5.2	3/4	20x20x1
036	21.5	26.00	43.25	16.0	14.0	4.0	5.0	2.75	10.77	18.87	24.0	22.0	24.0	5.0	3/4	24x24x1
042	21.5	26.00	43.25	16.0	14.0	4.0	5.0	2.75	10.77	18.87	24.0	22.0	24.0	5.0	3/4	24x24x1
048	24.0	32.50	45.25	18.0	14.0	7.0	6.2	3.26	13.20	20.87	30.0	22.0	24.0	6.2	1	24x30x1
060	24.0	32.50	45.25	18.0	14.0	7.0	6.2	3.26	13.20	20.87	30.0	22.0	24.0	6.2	1	24x30x1
070	26.0	33.25	58.25	18.0	16.0	7.8	7.2	2.92	13.36	25.87	30.0	30.0	32.0	7.2	1	16x30x1 (2)

* When waterside economizer is installed, increase width by 7 inches.
† When WSHP Open controller is installed increase depth by 2.6 inches. When waterside economizer is installed, increase depth by 7 inches.

NOTES:
1. All dimensions are within ± 0.125 inch.
2. All condensate drain connections are 3/4 in. FPT.
3. Specifications subject to change without notice.
4. The 1-in. filter rack extends 1.23-in. beyond the side of the unit. The 2-in. filter rack extends 2.89-in. beyond the side of the unit. The 2-in. filter rack is 4 sided with a filter access door on one end and can accept either a 1-in. or 2-in. filter. When a waterside economizer is installed the filter rack will be a 2-sided filter rack only.
5. Return and discharge orientations determined when facing panel with water connections.
6. The local electric codes may require 36" or more clearance at the electrical control box.

TRANQUILITY® TSM SERIES

CLIMATEMASTER®
Water-Source Heat Pump Systems

THE TRANQUILITY® VERTICAL STACK (TSM) SERIES

Installed System

Torsion-flex blower motors TSM09-12

Advanced digital controls with Remote Service Sentinel. (Shown with Optional Enhanced controls DXM2)

Exclusive dual-level compressor isolation lowers vibration and reduces noise for quiet operation

Removable chassis allows staged installation and ease of maintenance/service once installation is complete

Integrated Drain Pan with condensate overflow protection (Optional Stainless Steel Drain Pan)

The Tranquility® Vertical Stack (TSM) Series offers an innovative, labor-saving solution for spaces where individual, quiet control of the heating and cooling system is important. Using EarthPure® (HFC-410A) refrigerant, the Tranquility® Vertical Stack (TSM) Series not only protects the environment, it does so while delivering unprecedented comfort, efficiency, and reliability.

UNIT FEATURES

- Sizes 09 (3/4 ton, 2.6 kW) through 36 (3 ton, 10.6 kW)
- Environmentally-friendly EarthPure® (HFC-410A) zero ozone depletion refrigerant
- High efficiency rotary and scroll compressors
- Exceeds ASHRAE 90.1 efficiencies
- Removable chassis allows staged installation and ease of maintenance
- Galvanized steel cabinet
- Unique double isolation compressor mounting for quiet operation
- TXV metering device
- Unit or remote-mounted controls available
- Choice of high efficiency ECM or PSC motor
- Cabinet can slide over riser ball valve easily. This allows riser stack to be completed first.
- Microprocessor controls standard (optional DXM2 and/or DDC controls)
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Unit Performance Sentinel performance monitoring system
- Attractive return air panel with hinged access door (“G” panel)
- Multiple supply air discharge options
- Stainless steel braided hose kits for connection from piping risers to chassis
- Eight safeties standard
- Wide variety of options including disconnect switch and extended range
- Short cabinet height for adding field ductwork
- Two cabinet footprint sizes

PERFORMANCE AND SPECIFICATIONS

AHRI/ISO/ASHRAE 13256-1 Data (English (I-P) Units & Metric (S-I) Units)

Model with ECM Motor	Refrigerant	Water Loop Heat Pump				Ground Water Heat Pump				Ground Loop Heat Pump			
		Cooling 86°F [30°C]		Heating 68°F [20°C]		Cooling 59°F [15°C]		Heating 60°F [10°C]		Cooling 77°F [25°C]		Heating 32°F [0°C]	
		Capacity	EER	Capacity	COP	Capacity	EER	Capacity	COP	Capacity	EER	Capacity	COP
		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]	
TSM-09	HFC-410A	9,800 [2.87]	15.0 [4.40]	12,900 [3.78]	5.4	11,700 [3.37]	24.5 [7.18]	10,300 [3.02]	4.5	10,500 [3.08]	17.8 [5.22]	7,400 [2.17]	3.4
TSM-12	HFC-410A	11,600 [3.34]	14.7 [4.31]	16,000 [4.69]	5.2	13,600 [3.99]	23.8 [6.98]	12,900 [3.78]	4.4	12,300 [3.60]	17.2 [5.04]	9,600 [2.81]	3.4
TSM-15	HFC-410A	14,600 [4.28]	15.9 [4.66]	17,500 [5.13]	5.3	16,800 [4.92]	25.6 [7.50]	14,500 [4.25]	4.5	15,500 [4.54]	18.8 [5.51]	11,000 [3.22]	3.6
TSM-18	HFC-410A	18,000 [5.28]	15.2 [4.45]	22,200 [6.51]	5.1	20,000 [5.86]	23.5 [6.89]	17,700 [5.19]	4.4	18,500 [5.42]	17.3 [5.07]	13,200 [3.87]	3.3
TSM-24	HFC-410A	25,000 [7.33]	15.7 [4.60]	32,500 [9.53]	5.1	29,500 [8.65]	25.3 [7.42]	26,000 [7.62]	4.5	26,500 [7.77]	18.5 [5.42]	18,200 [5.33]	3.5
TSM-30	HFC-410A	28,000 [8.21]	15.1 [4.43]	34,500 [10.11]	5.0	31,500 [9.23]	22.9 [6.71]	28,500 [8.35]	4.4	29,000 [8.50]	17.6 [5.16]	22,200 [6.51]	3.6
TSM-36	HFC-410A	37,500 [10.99]	14.6 [4.28]	44,000 [12.90]	5.0	42,500 [12.46]	22.6 [6.62]	36,000 [10.55]	4.3	38,500 [11.28]	16.5 [4.84]	28,000 [8.21]	3.5

Model with PSC Motor	Refrigerant	Water Loop Heat Pump				Ground Water Heat Pump				Ground Loop Heat Pump			
		Cooling 86°F [30°C]		Heating 68°F [20°C]		Cooling 59°F [15°C]		Heating 60°F [10°C]		Cooling 77°F [25°C]		Heating 32°F [0°C]	
		Capacity	EER	Capacity	COP	Capacity	EER	Capacity	COP	Capacity	EER	Capacity	COP
		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]		Btuh [kW]	Btuh/W [W/W]	Btuh [kW]	
TSM-09	HFC-410A	9,700 [2.84]	13.9 [4.07]	12,700 [3.72]	5.2	11,500 [3.37]	22.1 [6.48]	10,400 [3.05]	4.3	10,300 [3.08]	16.2 [4.75]	7,600 [2.23]	3.2
TSM-12	HFC-410A	11,400 [3.34]	13.8 [4.04]	16,000 [4.69]	5.1	13,500 [3.99]	21.8 [6.39]	13,000 [3.81]	4.3	12,200 [3.58]	16.0 [4.69]	9,700 [2.84]	3.3
TSM-15	HFC-410A	14,300 [4.19]	13.3 [3.90]	18,000 [5.28]	4.8	16,500 [4.84]	20.5 [6.01]	14,500 [4.25]	4.1	15,200 [4.45]	15.6 [4.57]	11,500 [3.37]	3.3
TSM-18	HFC-410A	17,300 [5.07]	13.2 [3.87]	22,500 [6.59]	4.8	20,000 [5.86]	20.0 [5.86]	18,000 [5.28]	4.0	18,400 [5.39]	15.1 [4.43]	13,500 [3.96]	3.2
TSM-24	HFC-410A	25,000 [7.33]	14.4 [4.22]	32,500 [9.53]	4.9	29,000 [8.50]	22.5 [6.59]	26,500 [7.77]	4.3	26,500 [7.77]	16.8 [4.92]	18,400 [5.39]	3.4
TSM-30	HFC-410A	27,500 [8.06]	13.4 [3.93]	34,500 [10.11]	4.7	31,000 [9.09]	19.5 [5.72]	28,500 [8.35]	4.1	28,500 [8.35]	15.2 [4.45]	22,000 [6.45]	3.3
TSM-36	HFC-410A	37,500 [10.99]	14.1 [4.13]	44,500 [13.04]	4.9	42,500 [12.46]	21.5 [6.30]	36,500 [10.70]	4.3	38,500 [11.28]	16.2 [4.75]	28,500 [8.35]	3.4

Cooling capacities based upon 80.6°F [27°C] DB, 66.2°F [19°C] WB entering air temperature.
Heating capacities based upon 68°F [20°C] DB, 59°F [15°C] WB entering air temperature.
All ratings based upon operation at the lower voltage of dual voltage rated models.

Dimensional Data

Model		Overall Cabinet*		
		W	D	H **
09 - 18	in. cm	19.0 48.3	19.0 48.3	88.0 223.5
24 - 36	in. cm	24.0 61.0	24.0 61.0	88.0 223.5

* Not including risers or flanges.
** 80″ [203.2cm], Also standard.

Voltage Options

Model	Volts	Hz	Phase
09 - 36	208/230 265	60 60	1 1

UNIT FEATURES

Product Series	Standard Features																Factory Installed Options																
	EarthPure® (HFC-410A) Refrigerant	Microprocessor CXM Controls *	Microprocessor DXM2 Controls	iGate® Advanced Control	ECM Fan Motor	Extended Range Capable Refrigerant Circuit (20°F to 120°F)	Copper Water Coil **	vFlow® Modulating Water Valve ‡	TXV	Dual Level Compressor Vibration Isolation	Field Convertible Discharge (Horizontal Units)	Multiple Access Panels for Installation and Service Ease	Scroll Compressors	Factory Installed Hanger Brackets (Horizontal Units)	Remote Reset at Thermostat	Condensate Overflow Protection	Cupro-Nickel Coil **	High Static Blower	UltraQuiet (Mute) Package	Extended Entering Water Temperature Insulation ***	Auto-Flow Water Regulation	Two-Way Control Valve	Downflow Configuration	Desuperheater Coil	DDC Controller	DXM Controller *	Coated Air Coil	Internal Secondary Pump	ECM Fan Motor	ClimaDry® Reheat	Internal Service Disconnect	vFlow® Modulating Water Valve ‡	vFlow® Internal Variable Water Flow Pump
Tranquility® 30 Digital Two-Stage (TE)	•		•	•	•	•	•		•	•	•	•	•	•	•	•	•		•	•			•	•	•		•	•			•	•	•
Tranquility® 30 Two-Stage (TT)	•	•			•	•	•		•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•		•	•		
Tranquility® High Efficiency Two-Stage (TZ)	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•				•	•		•	•					•
Tranquility® 22 High Efficiency Two-Stage (TY)	•		•	•	•	•	•		•	•	•	•	•	•	•	•	•		•	•					•		•						
Tranquility® 20 Single-Stage (TS)	•	•				•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Tranquility® 16 Compact (TC)	•	•				•	•		•	•	•	•	•	•	•	•	•	•	•	•					•	•	•		•				
Tranquility® High Efficiency (TR)	•	•				•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•			
Tranquility® Vertical Stack (TSM)	•	•				•	•		•	•					•	•	•		•	•	•	•			•	•	•	•	•		•		
Tranquility® Vertical Stack (TSL)	•	•				•	•		•	•					•	•	•		•	•	•	•			•	•	•	•	•		•		
Tranquility® Large (TL)	•	•				•	•		•			•	•		•	•	•	•	•	•	•	•			•	•	•	•		•			
Tranquility® Compact Belt Drive (TC)	•	•				•	•		•	•	•	•	•	•	•	•	•	•	•	•					•	•	•						
Tranquility® Console (TRC)	•	•				•	•		•						•	•	•		•	•	•	•			•	•	•	•			•		
Tranquility® Rooftop (TRE)	•	•				•	•		•	•		•	•		•	•	•	•		•	•	•	•		•	•	•	•		•			
Rx Energy Recovery Ventilator (ERV)						•						•																					
Tranquility® Modular Water-to-Water (TMW)	•	•				•	•		•	•		•	•		•		•		•	•				•	•	•							
Vertical Dedicated Outdoor Air (TOV)	•					•	•		•			•	•						•	†					•		•						
Horizontal Dedicated Outdoor Air (TOH)	•					•	•		•			•	•					•		†			•		•		•						

Some exceptions may apply to standard features and options, consult product submittal materials to determine availability.
* Control for TO Series is DDC with modulating HGR. Control for TMW 360-600 is DDC.
** Water coil construction for TO Series and TMW 360-600 is stainless steel.
*** Standard on TMW Series.
† Extended Range = 35°F–95°F EWT.
‡ Low system pressure drop valve is a standard feature, high system pressure drop valve is optional.

CLIMATEMASTER®
Water-Source Heat Pump Systems

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climatemaster.com

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Quality: First & Always

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Rev.: September 7, 2014

PLUMBING CALCULATIONS AND CUTSHEETS

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PLUMBING CALCULATIONS

DOMESTIC WATER SERVICE
PER UFC (IPC)

FLOW TEST (28 OCT 2014)
STATIC = 50 PSI
RESIDUAL = 43 PSI @ 1021 GPM

FIXTURE	#	WSFU		
WC (TANK) LAV TUB/SH	55	3.6 (GROUP)	=	198
SINK	26	1.4	=	36.4
WASHER	26	1.4	=	36.4
WC (FV)	1	5	=	5
LAV	1	2	=	2
MB	3	3	=	9
EWC	3	0.25	=	0.75

287.55 = 82.5 GPM

EXISTING SERVICE IS 2½"

2½" @ 82.5 GPM = 5.6 FT/SEC & 1.9 PSI LOSS/100'

EXISTING 2½" IS ADEQUATE

Project/Description: MINOT 276	Project No.	Date
1/8 Inch Calc Sheet	Sheet	Design By: WAO / Checked By

Notes / Other

leidos

SANITARY SEWER
PER UFC (IPC)

FIXTURE	#	DFU	
WC, LAV, TUB/SH	55	5 (GROUP)	= 275
SINK	26	2	= 52
MB	3	2	= 6
EWC	3	0.5	= 1.5
FD (EMERGENCY ONLY)			—
WC (FV PUBLIC)	1	4	= 4
LAV (PUBLIC)	1	1	= 1
WASHER	26	2	= 52
			391.5 DFU

EXISTING BUILDING DRAIN IS 5"
5" IS GOOD FOR A MAXIMUM OF 390 DFU @ 1/8"/FT. SLOPE
OR 480 DFU @ 1/4"/FT. SLOPE
5" IS NOT A COMMONLY USED PIPE SIZE

NEW SANITARY SEWER WILL BE 6"
6" IS GOOD FOR UP TO 700 DFU @ 1/8"/FT. SLOPE

Project/Description: MINOT 276	Project No.	Date
1/8 Inch Calc Sheet	Sheet	Design By: WAO	Checked By

Notes / Other

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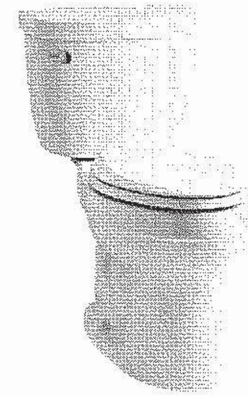
PLUMBING CUTSHEETS

WC-1

KOHLER®

Cimarron®
Comfort Height® Toilet
K-3609



Features
- Vitreous china.
- Two-piece toilet.
- Comfort Height® Elongated bowl.
- AquaPiston® flushing system.
- Includes left-hand polished chrome trip lever.
- 1.28 gpf (4.8 lpf).
- 2-1/8" (54 mm) fully glazed trapway.
- 12" (305 mm) rough-in.
- Less seat and supply.
- 10-1/2" (267 mm) x 7-1/8" (181 mm) water area.
- 28-3/4" (730 mm) x 17-5/8" (447 mm) x 30-3/4" (781 mm).
- Floor mount / Floor outlet.

Recommended Accessories
K-4650 Toilet Seat
K-7637 Angle Supply with Stop (single)

Components
Product includes:
K-4309 Elongated Toilet Bowl
K-4421 Toilet Tank
Additional included component/s: Tank cover, Trip lever, Bolt cap accessory pack, and Tank accessory pack.

ADA	CSA B651	OBC

Codes/Standards
ASME A112.19.2/CSA B45.1
DOE - Energy Policy Act 1992
EPA WaterSense®
ADA
ICC/ANSI A117.1
CSA B651
OBC

KOHLER® One-Year Limited Warranty
See website for detailed warranty information.

Available Color/Finishes
Color tiles intended for reference only.

Color	Code	Description
	0	White
	96	Biscuit
	47	Almond
	NY	Dune
	95	Ice™ Grey
	G9	Sandbar
	7	Black Black™

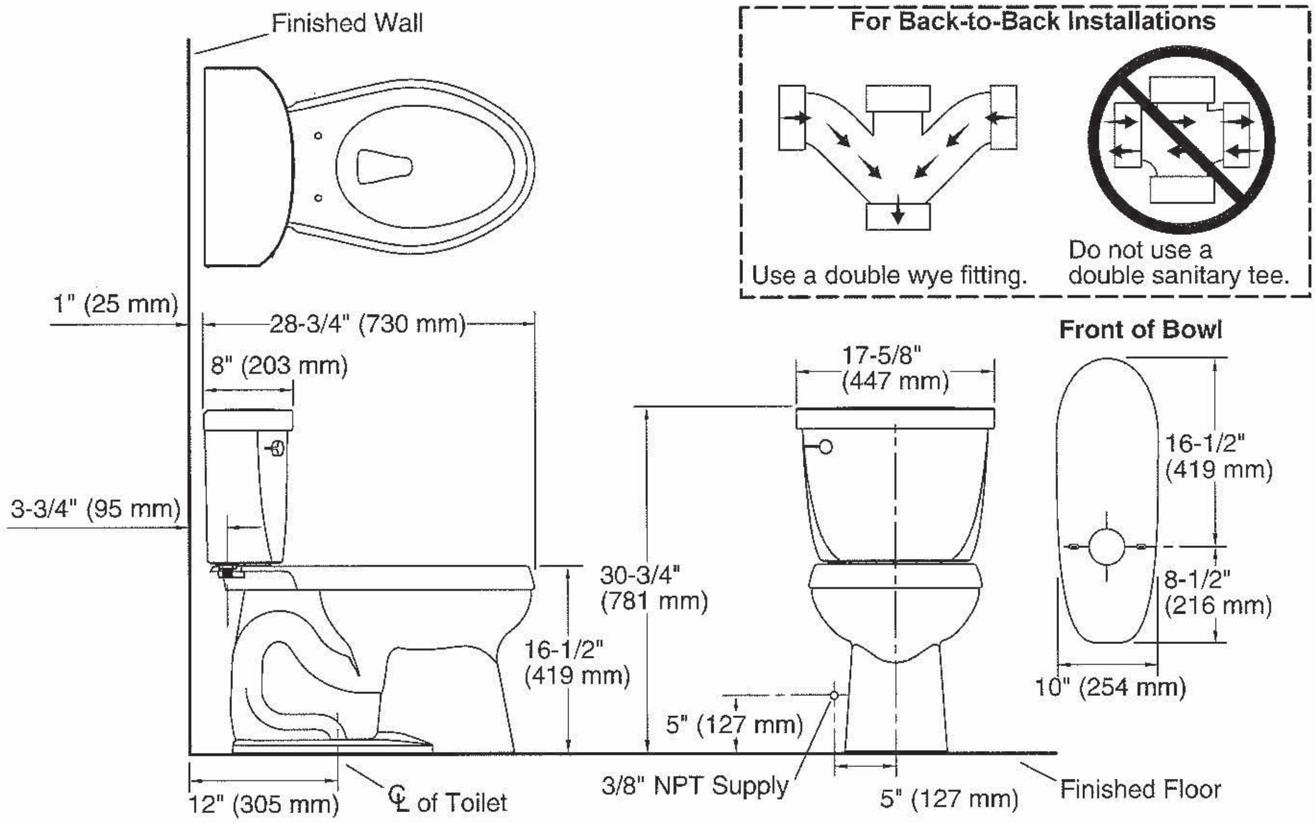
WC-1

KOHLER.

Cimarron®

Comfort Height® Toilet

K-3609



Technical Information

All product dimensions are nominal.

Toilet type:	Two-piece
Bowl shape:	Elongated front
Flush type:	AquaPiston
Trap passageway:	2-1/8" (54 mm)
Water Consumption	
Full:	1.28 gpf (4.8 lpf)
Water surface size:	10-1/2" x 7-7/8" (267 mm x 200 mm)
Rim to water surface:	6-3/8" (162 mm)
Rough-in:	12" (305 mm)
Seat-mounting holes:	5-1/2" (140 mm)

Notes

Install this product according to the installation guide.

For back-to-back toilet installations: Use only a 45° double wye fitting.

ADA, OBC, CSA B651 compliant when installed to the specific requirements of these regulations.

The Model Plumbing Codes require the installation of elongated open-front toilet seats on public bathrooms.

WC-2

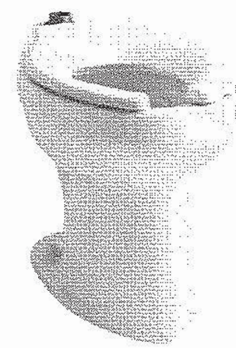
KOHLER®

Highline®
Elongated Toilet Bowl
K-4405

Features
- Vitreous china.
- Elongated bowl.
- 10" (254 mm) or 12" (305 mm) rough-in.
- 1-1/2" top spud.
- 2-1/4" (57 mm) passageway.
- 11" (279 mm) x 9" (229 mm) water area.
- 1.28 gpf (4.8 lpf) or 1.6 gpf (6.0 lpf) depending on flushometer specified.
- 28-1/4" (718 mm) x 14-7/8" (378 mm) x 17-1/8" (435 mm).

Recommended Accessories
4654
K-4654-A Commercial Toilet Seat
K-4670-CA Commercial Toilet Seat
K-4731-C Commercial Heavy-duty Toilet Seat
K-4731-SC Commercial Heavy-duty Toilet Seat
K-10673
K-10956
K-13517

Components
Additional included component/s: Spud, and Bolt cap accessory pack.



ADA | CSA B651

Codes/Standards
ASME A112.19.2/CSA B45.1
DOE - Energy Policy Act 1992
ADA
ICC/ANSI A117.1
CSA B651

KOHLER® One-Year Limited Warranty
See website for detailed warranty information.

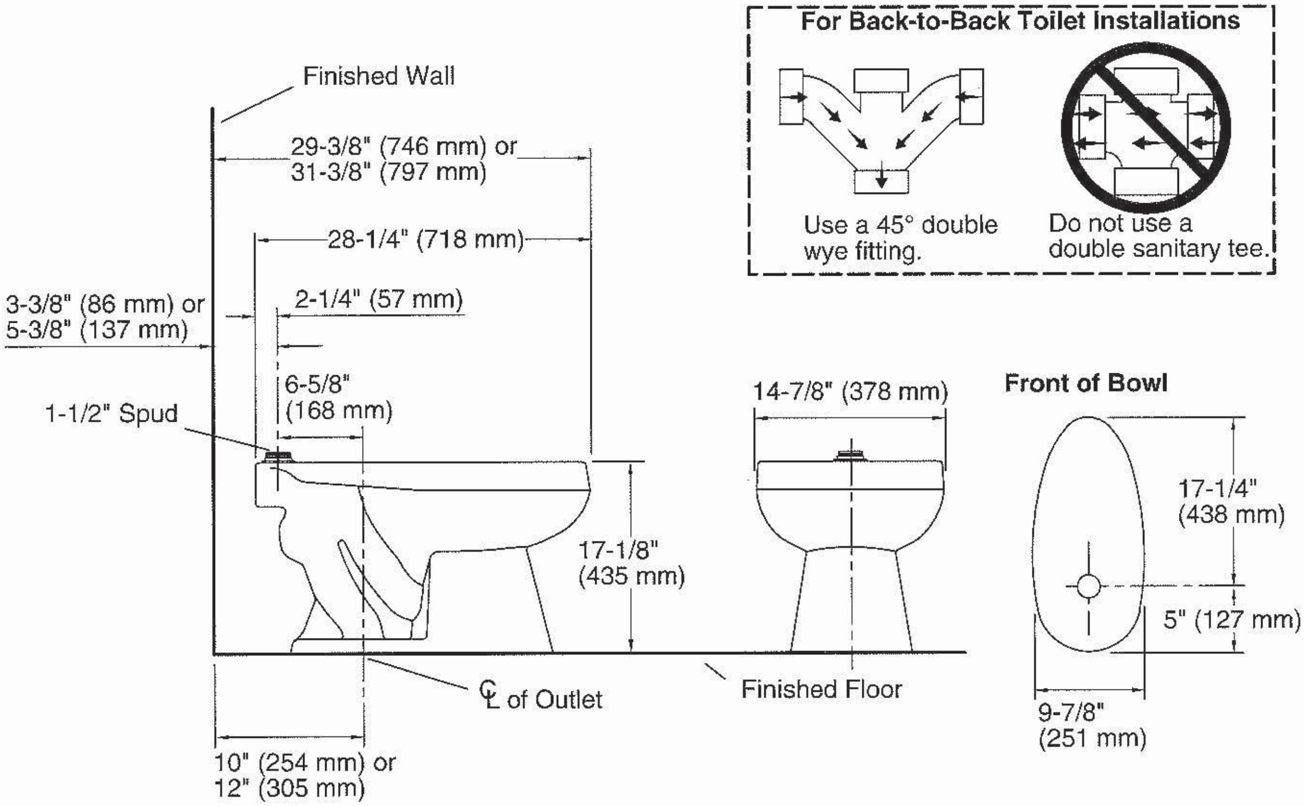
Available Color/Finishes
Color tiles intended for reference only.

Color	Code	Description
	0	White
	96	Biscuit
	47	Almond
	7	Black Black™

WC-2

KOHLER

Highline®
Elongated Toilet Bowl
K-4405



Technical Information
All product dimensions are nominal.

Bowl shape:	Elongated front
Spud size:	1-1/2", Inlet, Top
Trap passageway:	2-1/4" (57 mm)
Water surface size:	11" x 9" (279 mm x 229 mm)
Rim to water surface:	6" (152 mm)
Rough-in:	10" or 12" (254 or 305 mm)
Seat-mounting holes:	5-1/2" (140 mm)

Fixture Supply Requirements

Min static pressure:	35 psi (241.3 kPa)
Max static pressure:	80 psi (551.6 kPa)
Min flowing pressure:	25 psi (172.4 kPa)
Min flow rate:	25 gpm (94.6 lpm)

Notes
Install this product according to the installation guide.

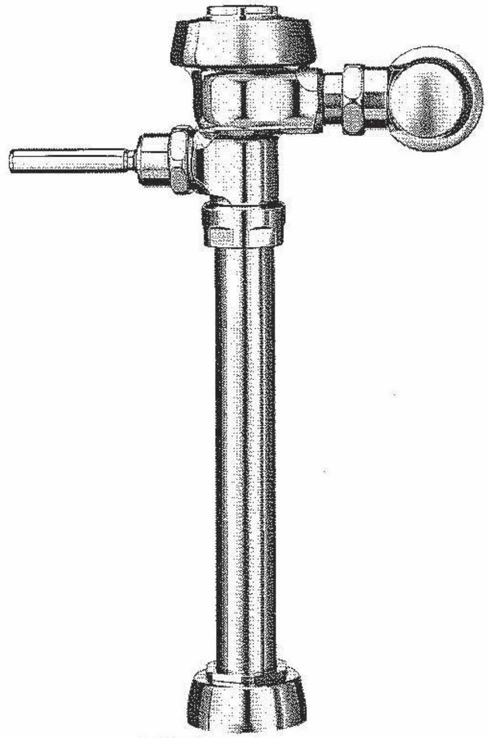
For back-to-back toilet installations: Use only a 45° double wye fitting.

ADA, CSA B651 compliant when installed to the specific requirements of these regulations.

The Model Plumbing Codes require the installation of elongated open-front toilet seats on public bathrooms.

WC-2

HIET
HIGH-EFFICIENCY TOILET



Buy American Act · Compliant

Made with Renewable Energy

EPA GREEN POWER PARTNER

Sloan Valve Company is buying renewable energy certificates to meet 100% of the company's purchased electricity use at its Franklin Park, Illinois facility.

Royal® Model Flushometer

→ 113-1.28
~~115-1.28~~
~~116-1.28~~

Description

Exposed Water Closet Flushometer, for floor mounted or wall hung top spud bowls.

Flush Cycle

- ☐ Model 113-1.28 High Efficiency (1.28 gpf/4.8 Lpf)
- ☐ Model 115-1.28 High Efficiency (1.28 gpf/4.8 Lpf)
- ☐ Model 116-1.28 High Efficiency (1.28 gpf/4.8 Lpf)

Specifications

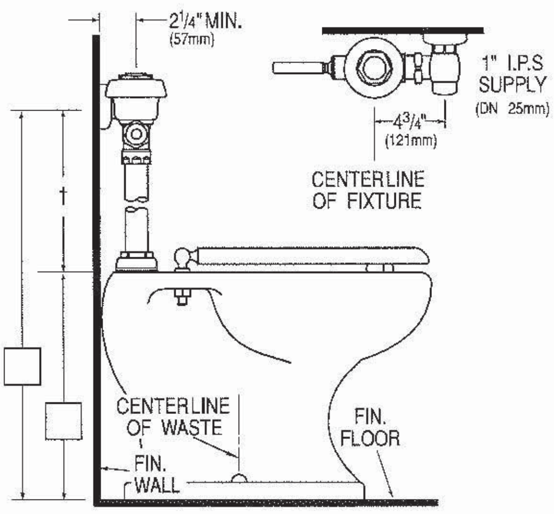
Quiet, Exposed, Diaphragm Type, Chrome Plated Closet Flushometer with the following features:

- PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass
- ADA Compliant Metal Oscillating Non-Hold-Open Handle with Triple Seal Handle Packing
- 1" I.P.S. Screwdriver Bak-Chek™ Angle Stop
- Free Spinning Vandal Resistant Stop Cap
- Adjustable Tailpiece
- High Back Pressure Vacuum Breaker Flush Connection with One-piece Bottom Hex Coupling Nut
- Spud Coupling and Flange for 1½" Top Spud
- Sweat Solder Adapter with Cover Tube and Cast Set Screw Wall Flange
- High Copper, Low Zinc Brass Castings for Dezincification Resistance
- Non-Hold-Open Handle, Fixed Metering Bypass and No External Volume Adjustment to Ensure Water Conservation
- Flush Accuracy Controlled by CID™ Technology
- Diaphragm, Handle Packing, Stop Seat and Vacuum Breaker to be molded from PERMEX™ Rubber Compound for Chloramine Resistance

Valve Body, Cover, Tailpiece and Control Stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance to the applicable sections of ASSE 1037 and ANSI/ASME 112.19.6.

Accessories

See Accessories Section of the Sloan catalog for details on these and other Flushometer variations.



† – 113 - 16" (406 mm)
~~115 - 24" (610 mm)~~
~~116 - 27" (686 mm)~~

This product may contribute to LEED credits. See details on LEED calculation worksheet.

U.S. GREEN BUILDING COUNCIL MEMBER

Made In The USA

This space for Architect/Engineer approval

The information contained in this document is subject to change without notice.

SLOAN

SLOAN VALVE COMPANY • 10500 SEYMOUR AVE. • FRANKLIN PARK, IL. 60131
Ph: 1-800-9-VALVE-9 or 1-847-671-4300 • Fax: 1-800-447-8329 or 1-847-671-4380
http://www.sloanvalve.com

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MECHANICAL FAUCETS

420-E2805ABCP

Manual Faucets

CHICAGO FAUCETS
a Geberit company

LAV-1

Product Type

Deck Mounted 4" Fixed Centers Single Lever Hot and Cold Water Mixing Sink Faucet

Features & Specifications

- 4" Fixed Centers
- 0.5 GPM (1.9 L/min) Vandal Proof Non-Aerating Spray
- Volume Control and Hot Water Limit Stop Cartridge
- 1/2" NPSM Supply Inlets for 3/8" or 1/2" Flexible Riser
- 4 5/8" Center to Center Rigid Cast Brass Spout
- ECAST® design provides durable construction with total lead content equal to or less than 0.25% by weighted average
- CFNow! Item Ships in 5 Days

Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140°F

Warranty

- 5-Year Limited Faucet Warranty
- 5-Year Limited Cartridge Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

- ASME A112.18.1/CSA B125.1
- Certified to NSF/ANSI 61, Section 9 by CSA
- California Health and Safety Code 116875 (AB1953-2006)
- Vermont Bill S.152
- NSF/ANSI 372 Low Lead Content
- ADA ANSI/ICC A117.1
- CALGreen

Job Name ______________________

Item Number ______________________

Section/Tag ______________________

Model Specified ______________________

Architect ______________________

Engineer ______________________

Contractor ______________________

[ ] Submitted as Shown [ ] Submitted with Variations

Date ______________________

ECAST

ECAST products are intended for installation where state laws and local codes mandate lead content levels or in any location where lead content is a concern.

LOW LEAD CONTENT

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F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

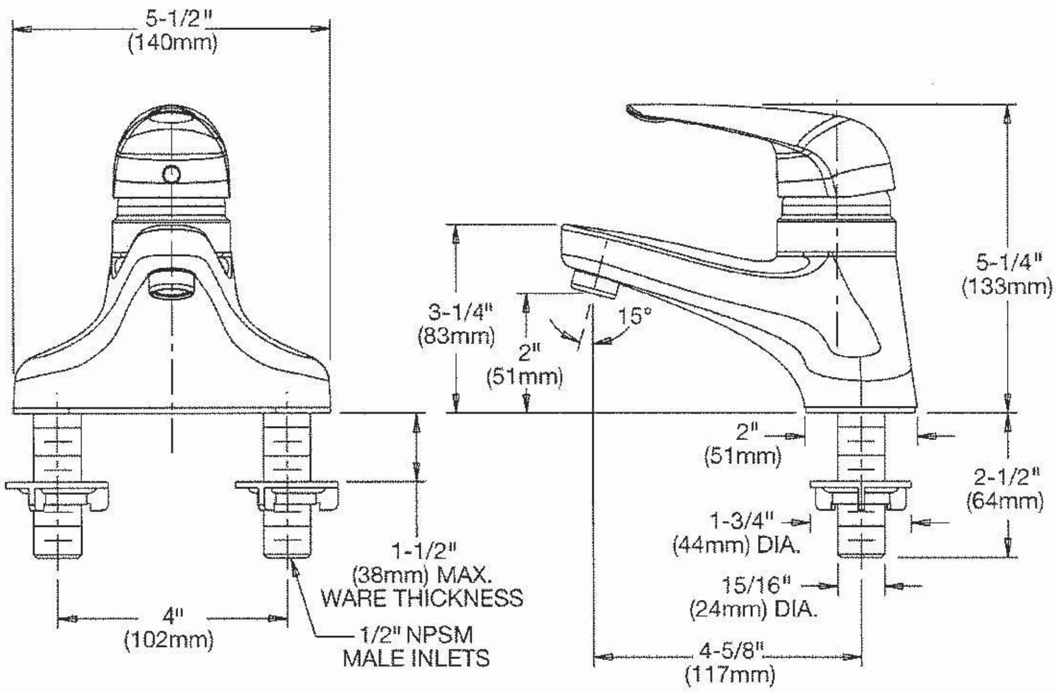
420-E2805ABCP
Manual Faucets

CHICAGO FAUCETS
a Geberit company

LAV-1

Architect/Engineer Specification

Chicago Faucets No. 420-E2805ABCP, Deck Mounted 4" Fixed Centers Single Lever Hot and Cold Water Mixing Sink Faucet, Chrome Plated solid brass construction. 4 5/8" Center to Center Rigid Cast Brass Spout. 0.5 GPM (1.9 L/min) Pressure Compensating Econo-Flo Vandal Proof Non-Aerating Spray. 1/2" NPSM Supply Inlets for 3/8" or 1/2" Flexible Riser. ECAST® construction with less than 0.25% lead content by weighted average. CALGreen Compliant. Secondary Control Valve: 4 5/8" Center to Center Rigid Cast Brass Spout. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, NSF/ANSI 372 Low Lead Content, and California Green Building Standards Code (CALGreen).



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.

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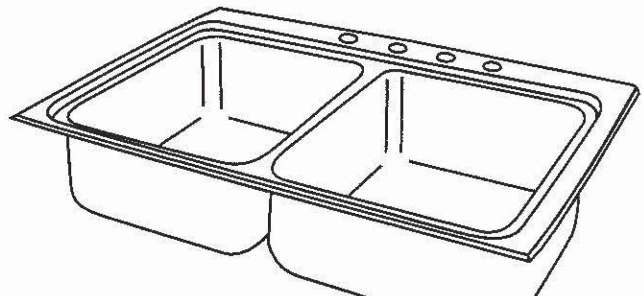
SK-1

ELKAY®
SPECIFICATIONS

Lustertone® Double Bowl Sink
Models LR3322, LRQ3322 and LRAD3322,
LRADQ3322 - A.D.A. Compliant Sinks

GENERAL
Highest quality sink formed of #18 (1.2mm) gauge, type 304 (18-8) nickel bearing stainless steel. Top Mount.

DESIGN FEATURES
LR(Q) Bowl Depth: 8-1/8" (206mm).
LRAD(Q) Bowl Depth: 4" (102mm), 4-1/2" (114mm), 5" (127mm), 5-1/2" (140mm), 6" (152mm), or 6-1/2" (165mm).
Coved Corners: 1-3/4" (44mm) vertical and horizontal radius.
Bowl Recess: 3/8" (10mm) drop ledge with a raised faucet deck.
Finish: Exposed surfaces are hand blended to a lustrous highlighted satin finish.
Underside: LR(Q)3322 is fully protected by Sound Guard® undercoating to dampen sound and prevent condensation. LRAD(Q)3322 is fully undercoated to dampen sound and reduce condensation.



Model LR(Q)33224

OTHER
LR(Q)3322 Drain Openings: 3-1/2" (89mm) and centered in bowls as illustrated.
LRAD(Q)3322 Drain Openings: 3-1/2" (89mm) and located centered left-to-right and off-center front-to-back as illustrated.
NOTE: Unless otherwise specified, sink is furnished with / 3 faucet holes as shown.

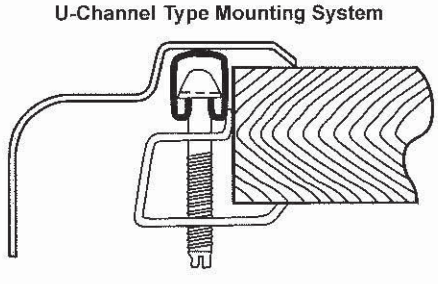
OPTIONAL ACCESSORIES
Rinsing Baskets: LKWRB1316SS or LKWERBSS.
Utensil Caddy for Rinsing Basket: LKWUCSS.
Bottom Grids: LKWBG1316SS for LR(Q)3322, LKWOBG1316SS for LRAD(Q)3322.
Cutting Boards: CB1613, CB1713, CBR1316, or CBS1316.

The LRAD3322 and LRADQ3322 model sinks are compliant to ADA and ANSI/ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards.

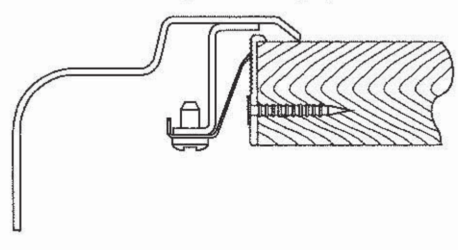
Sink complies with ASME A112.19.3/ CSA B45.4

Sinks are listed by IAPMO® as meeting the applicable requirements of the Uniform Plumbing Code®, International Plumbing Code®, and National Plumbing Code of Canada.

U-Channel Type Mounting System



Quick-Clip® Mounting System



SEE OTHER SIDE FOR PRODUCT DIMENSIONS.

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets.

This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

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SK-1

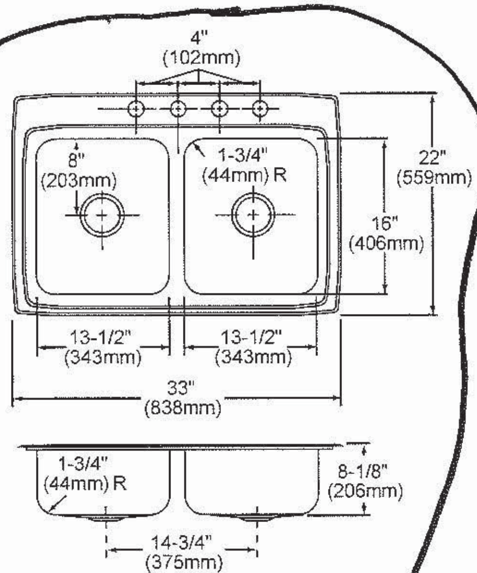
Lustertone® Double Bowl Sink
Models LR3322, LRQ3322 and LRAD3322, LRADQ3322 - A.D.A. Compliant Sinks

ELKAY®
SPECIFICATIONS

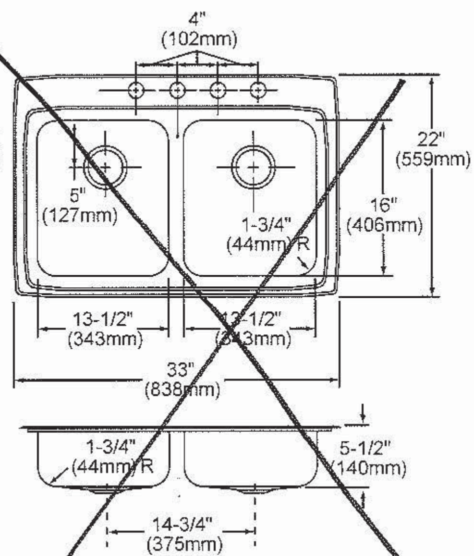
SINK DIMENSIONS*

U-Channel Model Number	Quick-Clip® Model Number	Overall		Inside Bowl			Cutout in Countertop (1 1/2" [38mm] Radius Corners)		No. of 1 1/2" (38mm) Dia. Faucet Holes 4" (102mm) Center	3 1/2" (89mm) Drain" Opening (see above for details)	Minimum Cabinet Size
		L	W	L	W	D	L	W			
LR3322	LRQ3322	33 (838mm)	22 (559mm)	13 1/2 (343mm)	16 (406mm)	8 1/8 (206mm)	32 3/8 (822mm)	21 3/8 (543mm)	1, 2, MR2, 3, 4 or 5	Centered	36 (914mm)
LRAD3322	LRADQ3322	33 (838mm)	22 (559mm)	13 1/2 (343mm)	16 (406mm)	**	32 3/8 (822mm)	21 3/8 (543mm)	1, 2, MR2, 3, 4 or 5	Off-Centered	36 (914mm)

*Length is left to right. Width is front to back.
**Available in 4" (102mm), 4-1/2" (114mm), 5" (127mm), 5-1/2" (140mm), 6" (152mm), and 6-1/2" (165mm) depths. Please consult your sales representative for other depths or modifications.

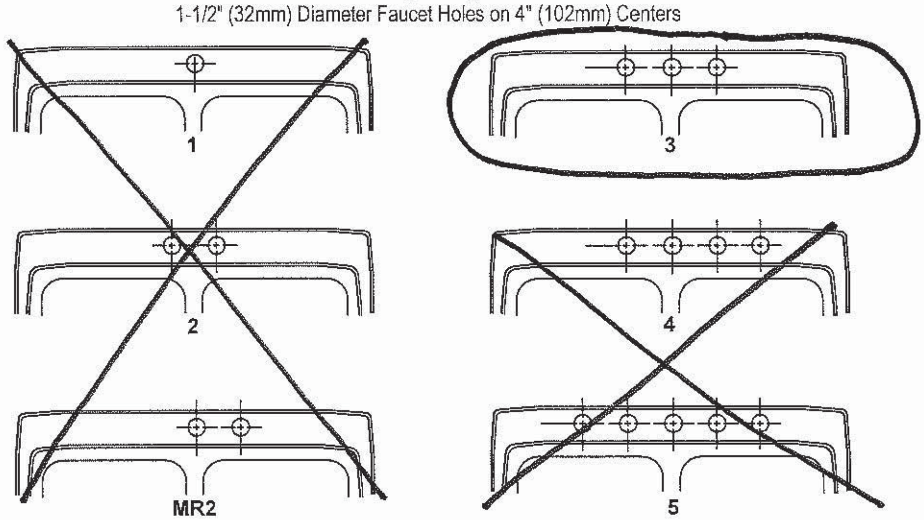


Model LR(Q)33224 Illustrated



Model LRAD(Q)3322554 Illustrated

Hole Drilling Configurations
1-1/2" (32mm) Diameter Faucet Holes on 4" (102mm) Centers



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This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

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MECHANICAL FAUCETS
201-RSL9E35VXKAB
Manual Faucets

CHICAGO FAUCETS
a Geberit company

SK-1

Product Type
Deck Mounted 8" Fixed Centers Concealed Hot and Cold Water Sink Faucet

Features & Specifications
- 8" Fixed Centers
- 9-1/2" Restricted Swing L Type Spout
- 1.5 GPM (5.7 L/min) Vandal Proof Aerator
- 2-3/8" Vandal Proof Lever Handle
- Ceramic 1/4 Turn Operating Cartridge
- ECAST® design provides durable construction with total lead content equal to or less than 0.25% by weighted average

Performance Specification
- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140ºF

Warranty
- Lifetime Limited Faucet Warranty
- 5-Year Limited Cartridge Warranty
- 1-Year Limited Finish Warranty

Codes & Standards
- ASME A112.18.1/CSA B125.1
- Certified to NSF/ANSI 61, Section 9 by CSA
- California Health and Safety Code 116875 (AB1953-2006)
- Vermont Bill S.152
- NSF/ANSI 372 Low Lead Content
- ADA ANSI/ICC A117.1
- CALGreen

Job Name ______________________

Item Number ______________________

Section/Tag ______________________

Model Specified ______________________

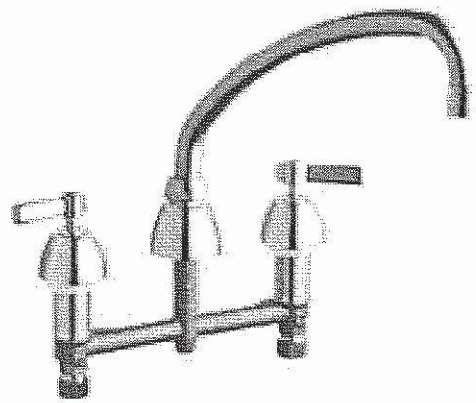
Architect ______________________

Engineer ______________________

Contractor ______________________

[ ] Submitted as Shown [ ] Submitted with Variations

Date ______________________



ECAST

ECAST products are intended for installation where state laws and local codes mandate lead content levels or in any location where lead content is a concern.

C US NSF/ANSI 372 LOW LEAD CONTENT

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201-RSL9E35VXKAB

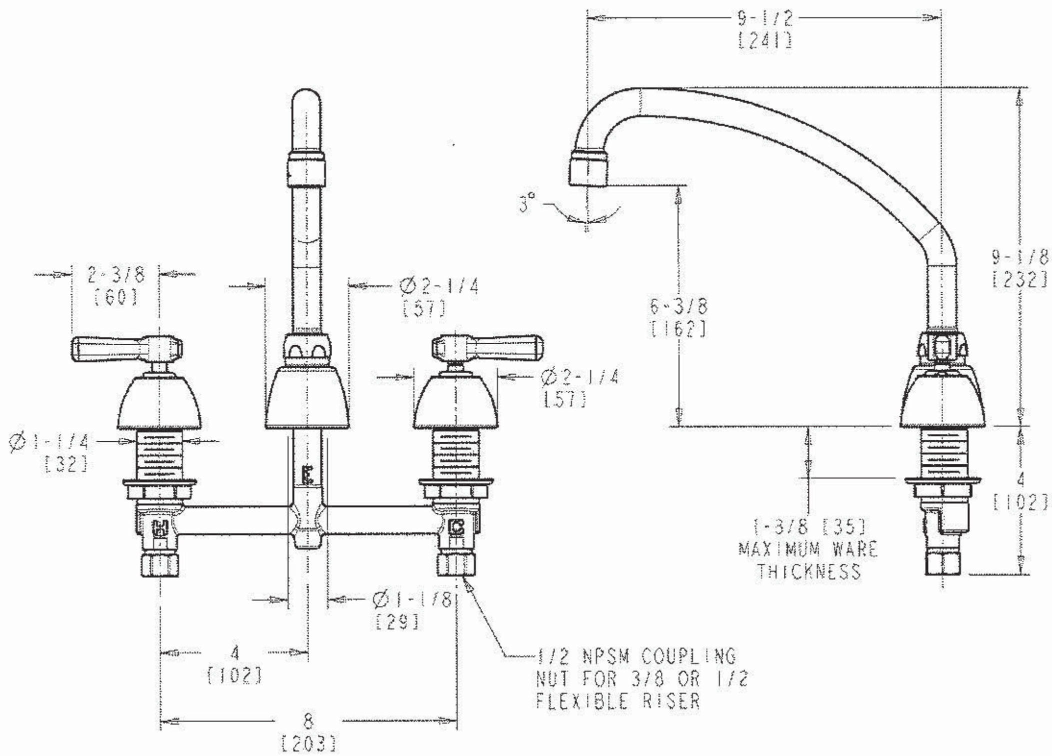
Manual Faucets

CHICAGO FAUCETS
a Geberit company

SK-1

Architect/Engineer Specification

Chicago Faucets No. 201-RSL9E35VXKAB, Deck Mounted 8" Fixed Centers Concealed Hot and Cold Water Sink Faucet, Chrome Plated solid brass construction. 9-1/2" Center to Center Restricted Swing L Type Spout. 1.5 GPM (5.7 L/min) Pressure Compensating Softflo Vandal Proof Aerator. 2-3/8" Metal Vandal Proof Lever handle(s) with Sixteen Point Tapered Broach and Secured Blue and Red Buttons. Ceramic quarter turn cartridge, features square tapered stem. Mounting hardware includedECAST® construction with less than 0.25% lead content by weighted average. CALGreen Compliant. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, NSF/ANSI 372 Low Lead Content, and California Green Building Standards Code (CALGreen).



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

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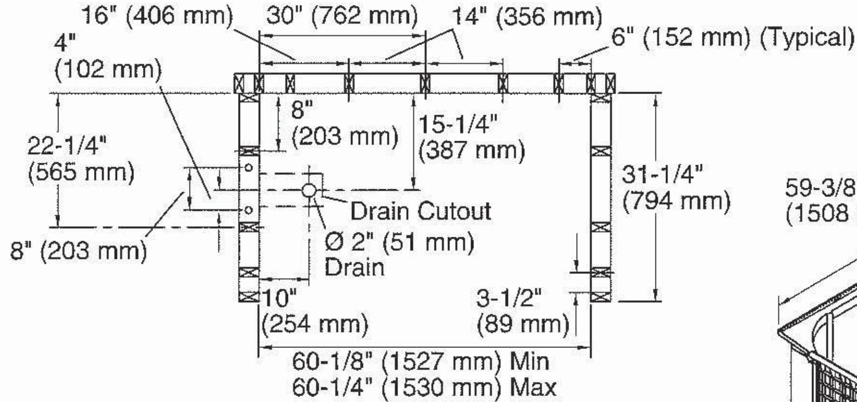
TUB/SH-1

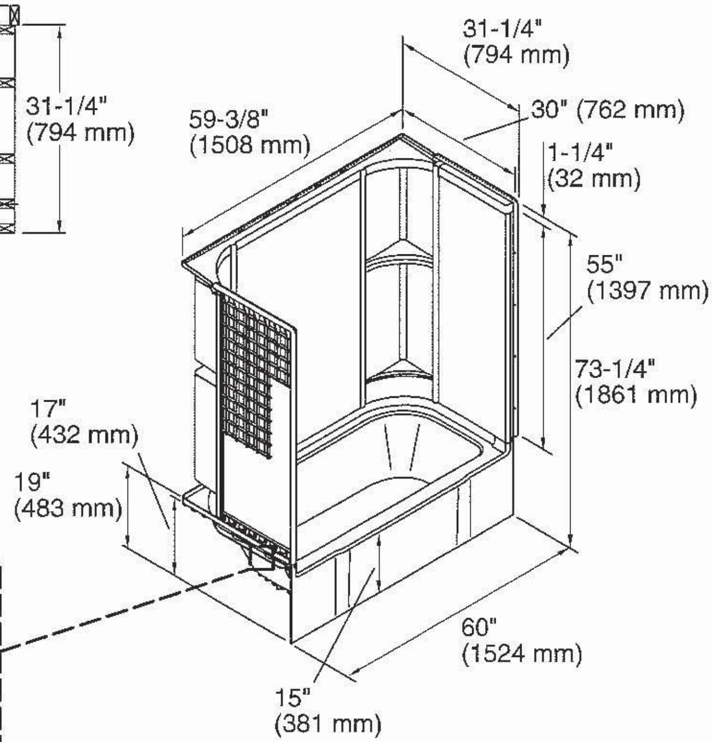
STERLING
A KOHLER COMPANY

Accord®

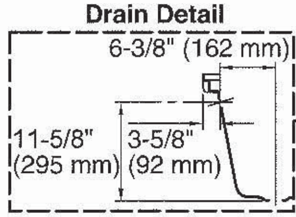
60" x 30" Smooth Bath/Shower

71240110





Drain Detail



Technical Information

All product dimensions are nominal.

Installation:	3-Wall Alcove
Drain location:	Left
Basin area, bottom:	46-1/4" x 20-1/2" (1175 mm x 521 mm)
Basin area, top:	52-1/4" x 22-1/2" (1327 mm x 572 mm)
Water depth:	11" (279 mm)
Water capacity:	34 gal (128.7 L)
Door height required:	56-1/2" (1435 mm)
Door width required:	56-3/4" (1441 mm)

Notes

Install this product according to the installation guide.

Double studding is recommended for pivot shower door installations.

Studs should be positioned roughly as shown.

Measure your actual product for roughing-in details.

Product is designed to be used with a single-handle mixer valve with an escutcheon cover not to exceed 7-3/4" (197 mm) in width.

Bath cannot be installed without the wall surround.

Width of back wall at top transitions from 60" (1524 mm) at the front to 59-3/8" (1508 mm) in the back corners. Furring strips approximately 1/4" (6 mm) thick should be used at the back corner studs if drywall is to be installed over the nailing flange.

TUB / SH-1

STERLING
A KOHLER. COMPANY

Accord®

60" x 30" Smooth Bath/Shower

71240110

Features

- Modular design allows it to be moved around corners and through doorways with ease.
- Durable high gloss finish.
- Smooth walls with integrated shelves for generous storage space.
- 15" (381 mm) bath depth (floor to top of threshold).
- 60" (1524 mm) x 30" (762 mm) x 72" (1829 mm) complete unit finished dimensions.

Material

- Compression molded from our exclusive Vikrell® material.

Installation

- Four-piece modular design with pivot "snap together" installation.
- Caulk-less seam installation.

Components

Product includes:
71244100 Smooth Wall Set
71141110 60" x 30" Bath

Codes/Standards

CSA B45.5/IAPMO Z124
ASTM E162
ASTM E662
Greenguard UL 2818 - Gold
HUD, UM Bulletin 73

STERLING® Warranty - Fixtures Made of Solid Vikrell Material

See website for detailed warranty information.

Available Color/Finishes

Color tiles intended for reference only.

Color	Code	Description
	0	White
	96	Biscuit

TUB / SH-1

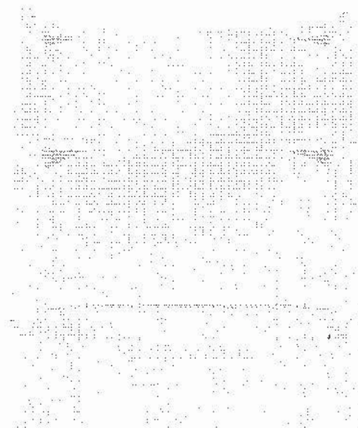
STERLING
A KOHLER COMPANY

Accord®

60" x 30" Smooth Bath/Shower

71240120

MATERIAL STRENGTH. PROVEN PERFORMANCE.



Features

- Modular design allows it to be moved around corners and through doorways with ease.
- Durable high gloss finish.
- Smooth walls with integrated shelves for generous storage space.
- 15" (381 mm) bath depth (floor to top of threshold).
- 60" (1524 mm) x 30" (762 mm) x 72" (1829 mm) complete unit finished dimensions.

Material

- Compression molded from our exclusive Vikrell® material.

Installation

- Four-piece modular design with pivot "snap together" installation.
- Caulk-less seam installation.

Components

Product includes:

71244100 Smooth Wall Set
71141120 60" x 30" Bath

Codes/Standards

CSA B45.11/IAPMO Z401
ASTM E162
ASTM E662
Greenguard UL 2818 - Gold
HUD, UM Bulletin 73

STERLING® Warranty - Fixtures Made of Solid Vikrell Material

See website for detailed warranty information.

Available Color/Finishes

Color tiles intended for reference only.

Color	Code	Description
	0	White
	96	Biscuit

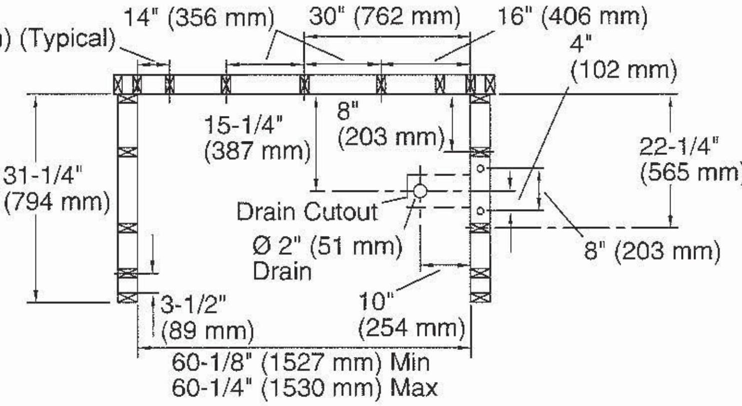
TUB/SH-1

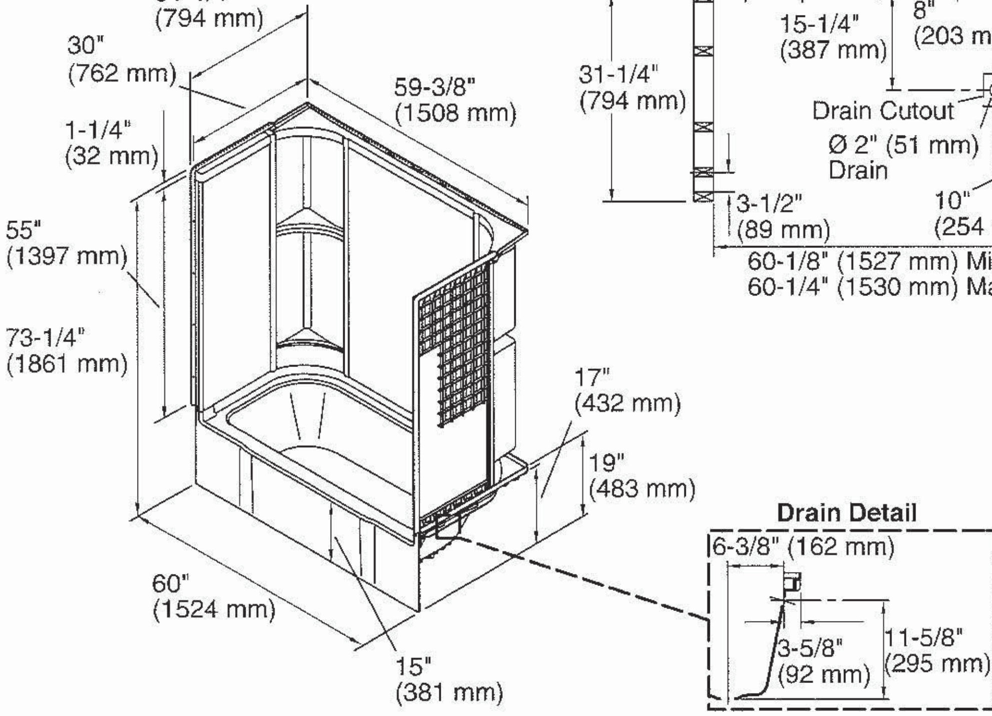
STERLING
A KOHLER. COMPANY

Accord®

60" x 30" Smooth Bath/Shower

71240120





Technical Information

All product dimensions are nominal.

Installation:	3-Wall Alcove
Drain location:	~~Left~~ RIGHT
Basin area, bottom:	46-1/4" x 20-1/2" (1175 mm x 521 mm)
Basin area, top:	52-1/4" x 22-1/2" (1327 mm x 572 mm)
Water depth:	11" (279 mm)
Water capacity:	34 gal (128.7 L)
Door height required:	56-1/2" (1435 mm)
Door width required:	56-3/4" (1441 mm)

Notes

Install this product according to the installation guide.

Double studding is recommended for pivot shower door installations.

Studs should be positioned roughly as shown.

Measure your actual product for roughing-in details.

Product is designed to be used with a single-handle mixer valve with an escutcheon cover not to exceed 7-3/4" (197 mm) in width.

Bath cannot be installed without the wall surround.

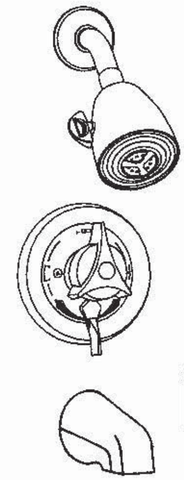
Width of back wall at the top transitions from 60" (1524 mm) at the front to 59-3/8" (1508 mm) in the back corners. Furring strips approximately 1/4" (6 mm) thick should be used at the back corner studs if drywall is to be installed over the nailing flange.

Location: TUB/SH-1

SYMMONS® Temptrol®

Tub-Shower System S-96-2-231

Specification Submittal



Feature Highlights

- Symmons tub-shower system with Symmons Temptrol® pressure balancing mixing valve with adjustable stop screw to limit handle turn.
- Seconday integral diverter and volume control
- Clear-flo showerhead #4-231 single mode with adjustable flood or mist spray
- Showerhead mounting arm and flange
- Flow rate 2.5 gpm (9.5 L/min)
  Optional lower flow rate restrictor available
- Open flow 5-1/4" zinc tub spout, #060
- Polished chrome finish (standard)

Model Numbers

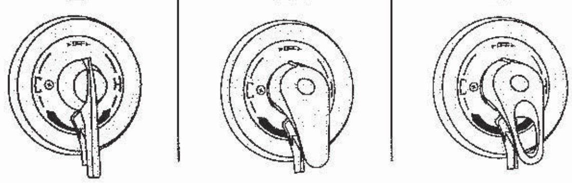
☑ S-96-2-231............Shower System with Symmons Temptrol® pressure balancing mixing valve.

☐ S-96-2-231-TRM...Trim only, valve must be ordered separately

Handle Options / Modifications

Append appropriate -suffix to model number.

-L -LR -LP



☐ -L Single blade style lever handle
☑ -LR lever handle
☐ -LP Loop style lever handle

Warranty

- Limited Lifetime - to the original end purchaser in consumer installations.
- 5 years - for commercial installations

Options / Modifications

Append appropriate -suffix to model number.

☐ -2.0 2.0 (7.6 L/min) flow rate restrictor
☑ -1.5 1.5 (5.7 L/min) flow rate restrictor
☐ -VP Vandal resistant
☐ -B Chrome plated brass escutcheon
☐ -D Chrome plated brass dome cover
☐ -SS Tub spout #061, zinc, slip-on type, 5-1/4"
☐ -LHD Shower head not included
☑ -X Integral Service Stops
Symmons Temptrol® pressure balancing mixing valve includes service stops to allow water shut-off for service,
☐ -CHKS Integral Check Stops.
Temptrol valve includes check stops.
Note: Only available with integral service stop option (-X) *Used in installations where a positive shut-off device is used downstream of mixing valve.*
☐ -IPS 1/2 inch female IPS connections on Symmons Temptrol® mixing valve
☐ -REV Reverse core in valve for back-to-back installations. HOT on the right and COLD on the left

Finish Options / Modifications

Append appropriate -suffix to model number.

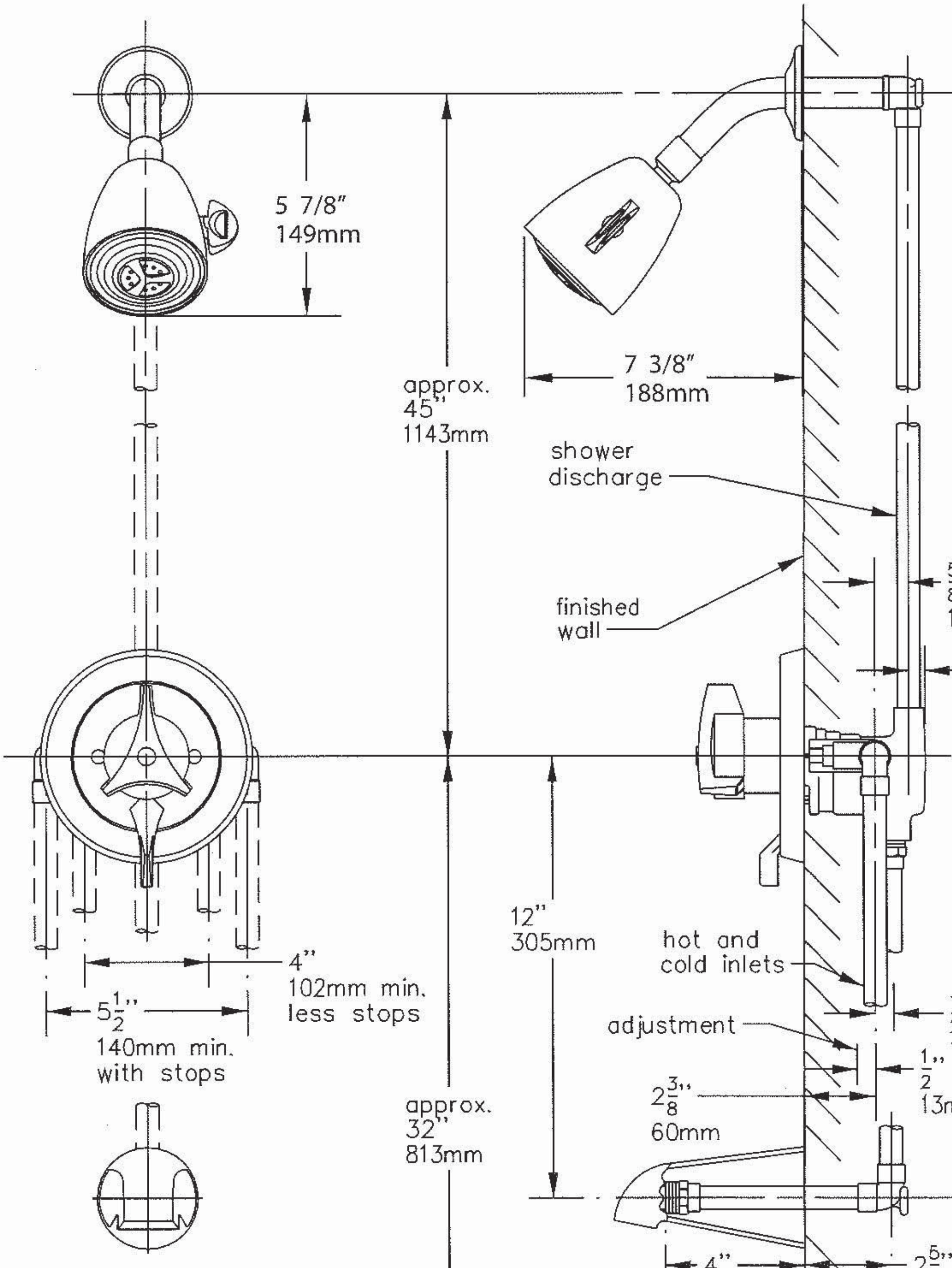
- Polished chrome (standard finish)

Standards / Certifications

ASME A112.18.1-2005/CSA B125.1-05

TUB/SH-1

Dimensions *Temptrol Tub-Shower System, S-96-2-231*



NOTE: Do not substitute other outlet accessories for the tub spout (such as hose and spray, body spray, etc.)

Note: Dimensions subject to change without notice.

Symmons Industries, Inc. ▪ 31 Brooks Drive ▪ Braintree, MA 02184
(800) 796-6667, (781) 848-2250 ▪ Fax (800) 961-9621, (781) 664-1300
Website: www.symmons.com ▪ Email: customerservice@symmons.com

SYMMONS® the smart choice™

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MB-1

FIAT PRODUCTS

TERRAZZO MOP SERVICE BASIN 12" DEPTH CONTINUOUS

TERRAZZO 12" MOP SERVICE BASIN

- One piece, precast terrazzo made of black and white marble chips in gray portland cement to produce a compressive strength not less than 3000 P.S.I. seven days after casting.
- Terrazzo surface shall be ground and polished with all air holes or pits grouted and excess removed.
- Shoulders shall be not less than 12" high outside and 10" inside at lowest wall. Shoulder width not less than 2" on all sides with a 1/4" pitch towards the inside.
- Standard drain body is stainless steel cast integrally and provides for a caulked lead connection not less than 1" deep to a 3" pipe.
- Stainless steel strainer # 1453BB

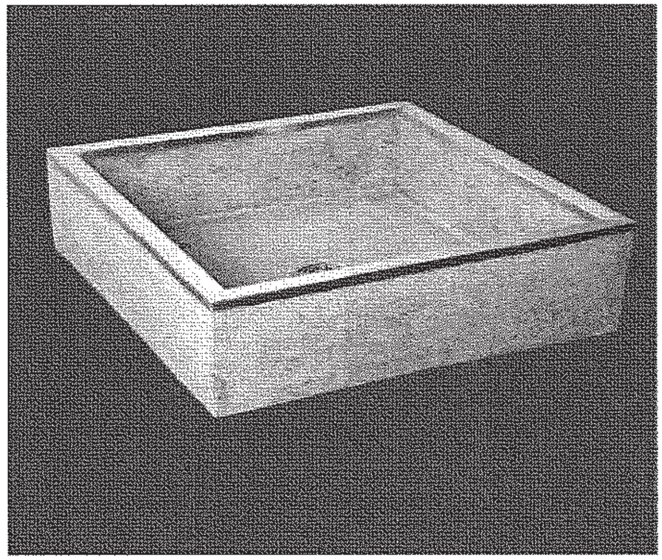
Options

- QDC quick drain connectors
- Integral galvanized tiling flanges available at no additional charge.
- Stainless steel tiling flanges available with up-charge. Must be custom order.
- Chrome plated brass drain or Vandal proof drain. Must be custom order.

- ☒ **TSB100, TSB300, TSB500, TSB700 Series** with stainless steel caps on all curbs
- ☐ **TSB200, TSB400, TSB600, TSB800 Series** with plain curbs
- ☐ **TSBC6000, TSBC6001, TSBC6002 Neo-corner Series** with plain curbs
- ☐ **TSBC6010, TSBC6011, TSBC6012 Neo-corner Series** with stainless steel caps on all curbs

Optional Components:

- ☐ **830AA** Mop Service Basin Fitting
- ☐ **832AA** Hose & Hose Bracket
- ☐ **1239BB** Aluminum Bumperguard with Vinyl Insert
- ☐ **833AA** Silicone Sealant
- ☐ **MSG** Wall Guards - Stainless Steel
  - Wall Guards are manufactured of heavy gauge stainless steel and help protect walls adjacent to Mop Basin. Two panels are required for corner installations. Optional third panel is required for a recessed installation. (MSG2424; MSG2828; MSG3232; MSG3624; MSG3636)



Shown: TSB500

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

NOTES: Terrazzo Mop Basins **must** be installed on a 1/2" layer of mortar in order that the mop basin be level and to prevent cracking. Failure to install terrazzo without a mortar bed will void the warranty. Installations require a 1⁄4" clearance between mop basin and wall.

CERTIFICATIONS:

FIAT
QUALITY FOR LIFE

Customer Service Canada
1-800-387-0369
www.fiat.ca

Customer Service United States
1-800-442-1902
www.fiatproducts.com

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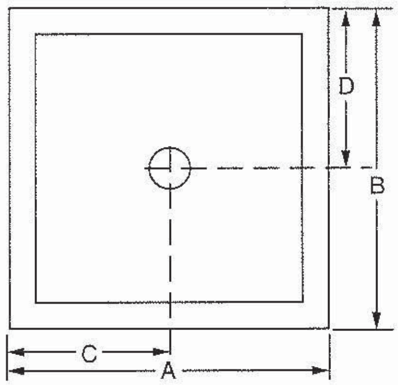
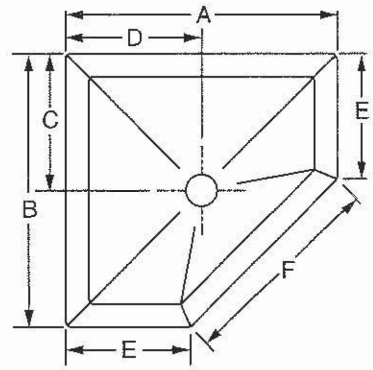
MB-1

FIAT PRODUCTS

TERRAZZO MOP SERVICE BASIN 12" DEPTH CONTINUOUS



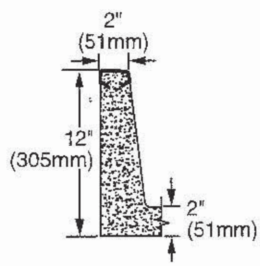


Series TSB100
With Stainless Steel Caps On All Curbs

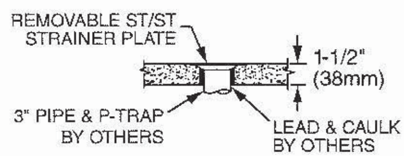
MODEL	SIZE	A	B	C	D
TSB100	24" x 24" x 12"	24	24	12	12
TSB300	32" x 32" x 12"	32	32	16	16
TSB500	36" x 36" x 12"	36	36	18	18
TSB700	36" x 24" x 12"	36	24	18	12

Series TSBC6010
With Stainless Steel Caps On All Curbs

MODEL	SIZE	A	B	C	D	E	F
TSBC6010	24" x 24" x 12"	24	24	12	12	11	18-1/4
TSBC6011	32" x 32" x 12"	32	32	12	12	14	25-3/8
TSBC6012	36" x 36" x 12"	36	36	12	12	18	25-3/8



ST/ST CAP DETAIL



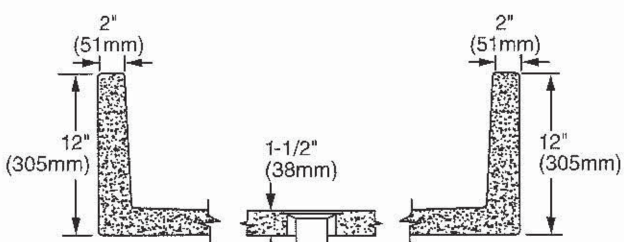
SECTION THRU DRAIN

Series TSB200
With Plain Curbs

MODEL	SIZE	A	B	C	D
TSB200	24" x 24" x 12"	24	24	12	12
TSB400	32" x 32" x 12"	32	32	16	16
TSB600	36" x 36" x 12"	36	36	18	18
TSB800	36" x 24" x 12"	36	24	18	12

Series TSBC6000
With Plain Curbs

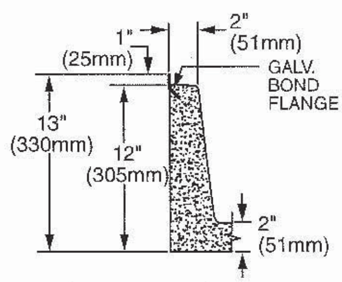
MODEL	SIZE	A	B	C	D	E	F
TSB6000	24" x 24" x 12"	24	24	12	12	11	18-1/4
TSB6001	32" x 32" x 12"	32	32	12	12	14	25-3/8
TSB6002	36" x 36" x 12"	36	36	12	12	18	25-3/8



SECTION THRU THRESHOLD

SECTION THRU DRAIN (LEAD CAULK & 3" PIPE "P" TRAP BY OTHERS)

SECTION THRU SIDES



OPTIONAL GALV. TILING FLANGE

IMPORTANT: Roughing in dimensions may vary 1/2" and are subject to change or cancellation without prior notice.

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www.fiat.ca

Customer Service United States
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Revised 8/12

MECHANICAL FAUCETS

897-CP

CHICAGO FAUCETS
a Geberit company

MB-1

Manual Faucets

Product Type

Wall Mounted 8" Body, Adjustable Arms 7-5/8" - 8-3/8" Hot and Cold Water Sink Faucet

Features & Specifications

- 8" Body, Adjustable Arms 7-5/8" - 8-3/8"
- 2-3/8" Vandal Proof Lever Handle
- Quaturn Compression Operating Cartridge
- 1/2" NPT Adjustable Female Union Nut Supply Arms
- 3/4" Male Hose Thread Outlet
- Integral Stop Valves for Servicing the product
- Atmospheric Vacuum Breaker, Not Intended for Continuous Pressure Applications
- Vacuum Breaker Spout with Pail Hook and Wall Brace
- Atmospheric Vacuum Breaker, Not Intended for Continuous Pressure Applications
- CFNow! Item Ships in 5 Days

Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140ºF

Warranty

- Lifetime Limited Faucet Warranty
- 5-Year Limited Cartridge Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

- ASME A112.18.1/CSA B125.1
- ADA ANSI/ICC A117.1

Job Name ______________________

Item Number ______________________

Section/Tag ______________________

Model Specified ______________________

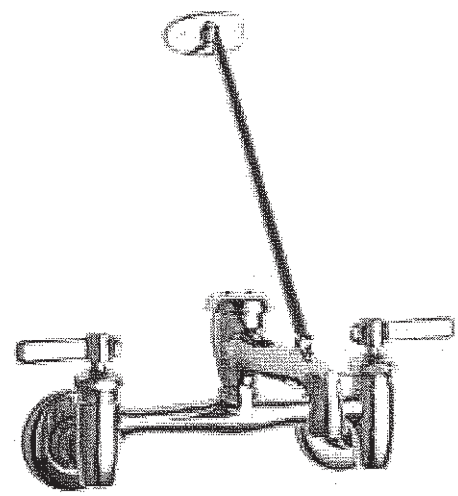
Architect ______________________

Engineer ______________________

Contractor ______________________

[ ] Submitted as Shown [ ] Submitted with Variations

Date ______________________



C US

2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

897-CP

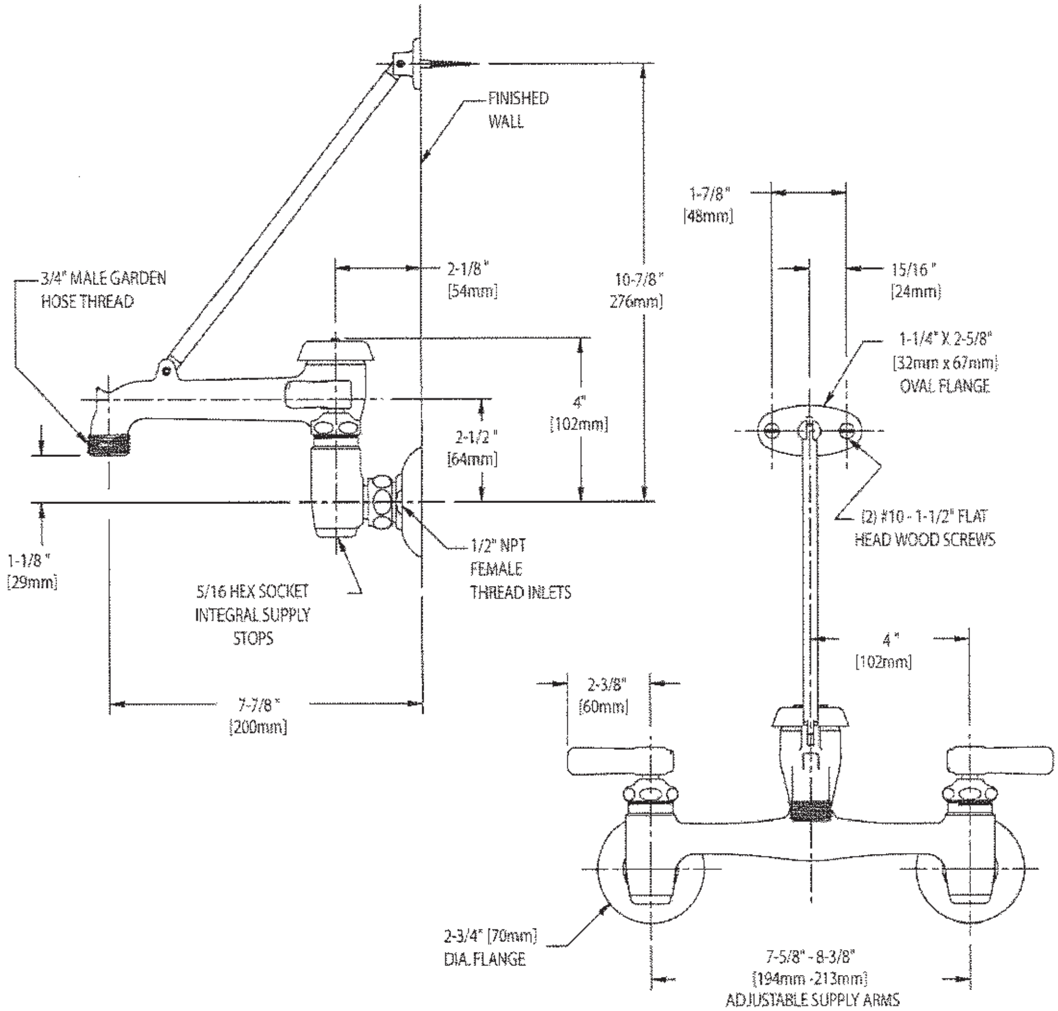
Manual Faucets

CHICAGO FAUCETS
a Geberit company

MB-1

Architect/Engineer Specification

Chicago Faucets No. 897-CP, Wall Mounted 8" Body, Adjustable Arms 7-5/8" - 8-3/8" Hot and Cold Water Sink Faucet, Chrome Plated solid brass construction. Vacuum Breaker Spout with Pail Hook and Wall Brace. 2-3/8" Metal Vandal Proof Lever handle(s) with Sixteen Point Tapered Broach and Secured Blue and Red Buttons. Quaturnï¿½ rebuildable compression cartridge, opens and closes 90ï¿½, closes with water pressure, features square tapered stem. 1/2" NPT Adjustable Female Union Nut Supply Arms. 3/4" Male Hose Thread Outlet. Integral Stop Valves for Servicing the product. Atmospheric Vacuum Breaker, Not Intended for Continuous Pressure Applications. Atmospheric Vacuum Breaker, Not Intended for Continuous Pressure Applications. Secondary Control Valve: Vacuum Breaker Spout with Pail Hook and Wall Brace. .



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.

U.S. GREEN BUILDING COUNCIL MEMBER

2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

EWC-1

ELKAY®
SPECIFICATIONS

Versatile Bi-Level Wall Mounted Water Cooler Filtered, Pushbar Activated Models LZ(S)TL8 and LZSTLDD

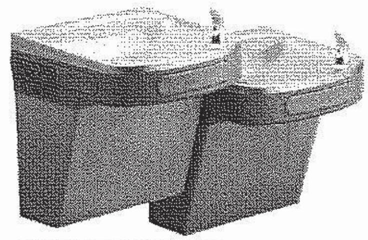
RATED FOR INDOOR USE ONLY

PRODUCT SPECIFICATION

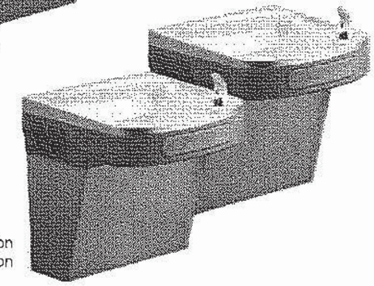
Self-contained wall mount electric two-level water cooler. Refrigerated LZ(S)TL8 models offer a chilling capacity of 8 GPH of 50°F drinking water, based upon 80°F inlet water and 90°F ambient. Models LZSTLDD is non-refrigerated shall deliver non-chilled drinking water. Shall include the WaterSentry® VII 1500-gallon capacity filter, certified to NSF/ANSI 42 and 53. Unit shall meet ADA guidelines. Unit shall be lead-free design which is certified to NSF/ANSI 61 and 372 and meets Federal and State low-lead requirements. Unit shall be certified to UL399 and CAN/CSA 22.2 No. 120.

Models LZSTL have self-closing Easy-Touch pushbar controls on front & sides.
Models LZTL have self-closing Easy-Touch pushbar controls on front only.
Models LZSTLDD are non-refrigerated. Requires outlet for power cord.

NOTE: Minimum 40 psi supply line pressure required in special circumstances where both sides of bi-level are in use simultaneously to ensure adequate stream height.



*Versatile cooler configuration as shipped



*Versatile cooler configuration alternate installation

STANDARD FEATURES

- Easy-Touch pushbar activation
- WaterSentry® VII 1500-gallon capacity Filtration System, certified to NSF/ANSI 42 & 53 (Lead, Class 1 Particulate, Chlorine, Taste & Odor)
- Extra deep basin minimizes splashing; with integral drain
- Available with Flexi-Guard® Safety bubbler or Vandal-resistant' bubbler Vandal-resistant' bubbler ('includes "VR" code in model no.)
- Valve with built-in flow regulator to provide constant stream from 20 to 105 psi water pressure
- *Versatile cooler design allows units to be installed either left-hand high and right-hand low or left-low and right high
- Cooler panel finishes: Light Gray Granite Vinyl Clad Steel or Stainless Steel
- Rated for Indoor Use

COOLING SYSTEM (Models LZ(S)TL(VR)8 only)

- Compressor: Hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication.
- Condenser: Fan cooled, copper tube with aluminum fins. Fan motor is permanently lubricated.
- Cooling Unit: Tube type. Self-cleansing. Continuous Copper tubing which is fully insulated with EPS foam that meets UL requirements for self-extinguishing material.
- Refrigerant Control: Refrigerant R134a is controlled by accurately calibrated capillary tube.
- Temperature Control: Easily accessible enclosed adjustable thermostat is factory preset. Requires no adjustment other than for altitude requirements.

CONSTRUCTION

- Stainless Steel basin with integral drain
- Galvanized structural steel cooler chassis provides structural integrity
- Cooler cabinet available as ~~Light Gray Granite Vinyl Clad Steel or~~ Stainless Steel (additional cost) construction
- Exclusive Flexi-Guard® Safety bubbler (option) utilizes an infused anti-microbial pliable polyester elastomer to prevent accidental mouth injuries. Flexes on impact.
- Vandal-resistant' bubbler (option) is one-piece heavy duty

REPLACEMENT FILTER:

- 51299C (single)

Warranty: 5 year limited warranty on the unit's refrigeration system. Electrical components and water system are warranted for 12 months from date of installation or 18 months from factory shipment, whichever date falls first.

CAPACITIES CHART						c UL us		C USA	
Model	Voltage / Hertz	Chilling** Capacity	F.L. Amps	Rated Watts	Approx. Ship Wt.	UL399 and CAN/CSA 22.2 No. 120 Certified	ADA Compliant	ANSI/NSF 61 and 372 Certified	ANSI/NSF 42 and 53 Certified (Filter only)
LZ(S)TL(VR)8*C	115V / 60Hz	8 GPH	4.0	370	75 lbs	•	•	•	•
LZ(S)TL(VR)8*2JOC	220V / 50Hz	6.7 GPH	2.5	370	75 lbs	++	•	•	•
LZ(S)TL(VR)8*3JOC	220V / 60Hz	8 GPH	2.5	370	75 lbs	++	•	•	•
LZSTL(VR)DD*C	115V / 60Hz	–	1.0	15	49 lbs	•	•	•	•

*Color code of (L) Light Gray Granite or (S) Stainless Steel cooler panels.
**Based on 80°F inlet water & 90°F ambient air temp for 50°F chilled drinking water.
++Complies; not third party certified.

This specification describes an Elkay product with design, quality and functional benefits to the user. When making a comparison of other producer's offerings, be certain these features are not overlooked.

EWC-1

Versatile Bi-Level Wall Mounted Water Cooler Filtered, Pushbar Activated Models LZ(S)TL8 and LZSTLDD

ELKAY®

ROUGH-IN DIMENSIONS

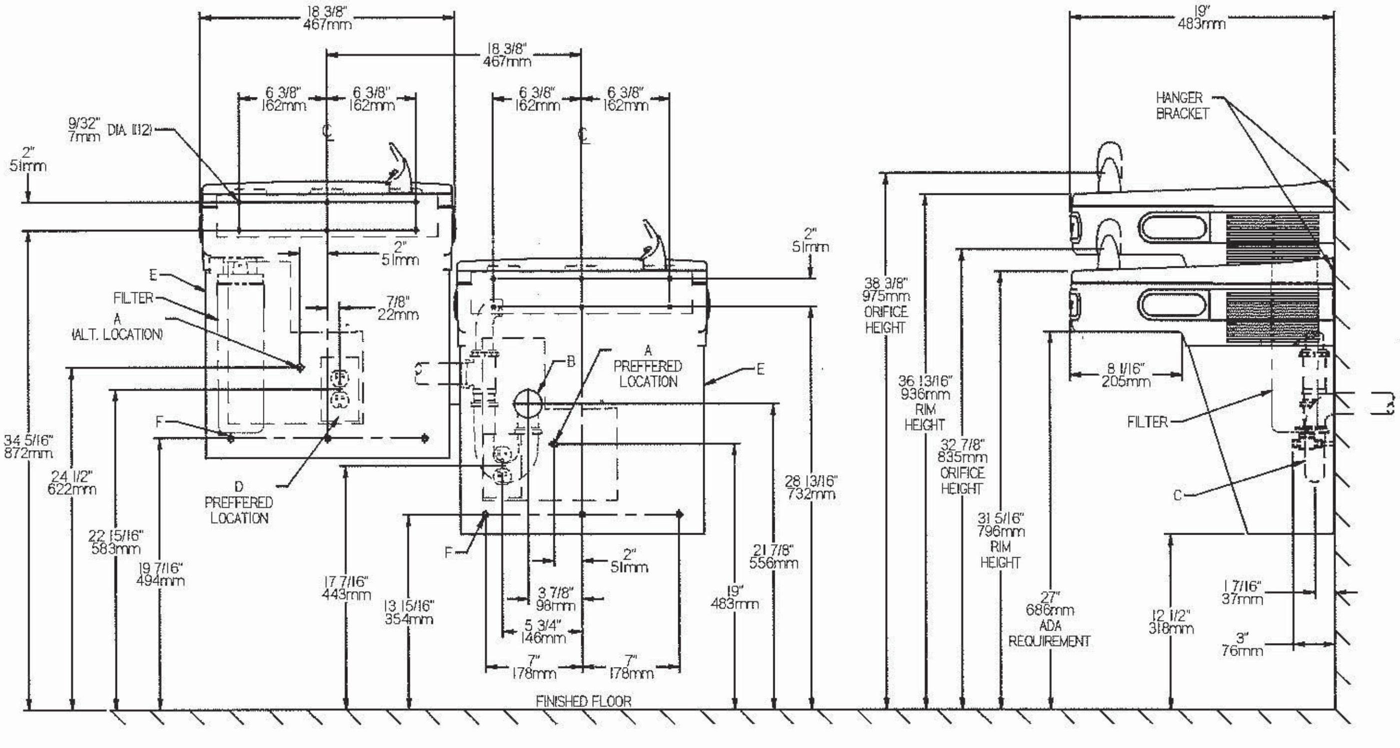
RATED FOR INDOOR USE ONLY

IMPORTANT! INSTALLER PLEASE NOTE:
These units are designed and built to provide water to the user which has not been altered by materials in the cooler waterway. The grounding of electrical equipment such as telephone, computers, etc. to water lines is a common procedure. This grounding may be in the building but may also occur away from the building. This grounding can cause electrical feedback into a water cooler creating an electrolysis which results in a metallic taste or an increase in the metal content of the water. This condition is avoidable by installing the cooler using the proper materials as shown.

NOTICE
This water cooler must be connected to the water supply using a dielectric coupling. The cooler is furnished with a non-metallic strainer which meets this requirement. The drain trap which is provided by the installer should also be plastic to completely isolate the cooler from the building plumbing system.

Model shown with Flexi-Guard® bubbler.

ROUGH-IN FOR LEFT-HAND HIGH SIDE MODELS



REDUCE HEIGHT BY 3 INCHES FOR INSTALLATION OF CHILDRENS ADA COOLER

LEGEND:
A = Recommended Water Supply location. Shut-off Valve (not furnished) to accept 3/8" O.D. unplated copper tube. Up to 3" (76mm) maximum out from wall.
B = Recommended Waste Outlet location. To accommodate 1-1/2" nominal drain. Drain stub 2" (51mm) out from wall.
C = 1-1/2" Trap (not furnished).
D = Electrical Supply (3) Wire Recessed Box Duplex Outlet.
E = Insure proper ventilation by maintaining 6" (152mm) minimum clearance from cabinet louvers to wall.
F = 7/16" (11mm) Bolt Holes for fastening to wall.
NOTE: New Installations Must Use Ground Fault Circuit Interrupter (GFCI)

Job Name: ____________________
Model: ____________________ Qty. __________
Contact: ____________________
Approval Signature: ____________________
Notes:

2222 Camden Court
Oak Brook, IL 60523
630-572-3192
elkay.com

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EWC-1

Versatile Bi-Level Wall Mounted Water Cooler Filtered, Pushbar Activated Models LZ(S)TL8 and LZSTLDD

ELKAY®

ROUGH-IN DIMENSIONS

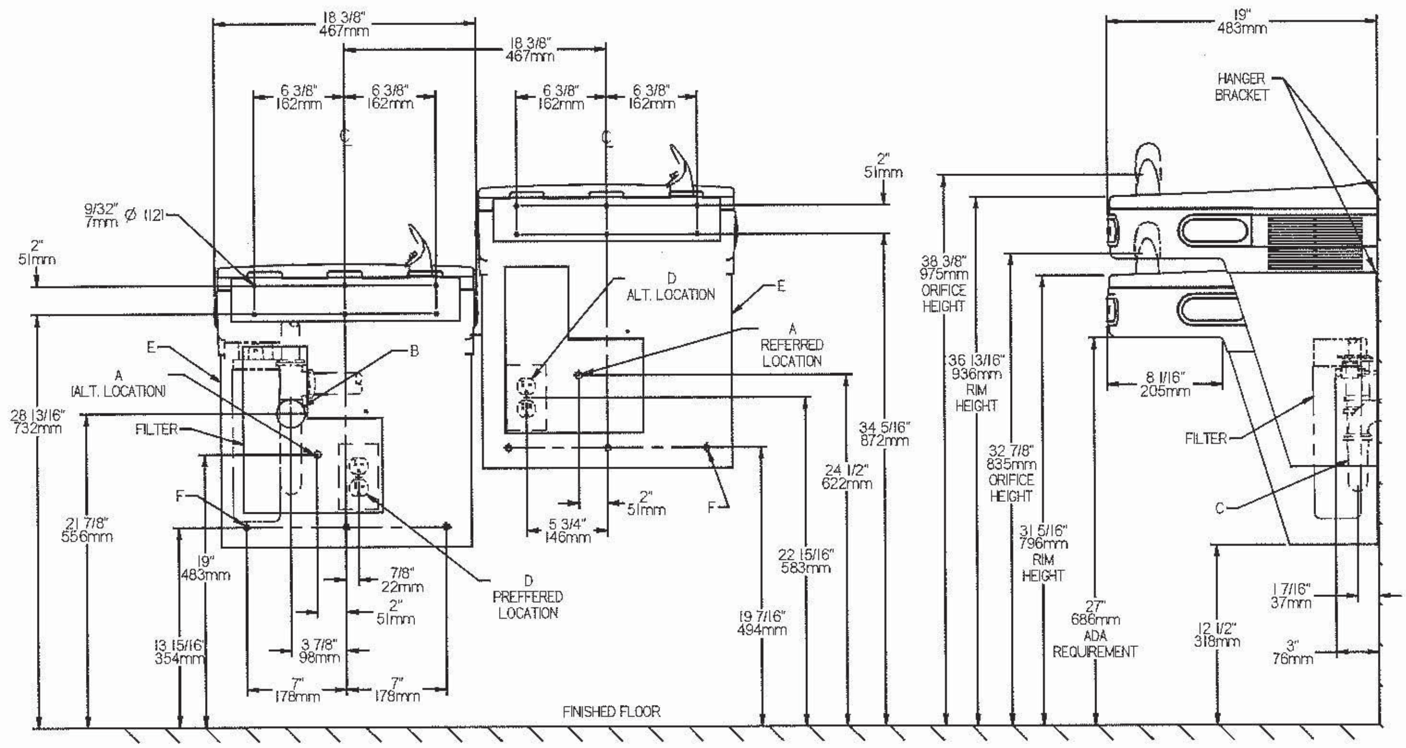
RATED FOR INDOOR USE ONLY

IMPORTANT! INSTALLER PLEASE NOTE:
These units are designed and built to provide water to the user which has not been altered by materials in the cooler waterway. The grounding of electrical equipment such as telephone, computers, etc. to water lines is a common procedure. This grounding may be in the building but may also occur away from the building. This grounding can cause electrical feedback into a water cooler creating an electrolysis which results in a metallic taste or an increase in the metal content of the water. This condition is avoidable by installing the cooler using the proper materials as shown.

NOTICE
This water cooler must be connected to the water supply using a dielectric coupling. The cooler is furnished with a non-metallic strainer which meets this requirement. The drain trap which is provided by the installer should also be plastic to completely isolate the cooler from the building plumbing system.

Model shown with Flexi-Guard® bubbler.

ROUGH-IN FOR RIGHT-HAND HIGH SIDE MODELS



REDUCE HEIGHT BY 3 INCHES FOR INSTALLATION OF CHILDRENS ADA COOLER

LEGEND:
A = Recommended Water Supply location. Shut-off Valve (not furnished) to accept 3/8" O.D. unplated copper tube. Up to 3" (76mm) maximum out from wall.
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NOTE: New Installations Must Use Ground Fault Circuit Interrupter (GFCI)

Job Name: ____________
Model: ____________ Qty. ______
Contact:
Approval Signature: ____________
Notes:

2222 Camden Court
Oak Brook, IL 60523
630-572-3192
elkay.com

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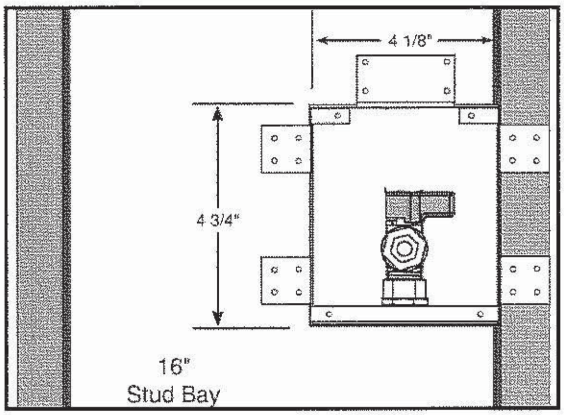
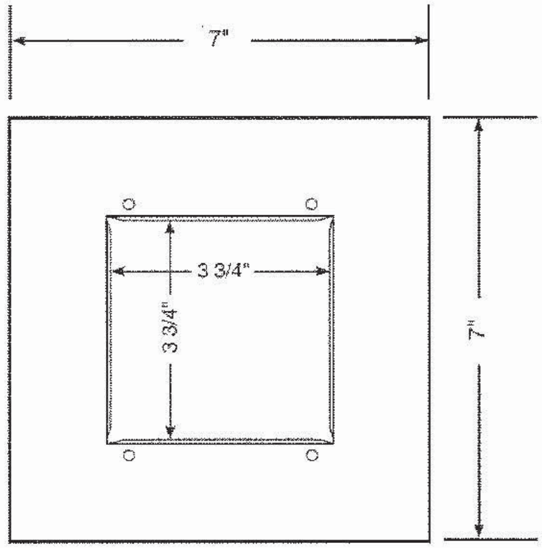
SPECIFICATION SUBMITTAL SHEET CBOX

GUY GRAY™
IPS CORPORATION





SPECIFICATION

Furnish and install recessed, white powder coated ice maker outlet box. Ice maker outlet box shall have a brass plated, quarter turn valve which complies with lead-free laws and ASME A112.18.1. shall feature either Mylar® tag and AB1953 stamping or white handle and check-mark logo for easy Lead-Free identification. Unit shall be Guy Gray™ product code checked below as manufactured by IPS Corporation.

	Product Code #	Model Number	Product Description	Units/ Case
X	88133	MIB1AB	Brass Qtr Turn Valve, Installed, 1/2" Sweat Conx.	5
	88532	MIB2AB	Brass Qtr Turn Valve, Installed, 1/2" CPVC Conx.	5
	88178	MIB3AB	Brass Qtr Turn Valve, Installed, 1/2" PEX Conx.	5
	88534	MIB4AB	Brass Qtr Turn Valve, Installed, 1/2" Sweat Conx. Contractor Pack	10
	88535	MIB5AB	Brass Qtr Turn Valve, Installed, 1/2" Wirsbo Conx.	5

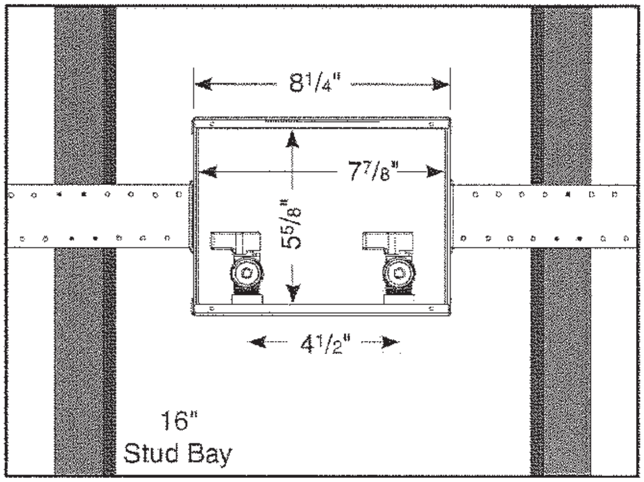
IPS® CORPORATION www.ipscorp.com watertite@ipscorp.com
500 Distribution Parkway, Collierville, TN 38017, USA ■ TEL: 901-853-5001 ■ WATS: 800-888-8312 ■ FAX: 901-853-5008

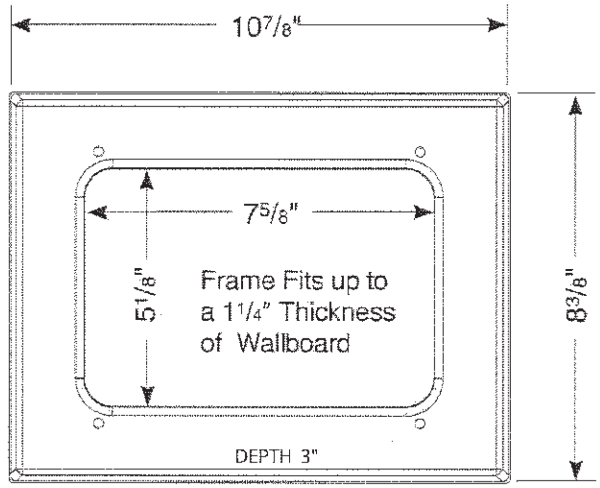
WMBOX

SPECIFICATION SUBMITTAL SHEET

GUY GRAY
IPS CORPORATION

CENTER DRAIN WHITE WHITE POWDER COATED METAL WMOB with Quarter Turn Valves





Specifications:

Furnish and install center drain white powder coated metal washing machine outlet box. Unit shall be Guy Gray product code as manufactured by IPS Corporation.

Box Material:

White Powder Coat on Cold Rolled Steel
20 gauge box with 20 gauge faceplate

Valve & Drain Option:

Qtr. Turn Valve with 1/2" Sweat/MIP, PEX, Wirsbo, or CPVC connection. 2" slipnut drain kit included. Valves comply with ASME A112.18.1.

	Item #	Product Description	Model #	Quantity
	82118	Center Drain Qtr Turn Valves*, 1/2" Sweat Conx., Unassembled	MWB-9	5
	82119	Center Drain Qtr Turn Valves*, 1/2" Sweat Conx., Cont. Pack, Unassembled	MWB-10	5
	82120	Center Drain Qtr Turn Valves*, 1/2" CPVC Conx., Unassembled	MWB-11	5
	82121	Center Drain Qtr Turn Valves*, 1/2" CPVC Conx., Cont. Pack, Unassembled	MWB-12	5
	82122	Center Drain Qtr Turn Valves* Installed, 1/2" Sweat Conx.	MWB-13	5
	82123	Center Drain Qtr Turn Valves* Installed, 1/2" Sweat Conx., Cont. Pack	MWB-14	5
	82146	Center Drain Qtr Turn Valves* Installed, 1/2" PEX Conx.	MWB-15	5
	82154	Qtr Turn Hammer Arrester Valves Installed, 1/2" Sweat Conx.	MWB-19	5
	82161	1/2" Qtr Turn Sweat Valve TM Installed, 2" Slipnut Drain Kit	MWB21	5
X	86162	1/2" Qtr Turn Sweat Valve TM Installed, Arrester, 2" Slipnut Drain Kit	MWB26	5
	82162	1/2" Qtr Turn Wirsbo@ Top Mount Installed, 2" Slipnut Drain Kit	MWB22	5
	86163	1/2" Qtr Turn CPVC Valve TM Installed, Arrester, 2" Slipnut Drain Kit	MWB27	5
	86164	1/2" Qtr Turn PEX Valve, Arrester Installed, 2" Slipnut Drain Kit	MWB28	5

IPS® CORPORATION

500 Distribution Parkway, Collierville, TN 38017, USA ■ TEL: 800-888-8321 ■ Fax: 901-853-8312 ■ www.ipscorp.com

GWH-1 & 2

A.O. Smith | Commercial Gas Water Heaters

CYCLONE® Mxi MODULATING

MODULATING BURNER ADVANCES THE CYCLONE TO HIGHER LEVELS OF EFFICIENCY

The full line of A. O. Smith Cyclone Mxi condensing water heaters has been designed to provide years of dependable service and feature industry leading technology. Models are available from 120,000 to 500,000 Btu/h and all deliver thermal efficiencies of 95% and higher. The unique helical coil heat exchanger limits weld joints for optimal service life while maximizing heat transfer.

Cyclone is the industry leader in high efficiency commercial water heating with over a quarter million Cyclones sold since 1996. The current Mxi modulating models adjust firing rate to the specific demand further increasing efficiency and money savings.

INTELLIGENT CONTROL SYSTEM WITH LCD DISPLAY

- Exclusive A. O. Smith designed control system
- Provides detailed water heater status information
- Precise temperature control adjustable from 90 to 180 degrees
- Built-in diagnostics
- Run history information
- Cyclone water heaters are compatible with the iCOMM™ remote monitoring system. Call 1.888.928.3702 for more information.

SUBMERGED COMBUSTION CHAMBER, WITH HELICAL HEAT EXCHANGER COIL

- Positioned in the center of the tank, surrounded by water to virtually eliminate radiant heat loss from chamber
- Direct spark ignition
- Spiral heat exchanger keeps hot burner gases swirling, uses centrifugal force to maximize efficiency of heat transfer to water in tank
- Spiral heat exchanger reduces lime scale from forming on water-side surfaces, which maintains energy efficiency over time

POWERED ANODES STANDARD ON ALL MODELS

- Provides long-lasting tank protection in varying water conditions
- Powered anodes are non-sacrificial
- Automatically adjusts output needed to properly protect the tank

PERMAGLAS® ULTRA COAT™ GLASS LINING

- Glass coating is applied using a liquid slush coating technique to ensure uniform coating
- Heat exchanger coil is glassed both externally and internally for optimum protection

MECHANICAL VENTING VERSATILITY

- Conventional power venting or direct venting
- Vents vertically or through a sidewall
- Front located exhaust and condensate connections allow for easy install and access
- Vents with low cost PVC Schedule 40 intake and exhaust pipe. Approved for optional CPVC Schedule 40, Polypropylene and AL29-4C stainless steel vent materials
- Direct-vent intake and exhaust pipe can terminate separately outside building or through single opening, using concentric vent assembly
- Canadian installations require ULC S636 PVC/CPVC, ULC S636 Polypropylene and AL29-4C stainless steel pipe for intake and exhaust

HIGH EFFICIENCY MODULATING PRE-MIX POWERED BURNER

- Down-fired pre-mix burner provides optimum efficiency and quiet operation
- Top-mounted burner position prevents condensation from affecting burner operation

SPACE-SAVING DESIGN FOR INSTALLATION FLEXIBILITY

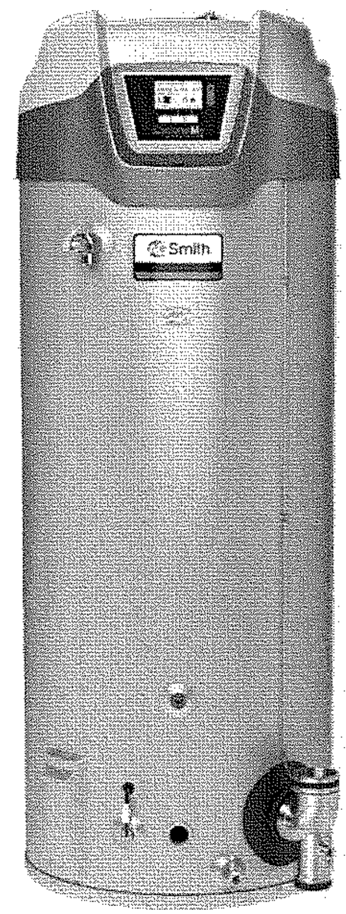
- Easy-to-remove top cover for convenient access to serviceable parts
- 0" installation clearances on sides and rear, 1-1/2" installation clearance on top
- Handhole cleanout allows easy access to tank interior for cleaning
- 0" clearance to combustibles, approved for installation on combustible floors

CODES AND STANDARDS

- CSA certified and ASME rated T&P relief valve
- Maximum hydrostatic working pressure: 160 PSI
- All models are design certified by Underwriters Laboratories (UL), Inc., to ANSI Z21.10.3 - CSA 4.3 Standards
- Meets the thermal efficiency and standby loss requirements of the U.S. Department of Energy and current edition ASHRAE/IESNA 90.1
- Design-certified by Underwriters Laboratories to NSF standard 5 for 180°F (62°C) water
- Complies with SCAQMD Rule 1146.2 and other Air Quality Management Districts with similar requirements for low-NOx emissions
- ASME tank construction optional on 120-500 model sizes

3-YEAR LIMITED TANK / 1-YEAR LIMITED PARTS WARRANTY

- For complete warranty information, consult written warranty or contact A. O. Smith.



Low Lead Content · ENERGY STAR · CERTIFIED UL WATER QUALITY · ASME HLW · GAS-FIRED c UL us LISTED · iCOMM · AHRI CERTIFIED · ASME (Optional)

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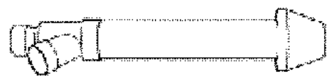
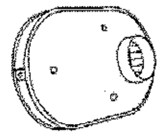
GWH-1&2

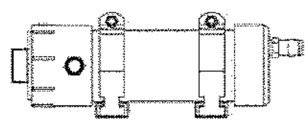
A.O. Smith® | Commercial Gas Water Heaters

OPTIONAL KITS

- Optional Concentric Vent Kits
  - BTH-120 - 250 vent kit p/n 9006328005
  - BTH-300 - 500 vent kit p/n 9008841005
- Optional Low Profile Termination Vent Kits
  - 3" Flush Mount Vent Kit p/n 9008933005
  - 4" Flush Mount Vent Kit p/n 9008934005
  - 6" Flush Mount Kit p/n 9008935005
- Optional Condensate Neutralization Kits
  - BTH-120-199 kit p/n 9007959005
  - BTH-250-500 kit p/n 9007960005







Vent Requirements for BTH 120(A) - 250(A)

Number of 90° Elbows Installed	3 Inch Pipe	4 Inch Pipe
	Maximum Feet (Meters)	Maximum Feet (Meters)
One (1)	45 feet (13.7 meters)	115 feet (35 meters)
Two (2)	40 feet (12.2 meters)	110 feet (33.5 meters)
Three (3)	35 feet (10.7 meters)	105 feet (32 meters)
Four (4)	30 feet (9.1 meters)	100 feet (30.5 meters)
Five (5)	N/A	95 feet (29 meters)
Six (6)	N/A	90 feet (27.4 meters)

Gas Line Connection Size

Model	Series	Natural Gas	Propane Gas
BTH 120	200/201	3/4" NPT	3/4" NPT
BTH 150	200/201	3/4" NPT	3/4" NPT
BTH 199	200/201	3/4" NPT	3/4" NPT
BTH 250	200/201	3/4" NPT	3/4" NPT
BTH 300	200/201	1-1/2" NPT	1-1/2" NPT
BTH 400	200/201	1-1/2" NPT	1-1/2" NPT
BTH 500	200/201	1-1/2" NPT	1-1/2" NPT

Vent Requirements for BTH 300(A) - 500(A)

Number of 90° Elbows Installed	4 Inch Pipe	6 Inch Pipe
	Maximum Feet (Meters)	Maximum Feet (Meters)
One (1)	65 feet (19.8 meters)	115 feet (35 meters)
Two (2)	60 feet (18.2 meters)	110 feet (33.5 meters)
Three (3)	55 feet (16.8 meters)	105 feet (32 meters)
Four (4)	50 feet (15.2 meters)	100 feet (30.5 meters)
Five (5)	45 feet (13.7 meters)	95 feet (29 meters)
Six (6)	40 feet (12.2 meters)	90 feet (27.4 meters)

Gas Pressure Requirements

Model Number	Manifold Pressure		Minimum Supply Pressure		Maximum Supply Pressure	
	Natural Gas	Propane Gas	Natural Gas	Propane Gas	Natural Gas	Propane Gas
BTH-120(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.4"W.C. (1.10 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-150(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.4"W.C. (1.10 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-199(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.4"W.C. (1.10 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-250(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.4"W.C. (1.10 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-300(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.8"W.C. (1.19 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-400(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.8"W.C. (1.19 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)
BTH-500(A)	0"W.C. (0 kPa)	0"W.C. (0 kPa)	4.8"W.C. (1.19 kPa)	8.5"W.C. (2.12 kPa)	14"W.C. (3.49 kPa)	14"W.C. (3.49 kPa)

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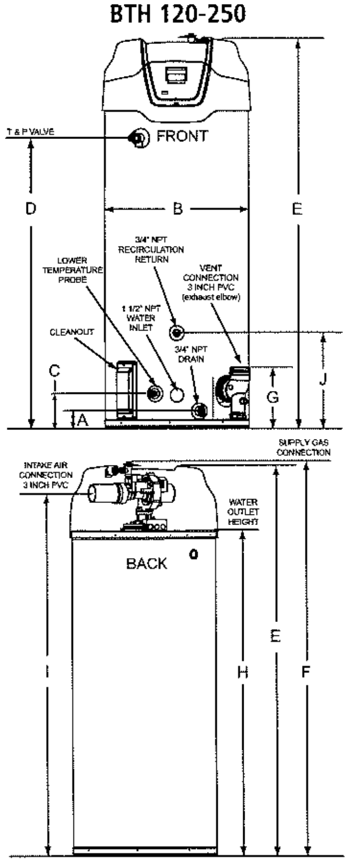
GWH-1 &2

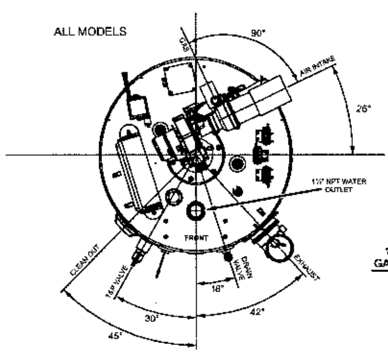
A.O. Smith® | Commercial Gas Water Heaters

Model Number	Approx. Capacity		Dimensions A	B	C	D	E	F	G	H	I	J	LBS/KG	Approx. Shipping Weight Std	Approx. Shipping Weight ASME
BTH-120(A)	GPH	60	3	27.75	6.3	35	55.5	53.5	11.25	42.25	48.5	18.25	LBS	460	490
	LPH	227	7.62	70.5	16	88.9	141	135.9	28.6	107.32	123.2	46.36	KG	208	220
BTH-150(A)	GPH	100	3	27.75	6.3	56.38	76	75.75	11.25	64	70	18.25	LBS	523	553
	LPH	379	7.62	70.5	16	143.2	193.04	192.4	28.6	162.6	177.8	46.36	KG	237	251
BTH-199(A)	GPH	100	3	27.75	6.3	56.38	76	75.75	11.25	64	70	18.25	LBS	523	553
	LPH	379	7.62	70.5	16	143.2	193.04	192.4	28.6	162.6	177.8	46.36	KG	237	251
BTH-250(A)	GPH	100	3	27.75	6.3	56.38	76	75.75	11.25	64	70	18.25	LBS	523	553
	LPH	379	7.62	70.5	16	143.2	193.04	192.4	28.6	162.6	177.8	46.36	KG	237	251
BTH-300(A)	GPH	119	4.75	33.12	4.75	52	75.75	73.75	12.75	63.13	69.25	23	LBS	855	855
	LPH	450.96	12.07	84.12	12.07	132.08	192.41	187.3	32.39	160.35	175.9	58.43	KG	387	387
BTH-400(A)	GPH	119	4.75	33.12	4.75	52	75.75	73.75	12.75	63.13	69.25	23	LBS	855	855
	LPH	450.96	12.07	84.12	12.07	132.08	192.41	187.3	32.39	160.35	175.9	58.43	KG	387	387
BTH-500(A)	GPH	119	4.75	33.12	4.75	52	75.75	73.75	12.75	63.13	69.25	23	LBS	855	855
	LPH	450.96	12.07	84.12	12.07	132.08	192.41	187.3	32.39	160.35	175.9	58.43	KG	387	387

Electrical characteristics-120V-60Hz A.C., 5.0 A
"A" in model represents ASME construction
Propane gas models available
Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.

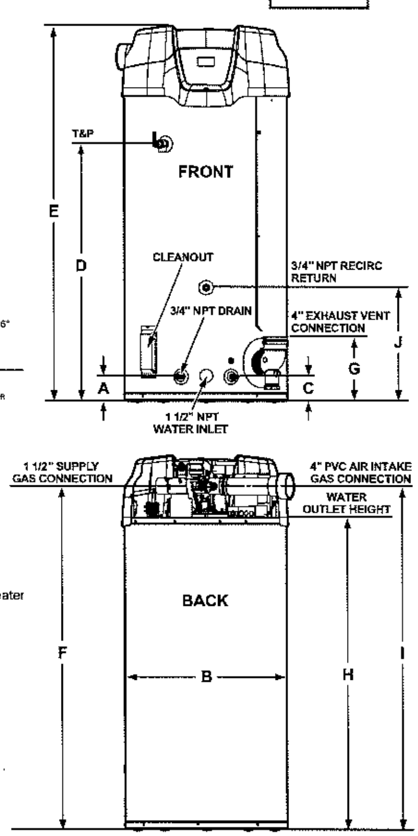
BTH 120-250

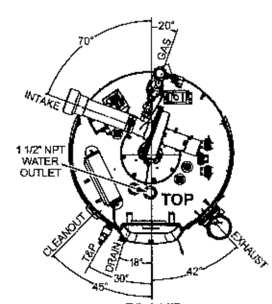




* Center line of water outlet on top of the water heaters is approximately 7 inches from the front edge of the water heater

BTH 300-500





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GWH-1 &2

A.O. Smith® | Commercial Gas Water Heaters

Recovery Capacity

Model Number	Type of Gas	Input BTU/HR	Input kW	Thermal Efficiency	Approx. Capacity	°F / °C	30°F / 17°C	40°F / 22°C	50°F / 28°C	60°F / 33°C	70°F / 39°C	80°F / 44°C	90°F / 50°C	100°F / 56°C	110°F / 61°C	120°F / 67°C	130°F / 72°C	140°F / 78°C
BTH-120(A)	Natural/ Propane	120,000	35	95%	60 U.S. Gals.	GPH	461	345	276	230	197	173	154	138	126	115	106	99
					227 Litres	LPH	1743	1308	1046	872	747	654	581	523	475	436	402	374
BTH-150(A)	Natural/ Propane	150,000	44	98%	100 U.S. Gals.	GPH	594	445	356	297	255	223	198	178	162	148	137	127
					379 Litres	LPH	2248	1686	1349	1124	963	843	749	674	613	562	519	482
BTH-199(A)	Natural/ Propane	199,900	58	97%	100 U.S. Gals.	GPH	783	588	470	392	336	294	261	235	214	196	181	168
					379 Litres	LPH	2965	2224	1779	1483	1271	1112	988	890	809	741	684	635
BTH-250(A)	Natural/ Propane	250,000	73	96%	100 U.S. Gals.	GPH	970	727	582	485	416	364	323	291	264	242	224	208
					379 Litres	LPH	3670	2753	2202	1835	1573	1376	1223	1101	1001	918	847	786
BTH-300(A)	Natural/ Propane	300,000	88	96%	119 U.S. Gals.	GPH	1164	873	698	582	499	436	388	349	317	291	269	249
					451 Litres	LPH	4405	3304	2643	2202	1888	1652	1468	1321	1201	1101	1017	944
BTH-400(A)	Natural/ Propane	399,900	117	95%	119 U.S. Gals.	GPH	1535	1151	921	767	658	576	512	460	419	384	354	329
					451 Litres	LPH	5810	4358	3486	2905	2490	2179	1937	1743	1585	1453	1341	1245
BTH-500(A)	Natural/ Propane	499,900	146	95%	119 U.S. Gals.	GPH	1919	1439	1151	959	822	720	640	576	523	480	443	411
					451 Litres	LPH	7263	5448	4358	3632	3113	2724	2421	2179	1981	1816	1676	1556

Recovery capacities are based on AHRI rated thermal efficiencies. For ASME construction add an "A" to the end of the model ex: BTH-120(A).

SPECIFICATION

(Natural or Propane) gas water heater(s) shall be A. O. Smith Cyclone Mxi model # __________ or equal, minimum 95% thermal efficiency, a storage capacity of _______ gallons, an input rating of __________ BTUs per hour, a recovery rating of ____________ gallons per hour (gph) at 100°F rise and a maximum hydrostatic working pressure of 160 PSI. Water heater(s) shall: 1. Modulating gas burner that automatically adjusts the input based on demand. 2. Powered anodes that are non sacrificial and maintenance free. 3. Have seamless glass-lined steel tank construction, with glass lining applied to all water-side surfaces after the tank has been assembled and welded; 4. Meets the thermal efficiency and/or standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IESNA 90.1; 5. Have foam insulation and a CSA Certified and ASME rated T&P relief valve; 6. Have a down-fired power burner designed for precise mixing of air and gas for optimum efficiency, requiring no special calibration on start-up; 7. Be approved for 0" clearance to combustibles.

The control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and shall have digital temperature readout. 1. All models are design certified by Underwriters Laboratories (UL), Inc., according to ANSI Z21.10.3 - CSA 4.3 standards governing storage type water heaters; 2. Meet the thermal efficiency and standby loss requirements of the U. S. Department of Energy and current edition ASHRAE/IESNA 90.1. Complies with SCAQMD Rule 1146.2 and other air quality management districts with similar requirements for low NOx emissions.

120K-250K BTU Input: For Standard Power Venting: Water heater(s) shall be suitable for power venting using a (3" or 4") ________ diameter PVC pipe for a total distance of (50 ft or 120 ft.) ______ equivalent feet of vent piping. For Power Direct Venting: Water heater(s) shall be suitable for power direct venting using a (3" or 4") ________ diameter PVC pipe for a total distance of (50 ft or 120 ft.) ______ equivalent feet of vent piping and (50 ft. or 120 ft.)_______ equivalent feet of intake air piping.

300K - 500K BTU Input: For Standard Power Venting: Water heater(s) shall be suitable for standard power venting using a (4" or 6")______ diameter PVC pipe for a total distance of (70 ft. or 120 ft.)_____ equivalent feet of vent piping. For Power Direct Venting: Water heater(s) shall be suitable for power direct venting using a (4" or 6") _______ diameter PVC pipe for a total distance of (70 ft or 120 ft.) ______ equivalent feet of vent piping and (70 ft. or 120 ft.)_______ equivalent feet of intake air piping.

Operation of the water heater(s) in a closed system where thermal expansion has not been compensated for (with a properly sized thermal expansion tank) will void the warranty.

Water heater should incorporate the iCOMM™ system for remote monitoring, leak detection and fault alert.

For technical information, call 800-527-1953. A. O. Smith Corporation reserves the right to make product changes or improvements without prior notice.

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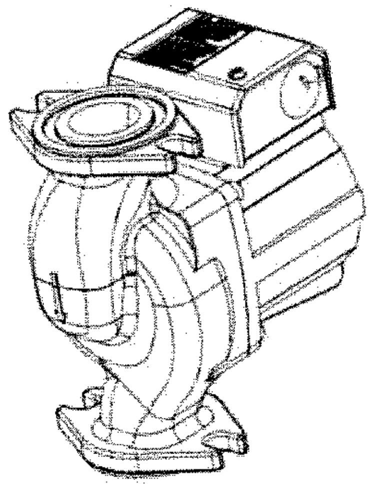
Bell & Gossett
a xylem brand

HWRP-1

SUBMITTAL
A-123B

JOB:	REPRESENTATIVE:	
UNIT TAG:	ORDER NO.	DATE:
ENGINEER:	SUBMITTED BY:	DATE:
CONTRACTOR:	APPROVED BY:	DATE:



Series LR Iron & Lead-Free† Bronze Booster Pumps

Where potable water is pumped, use a lead-free† bronze Series LR circulator.

c UL us LISTED

DESCRIPTION

The Series LR is a flanged in-line system lubricated circulating pump designed specifically for quiet operation in closed loop systems. The Series LR is available in cast iron body construction for hydronic heating systems or lead-free † bronze body construction for potable water applications.

CONSTRUCTION

Pump Body
~~LR-20WR: Cast Iron~~
LR-15BWR:Lead-Free† Bronze
Impeller: Noryl®
Shaft: Ceramic
Bearings: Carbon

† Contains less than 0.25% Lead content by weight on wetted surfaces.

OPERATING DATA

Maximum working pressure: 150 psig (10 bar)
Maximum operating temperature: 225°F (107°C)

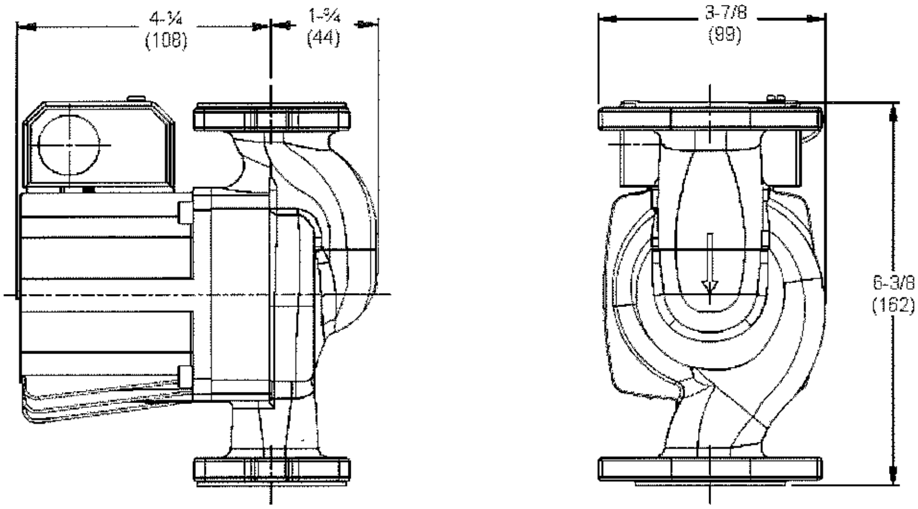
Model Number	Part Number	Pump Body Material	Flange Sizes Inches-NPT	Standard 60 Cycle Motor Characteristics				Tagging	Quantity
				Watts	Voltage	F.L. Amps	RPM		
LR-20WR	106507	Cast Iron	3/4, 1, 1-1/4, 1-1/2	125	115	1.1	2950		
LR-15BWR	106514LF	Lead-Free† Bronze	3/4, 1, 1-1/4, 1-1/2	125	115	1.1	2950		

xylem
Let's Solve Water

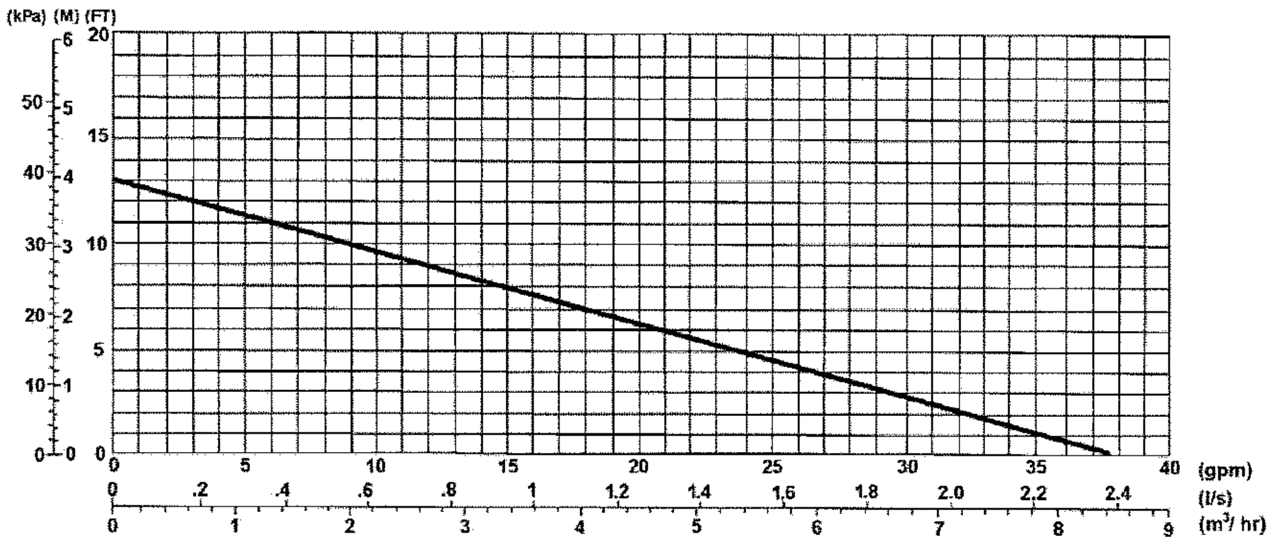
HWRP-1

Series LR System Lubricated Circulators

A-123B



PUMP PERFORMANCE CURVE



TYPICAL SPECIFICATIONS

The contractor shall furnish and install in-line circulating pumps as illustrated on the plans and in accordance with the following specifications:

1. The pump shall be of the horizontal system lubricated type specifically designed and guaranteed for quiet operation.
2. Pump to be suitable for 225° F (107° C) operation at 150 PSIG (10 Bar) working pressure.
3. The pumps shall have a ceramic shaft supported by carbon bearings. Bearings are to be lubricated by the circulating fluid.
4. Motor stator to be isolated from circulating fluid through use of stainless steel can. Rotor to be sheathed in stainless steel.
5. Motors shall be non-overloading at any point on the pump curve. Motors to have built-in impedance protection.
6. The pump manufacturer shall be ISO-9001 certified.

Pumps to have a capacity of __________ GPM at ________ foot head when powered by 115 volt, 60 cycle, single phase electrical supply.
All pumps are to, ITT Industries–Bell & Gossett Model LR-___________.

Xylem Inc.
8200 N. Austin Avenue
Morton Grove, IL 60053
Phone: (847)966-3700
Fax: (847)965-8379
www.xyleminc.com/brands/bellgossett

xylem
Let's Solve Water

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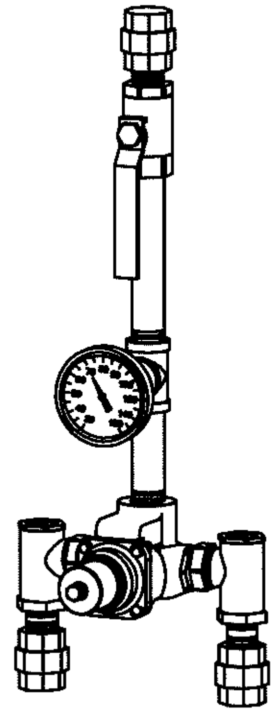
MIXING VALVE
Location:

SYMMONS® TempControl®

Thermostatic Mixing Valve and Piping, A Series Specification Submittal



Feature Highlights

- TempControl thermostatic controller
  - ▹ Check stops
  - ▹ Removable/replaceable cartridge
  - ▹ Stainless steel piston
  - ▹ Thermal motor with Turbulator™
- Volume control shut-off valve
- Bimetal dial thermometer
  - ▹ Range 20°-240°F (-7°- 116°C)
  - ▹ 3 inch (76 mm) face
- Brass pipes, fittings and unions
- Standard rough bronze finish
- **TempControl valves are certified to:**
  - ▹ ASME A112.18.1/CSA B125.1
  - ▹ CSA B125.3
  - ▹ ASSE 1017
  - ▹ CA 116875 (AB 1953)
  - ▹ NSF 372
  - ▹ US S.3874

Model Numbers

	Models	Pipe sizes: Inlets	Pipe sizes: Outlets
☒	7-900A*	1 1/2" (38mm)	1 1/2" (38mm)
☐	7-1000A*	1 1/2" (38mm)	2" (51mm)

***The 7 Series model numbers above replace the 6 Series.**

Options / Modifications

Append appropriate -suffix to model number

- ☐ -ASB Factory assembled and tested
- ☐ -V Vacuum breaker (not shown)
- ☐ -W Wall mounting bracket

Finish Options / Modifications

Append appropriate -suffix to model number

- ☐ -NI Rough nickel finish
- ☐ -P Valves and piping with a polished chrome highlight finish

Note: Finish options cannot be used in conjunction with suffix ASB

Warranty

- 5 years - for commercial installations

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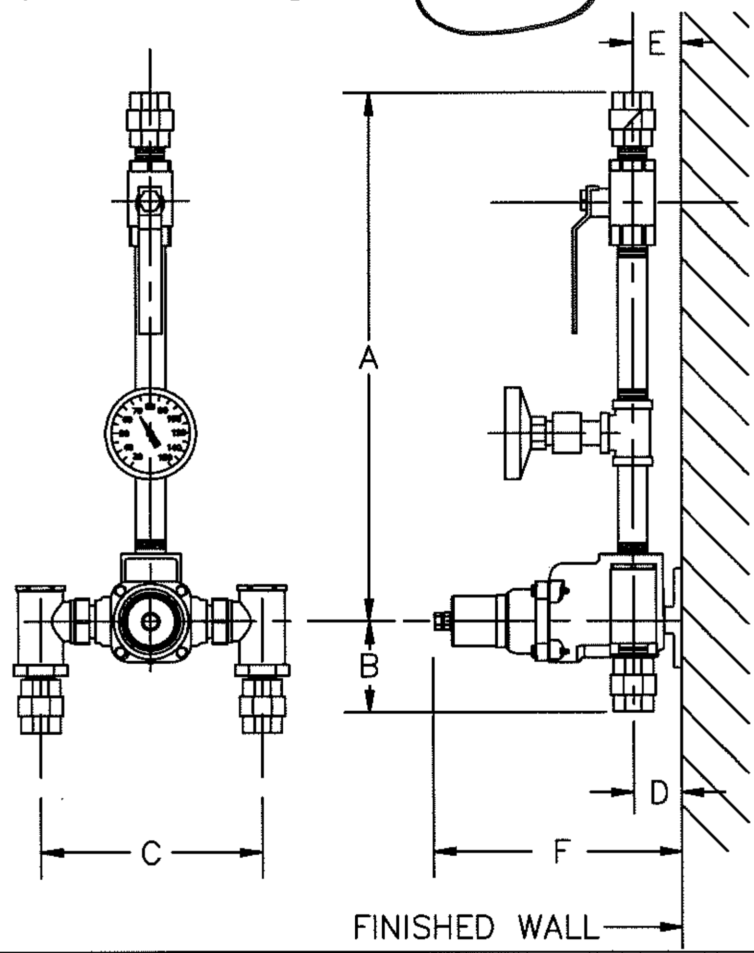
MIXING VALUE

Dimensions TempControl Mixing Valve 7-900A and 7-1000A



Physical Dimensions

Model No.	A	B	C	D	E	F
7-900A	22 3/4" (578mm)	2 11/16" (68mm)	11 1/2" (296mm)	2 9/16" (65mm)	2 9/16" (65mm)	11 3/8" (289mm)
7-1000A	22 3/4" (578mm)	2 11/16" (68mm)	11 1/2" (296mm)	2 9/16" (65mm)	2 9/16" (65mm)	11 3/8" (289mm)

Flow Rate - gpm (L/min)

Valve Model	Min. Flow Rate*	Min. Flow Rate	Pressure Differential - psi (kPa)					
			5 psi (34 kPa)	10 psi (69 kPa)	20 psi (138 kPa)	25 psi (172 kPa)	30 psi (207 kPa)	45 psi (310 kPa)
7-900A	0.5 gpm (1.9 L/min)	13 gpm (49 L/min)	30 gpm (114 L/min)	55 gpm (209 L/min)	76 gpm (288 L/min)	84 gpm (318 L/min)	89 gpm (337 L/min)	104 gpm (394 L/min)
7-1000A	0.5 gpm (1.9 L/min)	13 gpm (49 L/min)	38 gpm (144 L/min)	67 gpm (254 L/min)	100 gpm (379 L/min)	111 gpm (421 L/min)	120 gpm (455 L/min)	140 gpm (531 L/min)

*Minimum flow rate when valve is installed at or near the hot water source with recirculated tempered water and continuously operating circulating pump.

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ELECTRICAL CALCULATIONS AND CUTSHEETS

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ELECTRICAL CALCULATIONS

Main Electrical Service Calculations

Minot AFB - Bldg 276 Dorm Renovation
Main Electrical Service Calculations
(Calculations based on the NEC 2014)

General Loads	2 Bedroom Suite:	21	:Total Units
	General Lighting: (703 sq ft x 3VA) =	2109	VA
	Small Appliance Circuits: 3000VA		
	Laundry Circuit: 1500VA		
	Total Connected load for one unit :	6609	VA
	Sub-Total of all 2 Bedroom Suites:	138789	VA
	3 Bedroom Suite:	3	:Total Units
	General Lighting: (1020 sq ft x 3VA) =	3060	VA
	Small Appliance Circuits: 3000VA		
	Laundry Circuit: 1500VA		
	Total Connected load for one unit :	7560	VA
	Sub-Total of all 3 Bedroom Suites:	22680	VA
	Demand Factor per Table 220.11 :	161469	VA
	1st 3000VA at 100% =	3000	VA
	Next 117,000VA at 35% =	40950	VA
	Remainder at 25% =	10367.25	VA
	Total Demand Load =	54317.25	VA
Appliance and Mechanical Loads	A/C Units = 22 A at 208V =	4576	VA
	4576 VA x 81 units =	370656	VA
	Dryers at 5000VA each =	5000	VA
	Demand % for 24 units =	120000	VA
	35 - (.05x (#dryers -23))	41400	VA
	Range at 6900VA each =	6900	VA
	Demand % for 24 = (26%)	165600	VA
	Remainder after demand =	43056	VA
	Total Appliance load =	455112	VA
	Total load of all units =	455112	VA
	Misc Mech'l loads = 320A	115200	VA
Service Size	Total Load at Service =	624629	VA
	Main Electrical Service =	1735	Amps

Two Bedroom Suite

Minot - AFB Bldg 276 Dorm Renovation

Electrical Service Calculation - 2 Bedrm Suite

Ref: NEC 220-40, Appendix 'D' - Example 2c: Optional Calculation for One-Family Dwelling with Heat Pump (Single-Phase, 208/120-Volt Service)

Sq. Ft.	703		Service:	120/208	
	Heat	Cool	Total		
WAHP-1	2,500	765	3,265	(VA)	Heat/Cool are non-coincidental

General Load

Lighting	3va/ft	2,109	(VA)	
App. Outlets	1,500va ea.	3,000	(VA)	
Laundry		1,500	(VA)	
Range		6,900	(VA)	
Water Htr		0	(VA)	
Dishwasher		0	(VA)	
Dryer		5,000	(VA)	
Sub-Total		18,509	(VA)	
Demand		13,404	(VA)	First 10,000va of General Load (Sub-Total) @ 100%, and remainder of
Net-Total		13,404	(VA)	
Total		15,904	(VA)	Net-Total plus largest of non-coincidental Heat/Cool load.
Service		76.5	(Amps)	
Service Feeder Size				1 1/4"C-3#4 & 1#10 GND

Three Bedroom Suite

Minot - AFB Bldg 276 Dorm Renovation

Electrical Service Calculation - 3 Bedrm Suite

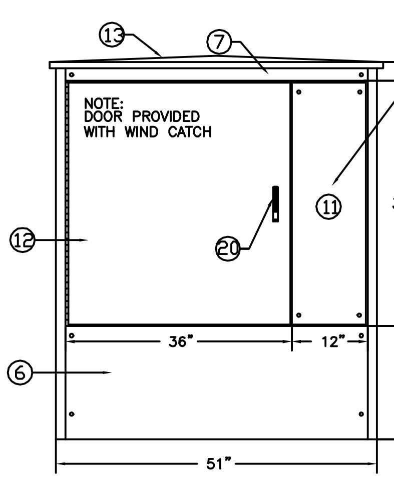
Ref: NEC 220-40, Appendix 'D' - Example 2c: Optional Calculation for One-Family Dwelling
with Heat Pump (Single-Phase, 208/120-Volt Service)

Sq. Ft.	1020		Service:	120/208	
	Heat	Cool	Total		
WAHP-1	2,500	765	3,265	(VA)	Heat/Cool are non-coincidental

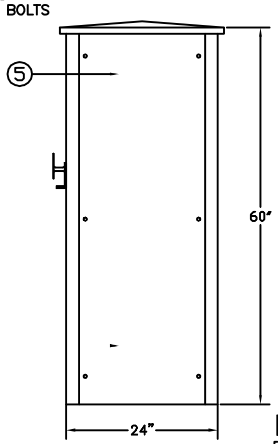
General Load

Lighting	3va/ft	3,060	(VA)	
App. Outlets	1,500va ea.	3,000	(VA)	
Laundry		1,500	(VA)	
Range		6,900	(VA)	
Water Htr		0	(VA)	
Dishwasher		0	(VA)	
Dryer		5,000	(VA)	
Sub-Total		19,460	(VA)	
Demand		13,784	(VA)	First 10,000va of General Load (Sub-Total) @ 100%, and remainder of
Net-Total		13,784	(VA)	
Total		16,284	(VA)	Net-Total plus largest of non-coincidental Heat/Cool load.
Service		78.3	(Amps)	
Service Feeder Size				1 1/4"C-3#4 & 1#10 GND

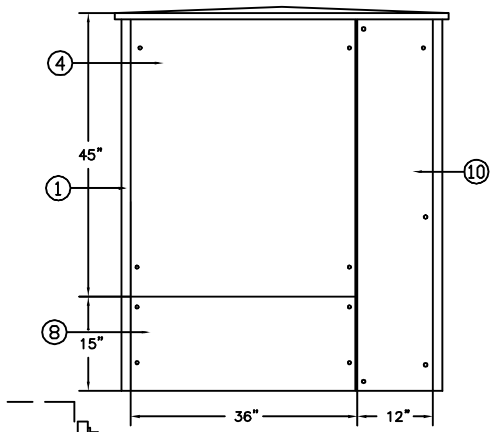
ELECTRICAL CUTSHEETS



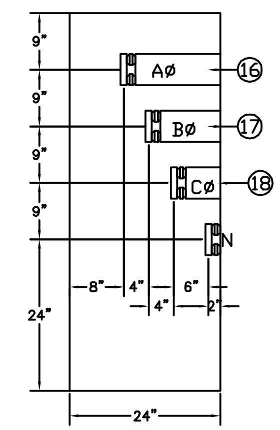
FRONT VIEW



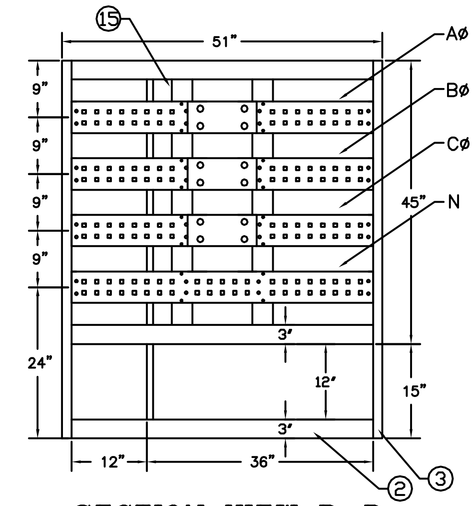
SIDE VIEW



BACK VIEW

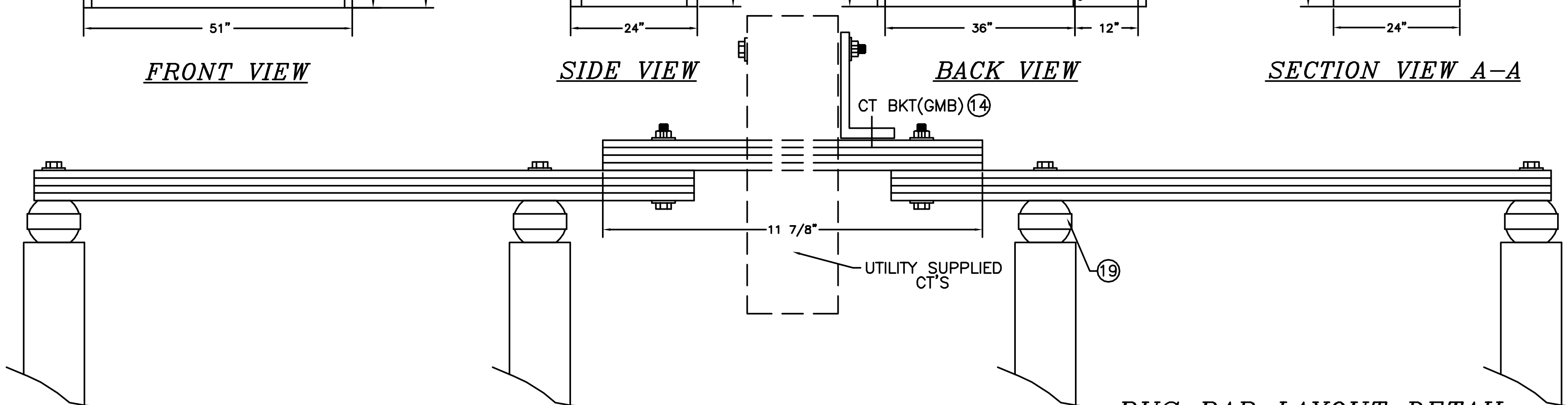


SECTION VIEW A–A



SECTION VIEW B–B

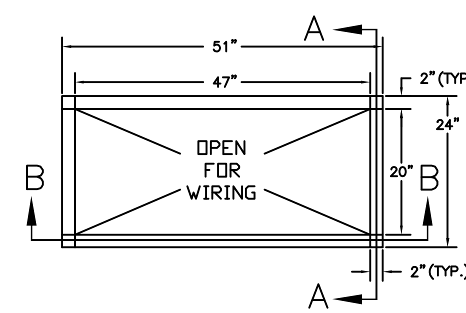
ITEM	QTY	CATALOG NUMBER	DESCRIPTION	SUPPLIER
1	4	FUF60	60" UPRIGHT FRAME MEMBER	AMP
2	5	FFF49	FRONT FRAME MEMBER	AMP
3	4	FSF22	SIDE FRAME MEMBER	AMP
4	1	FFP3645	BACK FILLER PLATE	AMP
5	2	FFP2160	SIDE FILLER PLATE	AMP
6	1	FFP4818F	FILLER PLATE	AMP
7	1	FFP4803F	FILLER PLATE	AMP
8	1	FFP3615F	FILLER PLATE	AMP
9				
10	1	FFP1260F	FILLER PLATE	AMP
11	1	FFP1239F	FILLER PLATE	AMP
12	1	FFP3639H	FILLER PLATE	AMP
13	1	FT5124	ROOF WITH CROSS HATCH	AMP
14	3	GMB	CT MOUNTING BRACKET	NOHL
15	2	FSBSC	BUS SUPPORT CHANNEL	AMP
16	4	FBMA	Aø BUS BAR STAND–OFF	AMP
17	4	FBMB	Bø BUS BAR STAND–OFF	AMP
18	4	FBMC	Cø BUS BAR STAND–OFF	AMP
19	32	R–1000GR1	STAND–OFF INSULATOR	RICH PLASTIC
20	1	72A/2500–50	PADLOCKABLE HANDLE WITH 3–POINT LATCH	AUSTIN



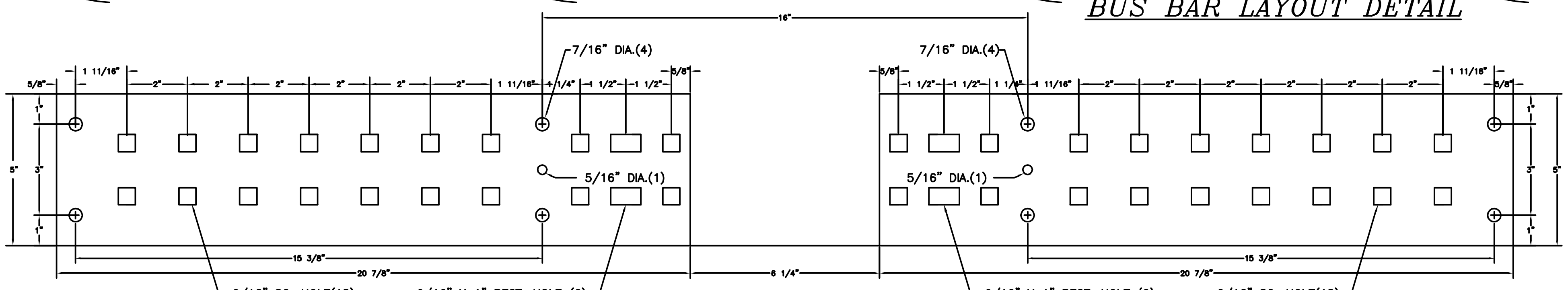
BUS BAR LAYOUT DETAIL

SPECIFICATIONS

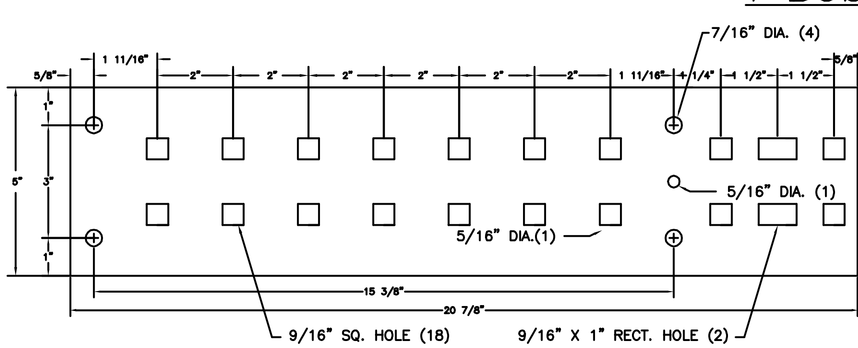
- **CABINET** is free standing NEMA 3R. Frame is 12 gauge steel galvanized steel bolted together and include leveling provisions. All side plates are pan formed galvanized steel and are bolted to the frame with tamper–resistaint zinic plated bolts. Enclosure is primed and painted transformer green enamel.
- **SUPPORTING STRUCTURE** for bus bars is bolted to framework such as that any phase bar can be relocated vertically as required to meet job requirements.
- **BUS BARS** are electrical grade plated aluminum # 6101T65 per ASTM specifictions # B317 supported on 17" centers using double glastic insulators Copper bus available on special order. Current density is 750A/square inch maximum for Aluminum bus and 1000A/square inch maximum for Copper bus. Each bus bar is punched with 16 sets of 9/16" square holes on 2" horizontally and 1 3/4"centers vertically.
- **RATINGS** are 2000A, 2500A, 3000A, 3600A, and 4000A at 600V maximum 3ø–4W, 3ø–3W, 1ø–3W. All cabinets shall have bus braced for 85,000A RMS amperes short circuit current rating.
- **CONNECTORS** in a range of #2 to 750 MCM are available in set screw type or compression type for field or factory installation. Connectors will be factory installed on right side of bus unless otherwise specified. Up to (12) – 750MCM or (24) – 250MCM conductors can be installed on each side, per bar.
- **ADJUSTABLE THROATS** painted transformer green are available to connect to CTC cabinet to the Power Company's transformer. The standard dimensions are 12H"x 12W" adjustable in length from 12" to 23". Other sizes are available on special orders.
- **MEETS STANDARDS**
  - ETL listed and labled conforms to U.L standard 1773 termination boxes
  - Conforms to NEMA standards
  - Meets National Electrical Code requirements
  - Meets Power Company requirements



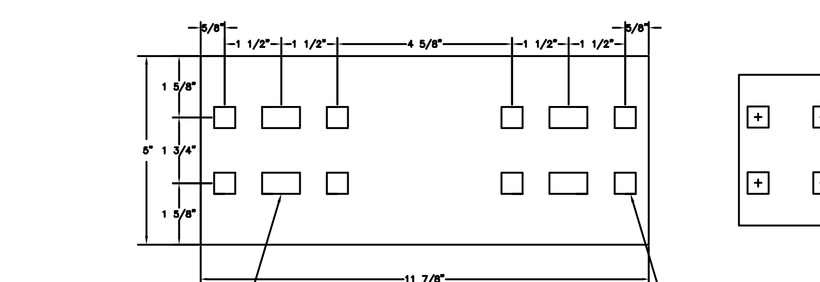
BOTTOM VIEW



ø BUS LAYOUT DETAIL

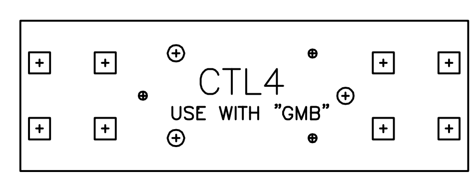


ø BUS BAR DETAIL



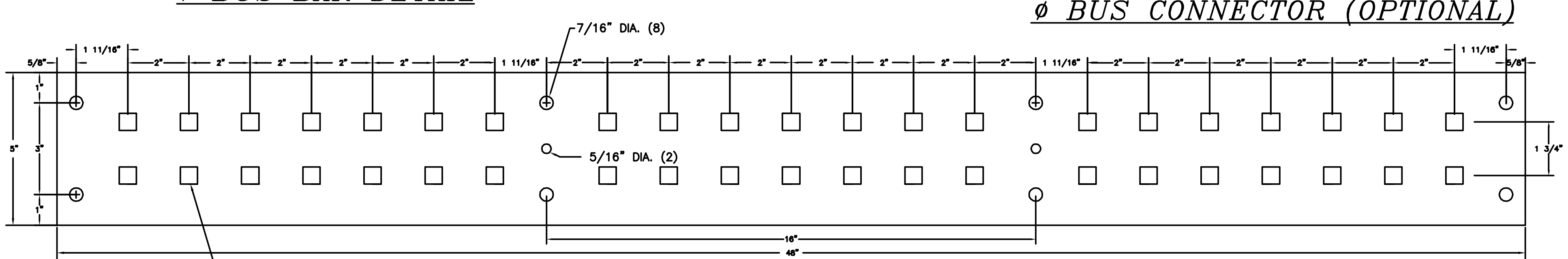
" WINDOW TYPE CT"

ø BUS CONNECTOR (OPTIONAL)

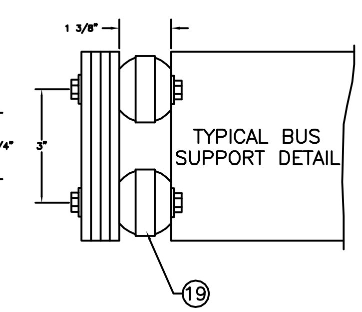


ALUMINUM BUS	4" AL			5" AL			COPPER BUS	4" CU			5" CU			REQ. LINKS	
AMP RATING	QUAN.	IN^2	A/IN^2	QUAN.	IN^2	A/IN^2	AMP RATING	QUAN.	IN^2	A/IN^2	QUAN.	IN^2	A/IN^2	AL. 1/4" X 4"	CU. 1/4" X 4"
2000	3	3	667				2000	2	2	1000				3	2
2500				3	3.75	667	2500				2	2.5	1000	4	3
3000	4	4	750				3000	3	3	1000				4	3
4000				5	6.25	640	4000	4	4	1000				6	4

Catalog No.: FCT20-4L
2000A - 120/208V, 3PH, 4W CT Cabinet



NEUTRAL BUS BAR DETAIL



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REV.	BY	DATE
	ECP	06/08/06
	ECP	09/28/07

JOB NAME: UTILITY APPROVAL DRAWING SERVICE CONNECTION CABINET

TITLE: SERVICE CONNECTION CABINET ' SCC ' W/CT PROVISION 2000–4000

DRAWN BY: CP | DATE: 10/3/03 | DO NOT SCALE DRAWING

APPROVED BY: | DATE: | SCALE: NTS

CUSTOMER: .

CUSTOMER NUMBER: .

AMERICAN MIDWEST POWER
3131 VICKSBURG LANE P.O. BOX 47036
MINNEAPOLIS, MINNESOTA 55447
PHONE (763) 551–1555 FAX (763) 551–9275

DRAWING NUMBER: SCC20–40CT

SHEET: 1 OF 1

LITHONIA LIGHTING®

Catalog Number	2TLX4 46L FW A12 D50 LP840 NX
Notes	
Type	A

FEATURES & SPECIFICATIONS

INTENDED USE — The T Series LED surface mount combines digital lighting and control technologies with a high-performance optical system to deliver general ambient lighting for many applications such as schools, offices and hospitals. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality light installation that is highly efficient and sustainable. **Certain airborne contaminants can diminish integrity of acrylic.** Click here for Acrylic Environmental Compatibility table for suitable uses.

CONSTRUCTION — Housing formed from cold-rolled steel. Housing is painted after fabrication for superior finish.

Smooth hemmed sides and smooth inward-formed end flanges, for easy handling.

Standard extruded aluminum door frame has superior structural integrity with premium appearance and mitered corners. Door frame is painted after fabrication, standard. Powder-painted rotary cam latches provide easy, secure door closure. Integral T-bar clips are standard. Acrylic shielding material is 100% UV stabilized.

OPTICS — Standard pattern #19 lens, 0.156" thick with highly transmissive overlay, is standard for superior brightness control. Overlay is 0.040" thick. Other lenses are available.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior level and quality of illumination for extended service life. TLX is rated to deliver L80 performance for 50,000 hours.

Standard nLight® embedded controls continuously monitor system performance, allow for constant lumen management/compensation function, facilitate simple "plug-and-play" network and controls upgrading via CAT5 cable.

LED driver delivers full-range dimming from 0-10V control signal.

Ballast disconnect is provided where required to comply with US and Canadian codes.

INSTALLATION — Surface mount. Drivers and internal components are accessible from floor. LED boards include plug-in connectors for easy replacement or servicing. Suitable for damp location.

LISTINGS — CSA certified to US and Canadian standards.

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

TLED

T SERIES SURFACE MOUNT

2TLX4

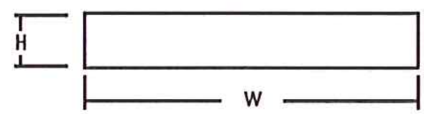
2' x 4' LED

Specifications

Length: 48-3/4 (123.8)

Width: 24-3/4 (62.9)

Depth: 4-3/4 (12.1)



All dimensions are inches (centimeters) unless otherwise indicated.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2TLX4 46L RW A19 D50 LP835 N100

2TLX4	46L				D50
Series	**Lumens**	**Door**	**Lens**	**Voltage**	**Wattage**
2TLX4 Surface mount LED	46L 4600 lumens[1]	FW Flush aluminum, white RW Regressed aluminum, white	A12 #12 pattern acrylic A19 #19 pattern acrylic, 0.156" thick MWS Matte white .040 thick MPL Micro prism SWL Satin white	(blank) MVOLT (120-277V)	D50 50W[2,3]

Color temperature	**Control**	**Options**
LP830 82 CRI, 3000 K[4] LP835 82 CRI, 3500 K LP840 82 CRI, 4000 K LP850 82 CRI, 5000 K[4]	NX Dimming, no nLight BLD Bi-level dimming N80 nLight with 80% (L80) lumen management[5] N80EMG nLight with 80% (L80) lumen management for use with generator supply EM power[5] N100 nLight without lumen management[5] N100EMG nLight without lumen management for use with generator supply EM power[5]	EL14L 1400 lumen battery pack

Notes

1 Nominal lumens.

2 Nominal wattage.

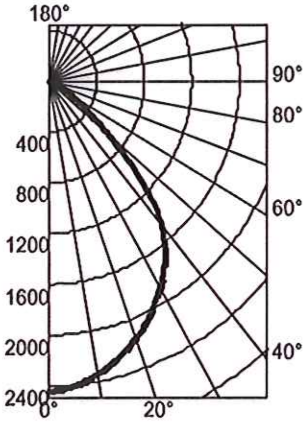
3 Actual wattage may differ by +/- 5% when operating between 120-277V +/- 10%.

4 Extended lead time.

5 Consider CAT5 access when specifying.

PHOTOMETRICS

2TLX4 46L RW A19 D50 LP835 N100, 4,549 delivered lumens,test no. LTL20533R, tested in accordance to IESNA LM-79.



– – 0° ▬▬ 90°

CP Summary

	0°	90
0°	2443	2443
5°	2426	2412
15°	2274	2259
25°	2045	2023
35°	1735	1699
45°	1113	1084
55°	408	357
65°	128	114
75°	111	100
85°	46	48
90	0	0

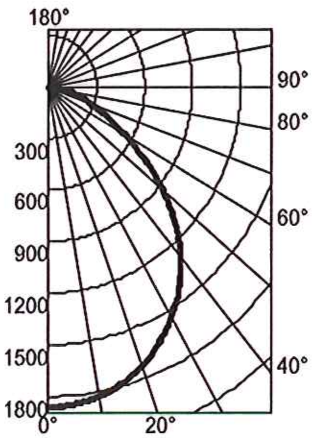
Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	111	107	103	105	102	99	101	98	96
2	103	96	90	94	89	85	91	86	83
3	95	86	80	85	79	73	82	77	72
4	88	78	71	77	70	65	75	69	64
5	82	71	63	70	63	57	68	62	57
6	77	65	57	64	57	51	62	56	51
7	72	60	52	59	51	46	57	51	46
8	67	55	47	54	47	42	53	46	42
9	63	51	43	50	43	38	49	43	38
10	59	47	40	47	40	35	46	39	35

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1799	39.5	39.5
0° - 40°	2852	62.7	62.7
0° - 60°	4137	90.9	90.9
0° - 90°	4549	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	4549	100.0	100.0

2TLX4 46L RW SWL D50 LP835, 4,485 delivered lumens,test no. LTL20938R, tested in accordance to IESNA LM-79.



– – 0° ▬▬ 90°

CP Summary

	0°	90
0°	1859	1859
5°	1848	1854
15°	1779	1787
25°	1635	1643
35°	1416	1427
45°	1106	1125
55°	712	732
65°	383	395
75°	192	193
85°	60	56
90	0	0

Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	110	105	102	103	100	96	99	96	93
2	101	93	87	91	85	81	88	83	79
3	92	83	75	81	74	68	78	72	67
4	85	74	66	72	65	59	70	63	58
5	79	66	58	65	57	51	63	56	51
6	73	60	52	59	51	45	57	50	45
7	68	55	46	54	46	40	52	45	40
8	63	50	42	49	42	36	48	41	36
9	59	46	38	45	38	33	44	37	33
10	55	43	35	42	35	30	41	34	30

Zonal Lumen Summary

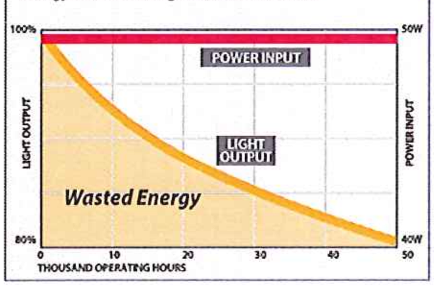
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1433	31.9	31.9
0° - 40°	2319	51.7	51.7
0° - 60°	3823	85.2	85.2
0° - 90°	4485	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	4485	100.0	100.0

Constant Lumen Management

Enabled by the embedded nLight control, the TLX actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.

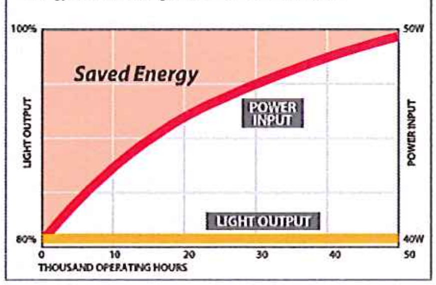
Without Lumen Management

Energy is wasted and light level is inconsistent.



With Lumen Management

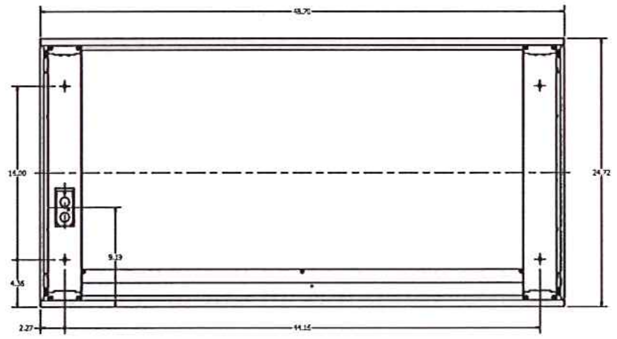
Energy is saved and light level remains consistent.



LITHONIA LIGHTING®
An AcuityBrands Company

LED: One Lithonia Way, Conyers, GA 30012 Phone: 800-858-7763 Fax: 770-929-8789 www.lithonia.com © 2013-2014 Acuity Brands Lighting, Inc. All rights reserved. Rev. 08/27/14

MOUNTING DATA



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LITHONIA LIGHTING®

Catalog Number	RT5D LED 40K 120
Notes	
Type	B

RT5D LED

RT5D LED

1' x 1'
LED

FEATURES & SPECIFICATIONS

INTENDED USE — Provides volumetric lighting by filling the entire volume of space with light, delivering the ideal amount of light to walls, cubicles, work surfaces and people. Typical applications include corridors, lobbies, conference rooms and private offices. RT5D LED will fill the space with light without glare or cave effect of traditional downlights. The RT5D LED is 20% more efficient when compared to the mean efficacy of a common two-lamp, 26W DTT compact fluorescent downlight. The system maintains 70% lumen output at more than 50,000 hours.

OPTICAL SYSTEM — Regressed, two-piece refractive system obscures the lamp and smoothly washes the reflector with light.

Impact-modified acrylic prismatic refractor with polymeric light-diffusing film.

CONSTRUCTION — 16-gauge galvanized steel mounting/plaster frame with mechanical trim retention integral yoke to retain optical system.

Rugged, one-piece white die-cast reflector system with linear facets softens and distributes light into the space (ships separately).

Mounting bars are 16-gauge galvanized steel with continuous 2-3/4" vertical adjustment, held in place with wingnuts. Post installation adjustment possible without the use of tools from above or below the ceiling.

Galvanized steel junction box with bottom-hinged access covers and spring latches. Two combination 1/2"-3/4" and three 1/2" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out) No. 12 AWG conductors, rated for 90°C.

Fixture height of 4-7/8" allows installation in shallow plenum applications.

Maximum 2" ceiling thickness.

ELECTRICAL SYSTEM — Utilizes high-efficiency LEDs mounted to a metal core circuit board, ensuring cool-running operation, 3500 Kelvin temperature, CRI > 80.

Patent-pending thermal dynamic control ensures cool running LEDs.

Reverse polarity protection and push-in connectors standard.

High-efficiency, thermally protected, electronic LED power supply and driver mounted to the junction box.

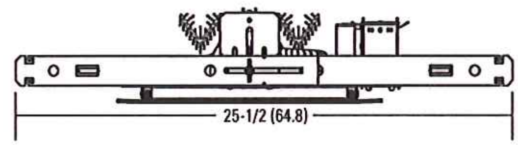
Typical lumens per system is 1700 utilizing 41 total system watts.

LISTING — CSA Certified to U.S. and Canadian safety standards. Damp location listed.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

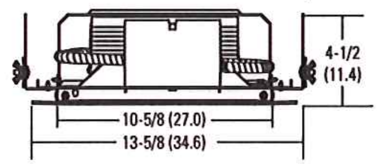
Protected by US Patents Nos. D533,781 and D581,376.

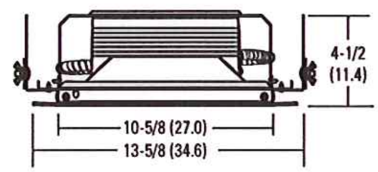
NOTE: Specifications subject to change without notice.



Specifications

Aperture: 10-5/8 (27.0)
Ceiling Opening: 11-1/4 X 11-1/4 (28.8 X 28.8)
Overlap Trim: 13-5/8 (34.4)
Height: 4-7/8 (12.4)
Length: 25-1/2 (64.8)
Standard Width: 15 (38.1)
All dimensions are inches (centimeters).





ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RT5D LED 35K 120

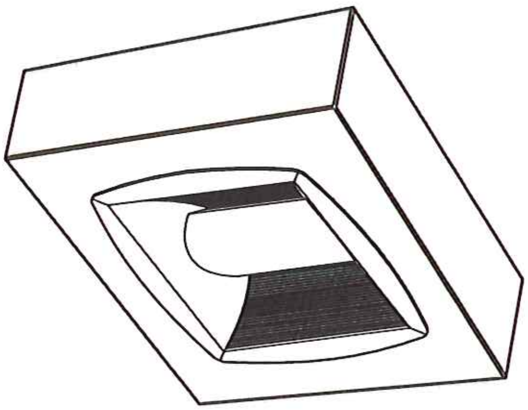
RT5D LED								
Series	**Lumen output[1]**		**Color temperature**		**Voltage**	**Options**		
RT5D LED	(blank)	1700L	35K	3500K	120	LFS	LED freezer shroud (shipped separately)[2]	
			40K	4000K	277	CP	Chigago Plenum	
					347	DIM	0 -10V dimming driver, 10% minimum light output[3]	
						ELR	Emergency battery pack; remote test switch provided[4]	

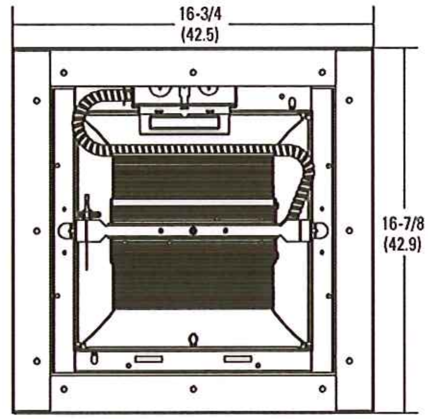
Accessories and Replacement Parts: *Order as separate catalog number.*	
Housing only	RT5D LED 120 HSG U RT5D LED 277 HSG U
Trim only	RT5D LED 1700L 3500K TRIM U
NPP16 D	nLight® network relay pack with 0-10V dimming. Refer to TN-602. Fixtures must be ordered with DIM option.
NPP16 D ER	nLight® network relay pack with 0-10V dimming for emergency circuit operation. Refer to TN-602. Fixtures must be ordered with DIM option.[5]

Notes

1 Typical system delivered lumens.
2 Available for use only with freezer applications.
3 Dimmable with any 0-10v dimmer.
4 Not available in 347V.
5 For use with generator supply EM power. Will require an emergency hot feed and normal hot feed.

FREEZER SHROUD (shown with fixture installed)





Dimensions

Height: 6 (15.2)

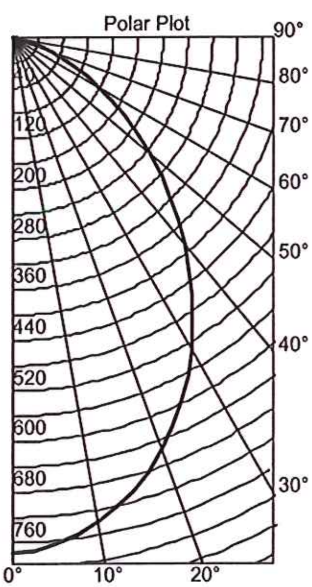
Length: 16-3/4 (42.6)

Width: 16-7/8 (42.9)

All dimensions are inches (centimeters).

PHOTOMETRICS

RT5D LED, 1700 system delivered lumens,test no. LTL16621, tested in accordance to IESNA LM-79-2008



Intensity Distribution

Vertical Angle	Horizontal Angle Lumens
0	
5	77
10	
15	212
20	
25	301
30	
35	330
40	
45	306
50	
55	246
60	
65	159
70	
75	63
80	
85	7
90	

Zonal Lumen Summary

Zone	Lumens	% Lamp
0° - 30°	589	34.6
0° - 40°	919	54.1
0° - 60°	1471	86.5
0° - 90°	1700	100.0
90° - 180°	0	0.0
0° - 180°	1700	*100.0

*Total Efficiency

Coefficients of Utilization

pf	20%					
pc	80%		70%		50%	
pw	50%	30%	50%	30%	50%	30%
RCR 0	119	119	116	116	111	111
1	106	103	104	101	100	97
2	94	88	92	87	89	84
3	84	76	82	75	79	74
4	75	67	74	66	71	65
5	68	59	67	59	64	58
6	61	53	60	53	59	52
7	56	48	55	47	54	47
8	51	43	51	43	49	42
9	47	40	47	39	46	39
10	44	36	43	36	42	36

- Performance can be affected by ambient temperature and binning processes. Please consult factory for details.
- Actual wattage may differ by +/- 5% when operating between 120-347V +/- 10%.

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800.315.4935 Fax: 770-918-1209 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	RT5D LED 40K 120 ELR
Notes	
Type	B2

RT5D LED

RT5D LED

1' x 1'
LED

FEATURES & SPECIFICATIONS

INTENDED USE — Provides volumetric lighting by filling the entire volume of space with light, delivering the ideal amount of light to walls, cubicles, work surfaces and people. Typical applications include corridors, lobbies, conference rooms and private offices. RT5D LED will fill the space with light without glare or cave effect of traditional downlights. The RT5D LED is 20% more efficient when compared to the mean efficacy of a common two-lamp, 26W DTT compact fluorescent downlight. The system maintains 70% lumen output at more than 50,000 hours.

OPTICAL SYSTEM — Regressed, two-piece refractive system obscures the lamp and smoothly washes the reflector with light.

Impact-modified acrylic prismatic refractor with polymeric light-diffusing film.

CONSTRUCTION — 16-gauge galvanized steel mounting/plaster frame with mechanical trim retention integral yoke to retain optical system.

Rugged, one-piece white die-cast reflector system with linear facets softens and distributes light into the space (ships separately).

Mounting bars are 16-gauge galvanized steel with continuous 2-3/4" vertical adjustment, held in place with wingnuts. Post installation adjustment possible without the use of tools from above or below the ceiling.

Galvanized steel junction box with bottom-hinged access covers and spring latches. Two combination 1/2"-3/4" and three 1/2" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out) No. 12 AWG conductors, rated for 90°C.

Fixture height of 4-7/8" allows installation in shallow plenum applications.

Maximum 2" ceiling thickness.

ELECTRICAL SYSTEM — Utilizes high-efficiency LEDs mounted to a metal core circuit board, ensuring cool-running operation, 3500 Kelvin temperature, CRI > 80.

Patent-pending thermal dynamic control ensures cool running LEDs.

Reverse polarity protection and push-in connectors standard.

High-efficiency, thermally protected, electronic LED power supply and driver mounted to the junction box.

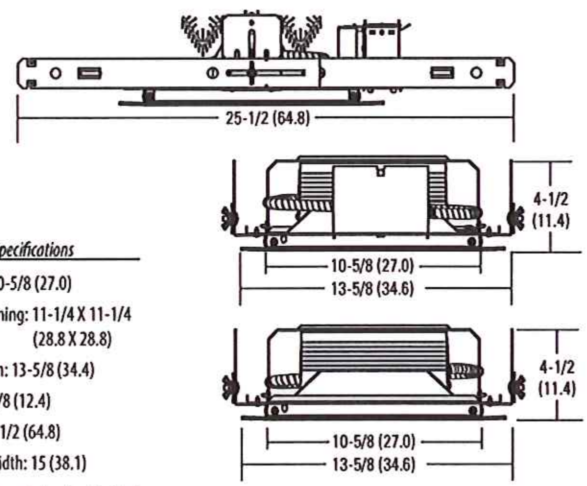
Typical lumens per system is 1700 utilizing 41 total system watts.

LISTING — CSA Certified to U.S. and Canadian safety standards. Damp location listed.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Protected by US Patents Nos. D533,781 and D581,376.

NOTE: Specifications subject to change without notice.



Specifications

Aperture: 10-5/8 (27.0)
Ceiling Opening: 11-1/4 X 11-1/4 (28.8 X 28.8)
Overlap Trim: 13-5/8 (34.4)
Height: 4-7/8 (12.4)
Length: 25-1/2 (64.8)
Standard Width: 15 (38.1)

All dimensions are inches (centimeters).

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RT5D LED 35K 120

RT5D LED				
Series	**Lumen output**[1]	**Color temperature**	**Voltage**	**Options**
RT5D LED	(blank) 1700L	35K 3500K 40K 4000K	120 277 347	LFS LED freezer shroud (shipped separately)[2] CP Chigago Plenum DIM 0-10V dimming driver, 10% minimum light output[3] ELR Emergency battery pack; remote test switch provided[4]

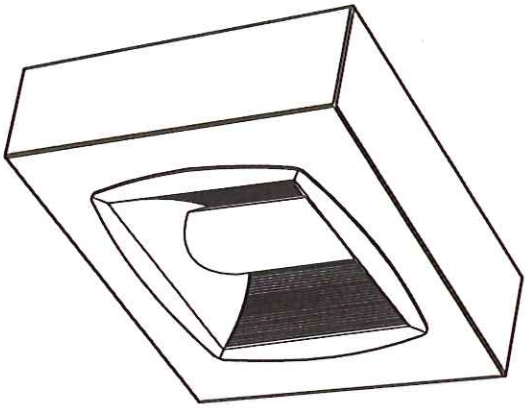
Accessories and Replacement Parts: *Order as separate catalog number.*	
Housing only	RT5D LED 120 HSG U RT5D LED 277 HSG U
Trim only	RT5D LED 1700L 3500K TRIM U
NPP16 D	nLight® network relay pack with 0-10V dimming. Refer to TN-602. Fixtures must be ordered with DIM option.
NPP16 D ER	nLight® network relay pack with 0-10V dimming for emergency circuit operation. Refer to TN-602. Fixtures must be ordered with DIM option.[5]

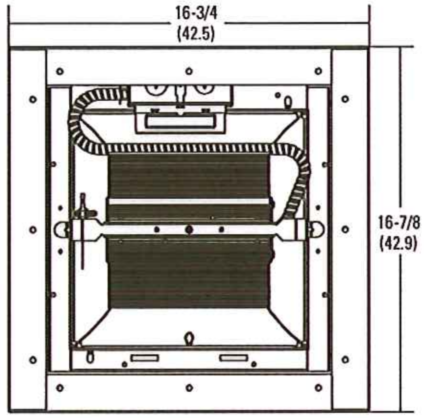
Notes

1 Typical system delivered lumens.
2 Available for use only with freezer applications.
3 Dimmable with any 0-10v dimmer.
4 Not available in 347V.
5 For use with generator supply EM power. Will require an emergency hot feed and normal hot feed.

RT5D LED Volumetric Recessed Downlight

FREEZER SHROUD (shown with fixture installed)





Dimensions

Height: 6 (15.2)

Length: 16-3/4 (42.6)

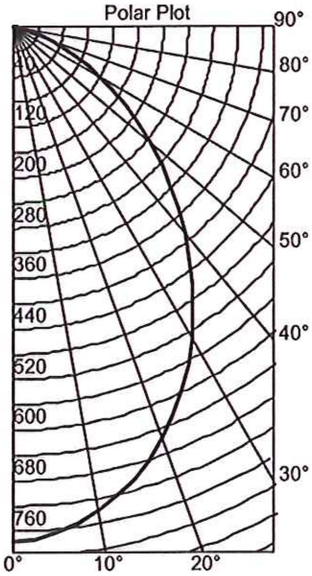
Width: 16-7/8 (42.9)

All dimensions are inches (centimeters).

PHOTOMETRICS

RT5D LED, 1700 system delivered lumens,test no. LTL16621, tested in accordance to IESNA LM-79-2008

Polar Plot



Intensity Distribution

Vertical Angle	Horizontal Angle Lumens
0	
5	77
10	
15	212
20	
25	301
30	
35	330
40	
45	306
50	
55	246
60	
65	159
70	
75	63
80	
85	7
90	

Zonal Lumen Summary

Zone	Lumens	% Lamp
0° - 30°	589	34.6
0° - 40°	919	54.1
0° - 60°	1471	86.5
0° - 90°	1700	100.0
90° - 180°	0	0.0
0° - 180°	1700	*100.0

*Total Efficiency

Coefficients of Utilization

pf	20%					
pc	80%		70%		50%	
pw	50%	30%	50%	30%	50%	30%
RCR 0	119	119	116	116	111	111
1	106	103	104	101	100	97
2	94	88	92	87	89	84
3	84	76	82	75	79	74
4	75	67	74	66	71	65
5	68	59	67	59	64	58
6	61	53	60	53	59	52
7	56	48	55	47	54	47
8	51	43	51	43	49	42
9	47	40	47	39	46	39
10	44	36	43	36	42	36

- Performance can be affected by ambient temperature and binning processes. Please consult factory for details.
- Actual wattage may differ by +/- 5% when operating between 120-347V +/- 10%.

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800.315.4935 Fax: 770-918-1209 www.lithonia.com

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Lumination™ LED Luminaires

FM Series – Flush Mount Round Ceiling Fixtures

Project name ______________

Date ______________

Type C

Product Description:

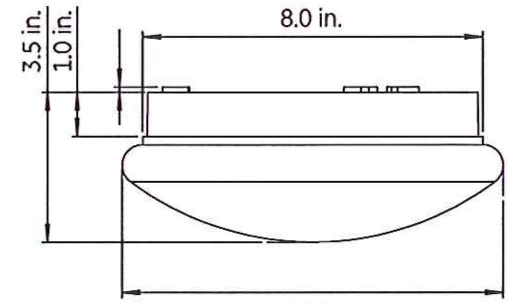
The Lumination FM Series LED Luminaires eliminate changing light bulbs for good while consuming just 15W of energy, resulting in significant cost savings over the life of the fixture. Ideal for hospitality, commercial office, and residential use, the FM series can be used for both retrofit and new construction applications. The integrated LED/fixture design distributes light evenly without pixilation, creating a soft glow around the entire fixture. Installation is quick with included mounting brackets and hardware.

Targeted Performance Summary:

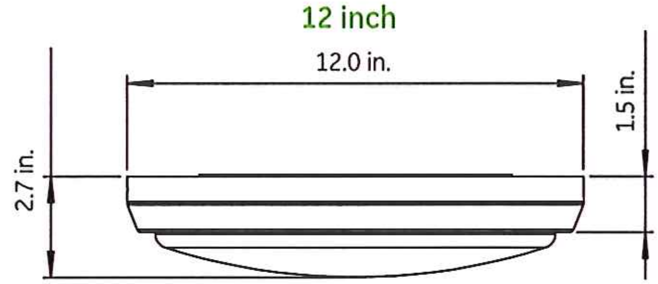
Distribution Patterns: Wide
Delivered Lumen Output: 1000 (9") / 975 (12")
System Input Power: 15W
System Efficacy (LPW): 65
Input Voltage: 120V
Standard Dimming Controls: Non-dimming
CCT: 2700K
CRI: 80+
Lifetime Rating: L70 @ 25,000 Hours
Input Frequency (Hz): 60Hz
Power Factor: >0.9
Mounting Options: Included mounting brackets and hardware
Weight: 0.9 lb. (9") / 2.3 lb. (12")
IC Rating: N/A
Limited Warranty: 5 years based on rated life at 3 hrs. use per day
Files Available: LM79, LM80, IES

Product Dimensions:

9 inch



12 inch



Listings:

c UL us LISTED

- UL and cUL Listed.
- Suitable for damp locations.

a product of ecomagination™

ENERGY STAR

Ordering Information:

PRODUCT CODE	DESCRIPTION	DIAMETER	CCT	CRI	LUMENS	WATTS	LPW	DIMMABLE	LOCATION RATING
33741	LED15FMM9-W120	9"	2700K	80	1000	15	65	No	Damp
20433	LED15FM12-W120	12"	2700K	80	975	15	65	No	Damp

Product Specifications:

Construction:

- Plastic housing with polycarbonate lens
- Worry free use and disposal

Installation:

- Included mounting bracket and hardware screws directly to 4" junction box
- Fixture wires directly to line voltage. No lamps to install or replace.
- Fixture attaches to mounting bracket with 2 included screws

Optical System:

- Edge-to-edge, uniform lit appearance with no hot spots or pixelation
- Highly transmissive lens material for optimal combination of light transmission while diffusing LEDs from direct view

Electrical System:

- Integrated, high-efficiency driver with power factor > 0.9

For more information and access to all of our resources, including our design tool visit: www.gelighting.com

GE imagination at work

Photometric Data: Lumination™

FM Series — 9 inch

COEFFICIENTS OF UTILIZATION																		
RC	80%				70%				50%			30%			10%			0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
0	117	117	117	117	113	113	113	113	105	105	105	99	99	99	93	93	93	90
1	104	99	94	89	101	96	91	87	89	86	82	84	81	78	78	76	74	71
2	94	85	78	72	91	82	76	70	77	72	67	72	68	64	68	64	61	58
3	86	74	66	59	82	72	64	58	67	61	55	63	58	53	59	55	51	48
4	78	66	56	49	75	64	55	48	60	52	47	56	50	45	53	48	43	41
5	72	58	49	42	69	57	48	41	53	46	40	50	44	39	47	42	37	35
6	66	52	43	37	63	51	42	36	48	40	35	45	39	34	43	37	33	30
7	61	47	38	32	59	46	38	32	44	36	31	41	35	30	39	33	29	27
8	57	43	34	29	55	42	34	28	40	33	27	38	31	27	36	30	26	24
9	53	40	31	26	51	39	31	25	37	29	25	35	28	24	33	27	23	21
10	50	36	28	23	48	35	28	23	34	27	22	32	26	22	31	25	21	19

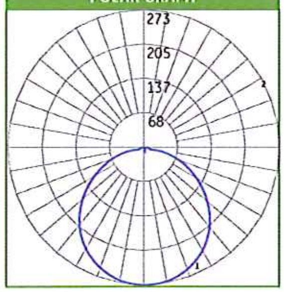
NOTE: Floor Cavity Reflectance : 20%

CANDLEPOWER SUMMARY	
Angle	Candela
0	273
5	272
15	264
25	248
35	239
45	192
55	154
65	113
75	79
85	50
90	39

ZONAL LUMEN SUMMARY		
Zone	Lumens	% of Fixture
0 - 30°	215	21.5
0 - 40°	355	35.5
0 - 60°	642	64.2
0 - 90°	896	89.7

Spacing Criteria: 1.3

POLAR GRAPH



FM Series — 12 inch

COEFFICIENTS OF UTILIZATION																		
RC	80%				70%				50%			30%			10%			0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
0	118	118	118	118	115	115	115	115	110	110	110	105	105	105	100	100	100	98
1	107	102	97	93	104	99	95	91	94	91	87	90	87	84	86	84	81	79
2	97	88	81	74	94	86	79	73	82	76	71	78	73	69	75	71	67	65
3	88	77	68	61	85	75	67	61	72	65	59	68	63	58	66	61	56	54
4	80	68	59	52	78	66	58	51	63	56	50	61	54	49	58	53	48	46
5	74	60	51	44	71	59	50	44	57	49	43	54	48	42	52	46	42	39
6	68	54	45	38	66	53	44	38	51	43	38	49	42	37	47	41	37	34
7	63	49	40	34	61	48	40	34	46	39	33	45	38	33	43	37	32	30
8	59	45	36	30	57	44	36	30	42	35	30	41	34	29	40	33	29	27
9	55	41	33	27	53	40	32	27	39	32	27	38	31	26	37	30	26	24
10	51	38	30	24	50	37	30	24	36	29	24	35	28	24	34	28	24	22

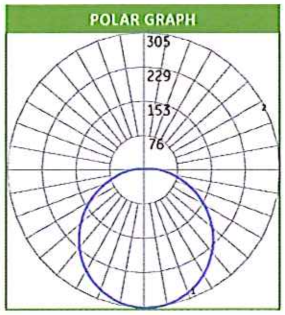
NOTE: Floor Cavity Reflectance : 20%

CANDLEPOWER SUMMARY	
Angle	Candela
0	305
5	304
15	294
25	275
35	247
45	211
55	169
65	122
75	75
85	37
90	23

ZONAL LUMEN SUMMARY		
Zone	Lumens	% of Fixture
0 - 30°	238	24.5
0 - 40°	393	40.4
0 - 60°	707	72.6
0 - 90°	950	97.5

Spacing Criteria: 1.28

POLAR GRAPH



www.gelighting.com

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IND156 (Rev 01/12/15)

LITHONIA LIGHTING®

Catalog Number	FMML 7 840
Notes	
Type	D

Decorative Indoor

Versi Lite™ 7" LED Flush

HIGH-PERFORMANCE LED

FEATURES & SPECIFICATIONS

INTENDED USE — Provides general illumination in commercial and residential applications. Ideal for use in closets, foyers, hallways, corridors, bedrooms, offices, utility work areas, stairways and much more.

CONSTRUCTION — This contemporary shaped fixture features a matte white acrylic diffuser and white or textured bronze aluminum housing.

OPTICS — Produces the following lumens at 50,000 hours life:
2700K 612 lumens
3000K 642 lumens
4000K 660 lumens

ELECTRICAL — Fixture operates at 120 volts, 60 Hz. Standard input = 9.3 watts, 70 lumens per watt.

Works with most standard incandescent dimmers (see list of suggested dimmers on page 2).

INSTALLATION — All mounting hardware included.

LISTINGS — CSA certified to US and Canadian standards and listed suitable for damp or wet locations.

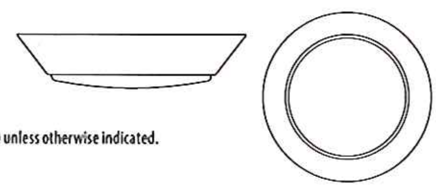
U.S. Patent No. D691,763

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Specifications subject to change without notice.

Specifications

Height: 1-3/4 (4.4)
Width: 7-1/4 (18.4)



All dimensions are inches (centimeters) unless otherwise indicated.

ORDERING INFORMATION For shortest lead times, configure product using standard options (shown in bold).

Example: FMML 7 840 WL

FMML	7				
Series	**Size**	**CRI**	**Color temperature**	**Fixture finish**	**Option**
FMML LED Versi Lite flushmount	**7** 7" diameter	**8** >80	**40** 4000K (660 lumens) **30** 3000K (642 lumens) **27** 2700K (612 lumens)	**(blank)** White **DDBT** Textured bronze	**WL** Wet location

FMML 7 840

LIGHTING FACTS

LED lighting facts® — A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	612
Watts	10.35
Lumens per Watt (Efficacy)	59
Color Accuracy (Color Rendering Index (CRI))	85
Light Color (Correlated Color Temperature (CCT))	2700 (Warm White)

Warm White | Bright White | Daylight
2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide.*

Registration Number: NJSM-5ECOFF (7/19/2013)
Model Number: FMML 7 827
Type: Surface-mounted fixture (other)

LED lighting facts® — A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	642
Watts	10.2
Lumens per Watt (Efficacy)	63
Color Accuracy (Color Rendering Index (CRI))	85
Light Color (Correlated Color Temperature (CCT))	3000 (Bright White)

Warm White | Bright White | Daylight
2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-2008. *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide.*

Registration Number: NJSM-B45YJO (7/19/2013)
Model Number: FMML 7 830
Type: Surface-mounted fixture (other)

LED lighting facts® — A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	659
Watts	9.4
Lumens per Watt (Efficacy)	70
Color Accuracy (Color Rendering Index (CRI))	85
Light Color (Correlated Color Temperature (CCT))	4000 (Bright White)

Warm White | Bright White | Daylight
2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-2008. *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide.*

Registration Number: NJSM-QSEG7G (8/6/2013)
Model Number: FMML 7 840 [UPGRADE 07/2013]
Type: Luminaire - Other

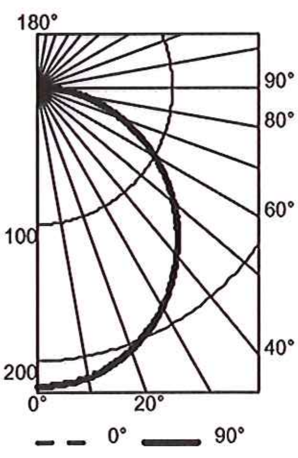
Suggested Dimmers

The FMML is designed to operate with most standard Triac Based (Forward Phase-Control or Leading Edge) dimmers and is not compatible with 0-10v dimming systems. The following is a list of dimmers tested and does not imply any guarantee or warranty of compatibility with a particular application. Unlisted dimmers do not imply non-compatibility.

Manufacturer	Part Number(s)	Manufacturer	Part Number(s)
Leviton	6633P	Lutron	DVELV 300P
Leviton	IPL06	Lutron	Skylark 300P
Leviton	6674P	Lutron	NTELV 300
Leviton	IPE04	Lutron	NLV 600
Leviton	Trimatron 600W	Synergy	ISD 600 I 120

PHOTOMETRICS

FMML 7 test no. LTL22758, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	219	219
5°	218	218
15°	211	211
25°	196	196
35°	173	174
45°	146	146
55°	116	116
65°	83	84
75°	50	50
85°	21	20
90	11	11

Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
pw / RCR	70%	50%	30%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	108	103	98	100	96	92	96	92	89
2	98	89	82	87	80	75	83	78	73
3	89	78	69	76	68	62	73	66	61
4	81	69	60	67	59	52	65	57	52
5	75	61	52	60	52	45	58	50	44
6	69	55	46	54	46	39	52	45	39
7	64	50	41	49	41	35	48	40	34
8	59	46	37	45	37	31	44	36	31
9	55	42	33	41	33	28	40	33	28
10	52	39	31	38	30	25	37	30	25

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	170	26.0	26.0
0° - 40°	279	42.5	42.5
0° - 60°	495	75.5	75.5
0° - 90°	654	99.7	99.7
90° - 120°	2	0.3	0.3
90° - 130°	2	0.3	0.3
90° - 150°	2	0.3	0.3
90° - 180°	2	0.3	0.3
0° - 180°	656	100.0	100.0

LITHONIA LIGHTING®
An Acuity Brands Company

DECORATIVE INDOOR & OUTDOOR: One Lithonia Way, Conyers, GA 30012 Phone: 800-748-5070 Fax: 770-860-3903 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	ELM 1254 RO SD90 NAWT
Notes	(Use with remote emergency heads which are exterior mounted)
Type	EMR (Remote Battery Unit)

FEATURES & SPECIFICATIONS

INTENDED USE — Provides a minimum of 90 minutes of illumination for the rated wattage upon loss of AC power. Ideal for applications requiring attractive unit equipment with quick installation.

CONSTRUCTION — White, compact, low-profile contemporary design. Engineering-grade thermoplastic housing is impact-resistant, scratch-resistant and corrosion-proof. UL94V-0 flame rating. UV-stable resin resists discoloration from natural and man-made light sources.

Patented, MR24, multi-faceted reflector significantly improves photometric performance – 48 percent more light delivered to path of egress.

Unique track-and-swivel arrangement permits full range of direction of lamp head adjustment. **US Patent No. D-532,918. Patent-pending Quick-Mount for simple installation.**

Tool-less access for maintenance. Rigid conduit entry on both top and side on large units (ELM654, ELM1254, and ELM1272), and top only for small units (ELM618 and ELM627).

Low-profile, integrated test switch/pilot light.

OPTICS — Two 9W wedge-based krypton lamps (standard) offer 80 percent more light output than standard 9W incandescent lamps.

ELECTRICAL — Universal input voltage capability (120 through 277 volt, 50 or 60 Hz).

Current-limiting charger maximizes battery life and minimizes energy consumption. Provides low operating costs.

SHORT-CIRCUIT PROTECTION – CURRENT-LIMITING CHARGER CIRCUITRY PROTECTS PRINTED CIRCUIT BOARD FROM SHORTS.

Thermal protection senses circuitry temperature and adjusts charge current to prevent overheating and charger failure.

Thermal compensation adjusts charger output to provide optimum charge voltage relative to ambient temperature.

Regulated charge voltage maintains constant-charge voltage over a wide range of line voltages. Prevents over/under charging that shortens battery life and reduces capacity.

Filtered charger input minimizes charge voltage ripple and extends battery life.

AC/LVD reset allows battery connection before AC power is applied and prevents battery damage from deep discharge

Battery: Sealed, maintenance-free lead-acid (SLA) battery standard. Automatic recharge after a 90-minute discharge. Single-circuit battery connection.

Self-Diagnostics: Single multi-color LED indicator to display two-state charging, test activation and three-state diagnostic status. Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection. Self diagnostic testing for five minutes every 30 days and 30 minutes biannually. Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

QUANTUM®

Thermoplastic Emergency Light

ELM 6-12

High Capacity Units
Lead-Acid (SLA) Battery

Continuously monitors AC functionality. Load learning capability self-calibrates to DC load at first test, enabling it to detect a lamp failure on future tests. It may be recalibrated at any time by holding down the test switch for 15 seconds.

INSTALLATION — Ceiling mount standard. Universal J-box mounting pattern.

LISTINGS — UL listed. Damp Location listing available. Meets UL 924, NFPA 101, NFPA 70-NEC and OSHA illumination standards.

WARRANTY — 3-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application. Specifications subject to change without notice.

ORDERING INFORMATION For shortest lead times, configure product using **standard options (shown in bold).** **Example:** ELM618

Family		Lamp type				Options[4]			
ELM618	6V, 18W	6-Volt MR 24 Composite		12-Volt MR 24 Composite[3]		TD	Time delay[5]	RO	Less heads[7]
ELM627	6V, 27W	**(blank)**	9W/6V krypton[1]	**(blank)**	9W/12V krypton	RT	Remote test[6]	DL	Damp location, 50°-104°F (10°-40°C)[8]
ELM654	6V, 54W	H1206	12W/6V halogen[2]	H1212	12W/12V halogen	SD	Self diagnostics	NOM	NOM Certified[9]
ELM1254	12V, 54W								
ELM1272	12V, 72W								

Options Availability Guide

Product	Size	SD	TD[5]	RT[6]	DL[8]	RO[7]	NOM[9]
ELM618	S				■	■	■
ELM627	S	■	■	■	■	■	
ELM654	L	■	■			■	
ELM1254	L				■	■	■
ELM1272	L	■	■	■		■	

Accessories: Order as separate items.

ELA LRT	Remote test (laser) for distances up to 15'
ELA VS2	Polycarbonate vandal shield (1/8" thick)[10]
ELA WG2M	Wireguard (21-1/4"W x 15"H x 12"D)[11]
ELA MR24	Compact MR24 remote lamp head ELA MR24 K0606 (6W, 6V krypton) ELA MR24 K0906 (9W, 6V krypton) ELA MR24 H1206 (12W, 6V halogen) ELA MR24 K0912 (9W, 12V krypton) ELA MR24 H1212 (12W, 12V halogen)

Notes

1 Available on ELM618, ELM627, and ELM654 only.
2 Available on ELM627 and ELM654 only.
3 Available on ELM1254 and ELM1272 only.
4 See Options Availability Guide.
5 TD not available with RT.
6 RT not available with SD or TD. Order ELA LRT separately.
7 Not available with any other options, except ELM1272 TD.
8 Available on ELM618, ELM627 and ELM1254 only. Damp location listed from 50°F - 104°F (10°C to 40°C).
9 NOM available with ELM618 and ELM1254 only (not available with any other options).
10 See spec sheet ELA-VS-VS2.
11 See spec sheet ELA-WG.

ELM 6-12 QUANTUM® Thermoplastic Emergency Light

SPECIFICATIONS

ELECTRICAL

Primary Circuit

Type	AC Input Volts	AC Input Amps	AC Input Max watts	Output volts	Watts output 1-1/2 hrs.	Watts output 2 hrs.	Watts output 3 hrs.	Watts output 4 hrs.
ELM618	120	.167	5.2	6	18	13.5	9	3
	277	.072	5.6					
ELM627	120	.10	5.2	6	27	20	13.5	10
	277	.04	5.6					
ELM654	120	.250	7.4	6	54	40.5	27	20
	277	.108	7.4					
ELM1254	120	.250	11	12	54	40.5	27	20
	277	.108	11.1					
ELM1272	120	.250	11	12	72	54	36	27
	277	.108	11.1					

BATTERY

Sealed Lead Acid (SLA)

Voltage	Shelf life[1]	Typical life[1]	Maintenance[2]	Optimum temperature[3]
6/12	12 months	3-5 years	none	60°–90°F (16°–32°C)

1 At 77°F (25°C).

2 All life safety equipment, including emergency lighting for path of egress, must be maintained, serviced and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service or testing could jeopardize the safety of occupants and will void all warranties.

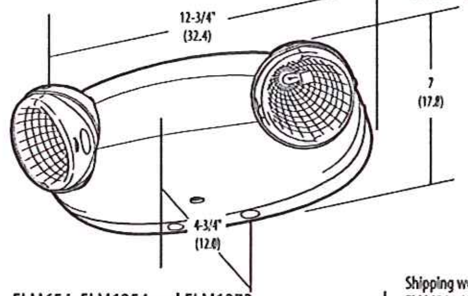
3 Optimum ambient temperature range where unit will provide capacity to 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

MOUNTING

All dimensions are in inches (centimeters).

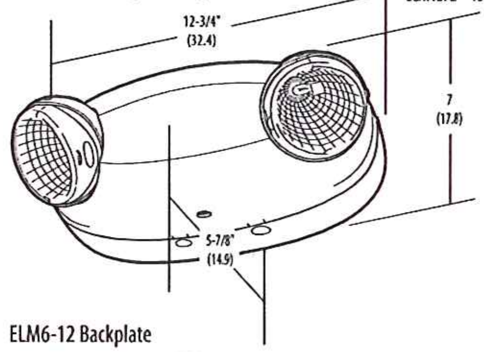
ELM618 and ELM627 Dimensions (small housing)

Shipping weight:
ELM618 - 6.8 lbs. (3.1 kgs)
ELM627 - 8.0 lbs. (3.6 kgs)

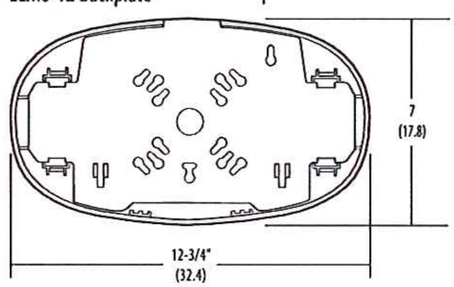


ELM654, ELM1254 and ELM1272 Dimensions (large housing)

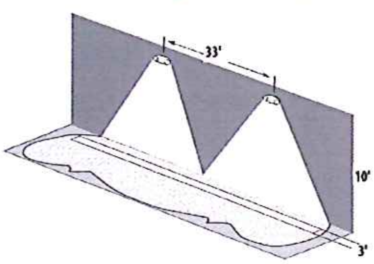
Shipping weight:
ELM654 - 13 lbs. (5.9 kgs)
ELM1254 - 13 lbs. (5.9 kgs)
ELM1272 - 13 lbs. (5.9 kgs)



ELM6-12 Backplate



PERFORMANCE DIAGRAMS



ELM12 Performance Advantage

- 12-volt, 9-watt krypton lamp
- Typical 10-foot mounting height delivers 33 feet center-to-center spacing
- 48% increase in center-to-center spacings over competitive 12-volt higher capacity emergency lighting units.

Recommended Center-to-Center Spacing

Lamps	Mounting height 7.5'	10'	12'	16'	20'
K0906	25'	31'	29'	27'	23'
K0912	25'	33'	30'	29'	26'
H1212	N/A	31'	33'	39'	41'

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 Fax: 770.981.8141 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	ELA T QWP L0309 SD
Notes	(Remote battery unit mounted on the interior of the building)
Type	EMR (Remote exterior heads)

FEATURES & SPECIFICATIONS

INTENDED USE

To be powered by Quantum® LED series unit or combo with high-output option as part of an emergency lighting system providing light for the path of egress. Remote lamp head matches the appearance of the Quantum LED series family units. **Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table, for suitable uses.**

CONSTRUCTION

Single or twin heads available. Fully adjustable lamp heads to meet all aiming requirements. Strong, compact and corrosion-resistant with a UL94V-0 flame rating. Constructed of UV-stabilized thermoplastic that resists discoloration by natural or artificial sunlight. Lamp housing snaps off for easy lamp replacement.

Lamps: 12 series-parallel white LEDs per head. The typical life of the LED lamp is 10 years.

INSTALLATION

Universal mounting base for use with single- or twin-head applications. Mounts to a single-gang switch box.

LISTINGS

UL Listed. Damp location listed (ELA Q) 50°F to 104°F (10°C to 40°C). Wet location listed (ELA QWP) 14°F to 122°F (-10°C to 50 °C).

WARRANTY

Complete warranty terms located at
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

QUANTUM®

Thermoplastic Emergency Light

ELA Q

Remote Fixture
Adjustable LED Lamp Head

ELA Q

ELA QWP

LED

ELA T Q

ELA T QWP

Specifications

Q single:	6-5/8" W x 4-3/4" H
Q twin:	8-1/4" W x 4-1/4" H
QWP single:	4-1/2" W x 5-3/4" H
QWP twin:	8-1/2" W x 5-3/4" H

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ELA Q L0304

ELA					
Family	**Housing**	**Number of heads**	**Fixture**	**Lamp type**	**Options**
ELA	(blank) White/gray[1] B Black	(blank) Single T Twin	Q Quantum LED series adjustable lamp head QWP Quantum LED series adjustable lamp head, weather-proof, cast aluminum	L0304 1.5W/3.6V LED lamps, per lamp head[2] L0309 1.5W/9.6V LED lamps, per lamp head[3]	SD For use with self-diagnostic fixtures[5]

Accessories: *Order as separate item.*	
ELA WG1	Wireguard, 15"W x 13-1/2" H x 6" D[4]

Notes

1 White standard for Q, gray standard for QWP.
2 For use with ELM2 LED only.
3 For use with LHQM LED only.
4 See spec sheet ELA_WG.
5 SD must be ordered in combination with ELM2 LED and LHQM LED fixtures.

ELA Q LED QUANTUM® Thermoplastic Emergency Light

The following information is provided to assist in planning layouts for emergency lighting systems. The National Electrical Code limits voltage drop to a maximum of 5% of nominal. Thus, circuit runs must be of sufficient size to maintain operating voltage when remote fixtures and/or exit signs are connected to the emergency lighting equipment. The table below shows the length of wire run based on system voltage, wire gauge and total wattage on the run.

ELA_ L0304 configurations (for use with ELM2 LED)

AWG	18	16	14	12	10
DC Resistance (ohms/ft)	0.0078	0.0049	0.0031	0.0019	0.0012

Watts	Length of Run				
1.5	26	42	67	106	170
3	13	21	33	53	85
4.5	9	14	22	35	57
6	7	10	17	27	42
7.5	5	8	13	21	34
9	4	7	11	18	28
10.5	4	6	10	15	24
12	3	5	8	13	21

ELA_ L0309 configurations (for use with LHQM LED)

AWG	18	16	14	12	10
DC Resistance (ohms/ft)	0.0078	0.0049	0.0031	0.0019	0.0012

Watts	Length of Run				
1.5	188	298	475	756	1206
3	94	149	238	378	603
4.5	63	99	158	252	402
6	47	75	119	189	301
7.5	38	60	95	151	241
9	31	50	79	126	201
10.5	27	43	68	108	172
12	23	37	59	95	151

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800-334-8694 Fax: 770-981-8141 www.lithonia.com
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LITHONIA LIGHTING®

Catalog Number	ELM2
Notes	
Type	EM

FEATURES & SPECIFICATIONS

INTENDED USE — Provides a minimum of 90 minutes of illumination for the rated wattage upon loss of AC power. Ideal for applications requiring attractive unit equipment with quick installation.

CONSTRUCTION — White, compact, low-profile contemporary design. Engineering-grade thermoplastic housing is impact-resistant, scratch-resistant and corrosion-proof. UL94V-0 flame rating. UV-stable resin resists discoloration from natural and man-made light sources.

OPTICS — Two 5.4W wedge-based krypton lamps offer 32 percent more light output than standard incandescent lamps.

Patented, MR24, multi-faceted reflector significantly improves photometric performance – 60 to 100 percent more light delivered to path of egress.

U.S. Patent No. D484,272

Low-profile, integrated test switch/pilot light. Easily visible bright red status indicator.

ELECTRICAL — Current-limiting charger maximizes battery life and minimizes energy consumption. Provides low operating costs.

Short-circuit protection – current-limiting charger circuitry protects printed circuit board from shorts.

Dual-voltage input capability (120/277V). Edge connectors on printed circuit board ensure long-term durability.

Thermal protection senses circuitry temperature and adjusts charge current to prevent overheating and charger failure.

Thermal compensation adjusts charger output to provide optimum charge voltage relative to ambient temperature.

Battery: Sealed, maintenance-free lead acid (SLA) provides 12W rated capacity. Automatic 48-hour recharge after a 90-minute discharge. Low-voltage disconnect prevents excessively deep discharge that can permanently damage the battery. Single-circuit battery connection.

Regulated charge voltage maintains constant-charge voltage over a wide range of line voltages. Prevents over/under charging that shortens battery life and reduces capacity.

Filtered charger input minimizes charge voltage ripple and extends battery life.

AC/LVD reset allows battery connection before AC power is applied and prevents battery damage from deep discharge

Brownout protection is automatically switched to emergency mode when supply voltage drops below 80 percent of nominal.

INSTALLATION — Unique track-and-swivel arrangement permits full range of direction of lamp head adjustment. Universal J-box mounting pattern. Tool-less access for maintenance. Flexible conduit entry provision on top of the unit. Ceiling mount standard. **US Patent No. D473,627.**

LISTINGS — Meets UL924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards. Meets all applicable FCC requirements.

WARRANTY — 3-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

QUANTUM®

Thermoplastic Emergency Light

ELM2

Lead-Calcium Battery

ORDERING INFORMATION For shortest lead times, configure product using **standard options (shown in bold).** **Example:** ELM2

ELM2	
Family	**Options**
ELM2	**B** Black housing

Accessories[1]: Order as separate item.	
ELA VS	Thermoplastic vandal shield[1]
ELA WG1	Wireguard, 15"W x 13-1/2"H x 6"D[2]

Notes

1 See spec sheet ELA-RTLP-MS-VS2.

2 See spec sheet ELA-WG.

ELM2 Quantum® Thermoplastic Emergency Light

SPECIFICATIONS

ELECTRICAL

Primary Circuit

Type	Input Volts	Input Amps	Input Watts	Output volts	Watts output 1-1/2 hrs.	Watts output 2hrs.
ELM2	120	.11	1.2	6	12	9
	277	.12	1.5			

BATTERY

Sealed Lead Acid (SLA)
*with lead calcium alloy grids

Voltage	Shelf life[1]	Typical life[1]	Maintenance[2]	Optimum temperature[3]
6	12 months	5 - 7 years	none	60°– 90°F (16°– 32°C)

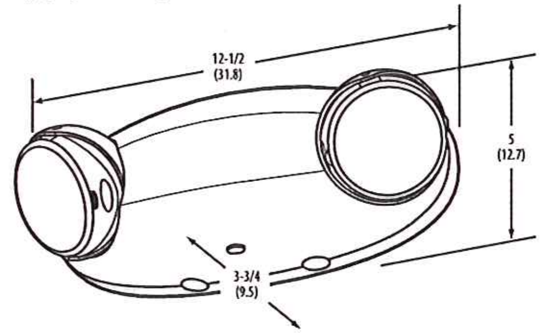
1 At 77°F (25°C).

2 All life safety equipment, including emergency lighting for path of egress, must be maintained, serviced and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service or testing could jeopardize the safety of occupants and will void all warranties.

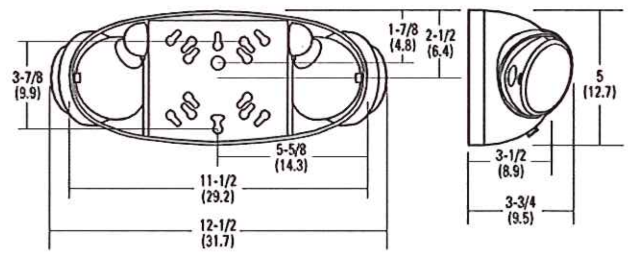
3 Optimum ambient temperature range where unit will provide capacity for 30 to 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

MOUNTING

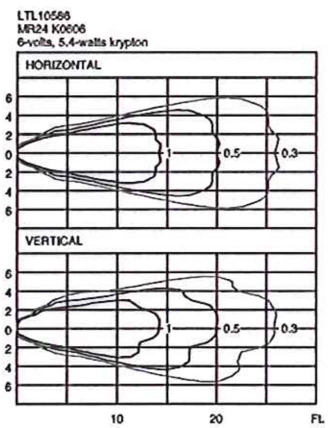
All dimensions are inches (centimeters).
Shipping weight: 4.0 lbs. (1.8 kgs.).



Mounting Plate



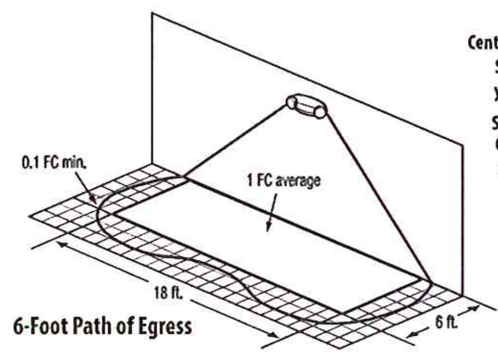
LAMP PHOTOMETRICS



SPACING/COVERAGE GUIDE

MR24 K0606 Lamp	Path of Egress 3'-wide	Path of Egress 6'-wide
Center-to-Center Spacing	25'	20'
Single-Unit Coverage	24'	18'

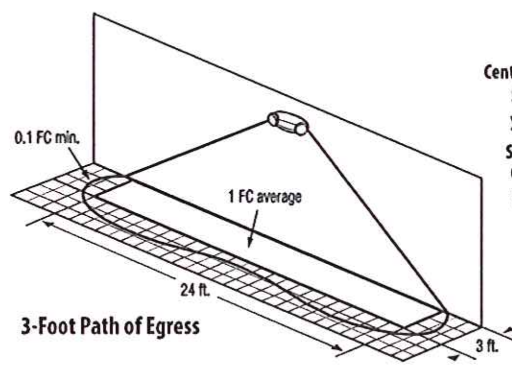
FIXTURE PERFORMANCE



6-Foot Path of Egress

Center-to-Center Spacing* yields 20'

Single-Unit Coverage* yields 18'



3-Foot Path of Egress

Center-to-Center Spacing* yields 25'

Single-Unit Coverage* yields 24'

* Meets Life Safety Code standard minimum illuminance of 0.1 FC and average illuminance of 1.0 FC. Assumes open space with no obstructions, mounting height: 7.5', ceiling height: 9', and reflectances: 80/50/20. Analysis based on independently tested photometrics.

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 Fax: 770.981.8141 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	UCLD 12 WH
Notes	
Type	K

FEATURES & SPECIFICATIONS

INTENDED USE

Provides task or accent lighting in commercial, retail, hospitality and residential applications. Ideal for use under and over cabinets, display cases, task lighting, office lighting, coves and utility/work areas.

CONSTRUCTION

Low profile design, with on/off rocker switch. Can be direct wired or powered by 5' cord-and-plug (Included). Connect multiple fixtures with 13" connector cord (Included).

Rugged low profile aluminum housing, available in either white, bronze, or brushed nickel finish. Swivel head allows light to be directed to desired area.

ELECTRICAL

LEDs have a 50,000 hour L70 rated life. Provides warm color temperature, 3000 K or 2700 K with CRI 83, and even illumination.

Standard with stepdown 120V driver (120V, 60Hz).

Can be used with standard dimmable switches.

INSTALLATION

All mounting hardware included.

LISTINGS

CUL listed to US and Canadian safety standards. ENERGY STAR® and Title 24 qualified.

WARRANTY

Five-year limited warranty. Full warranty terms located at www.AcuityBrands.com/CustomerResources/Terms_and_Conditions.aspx.

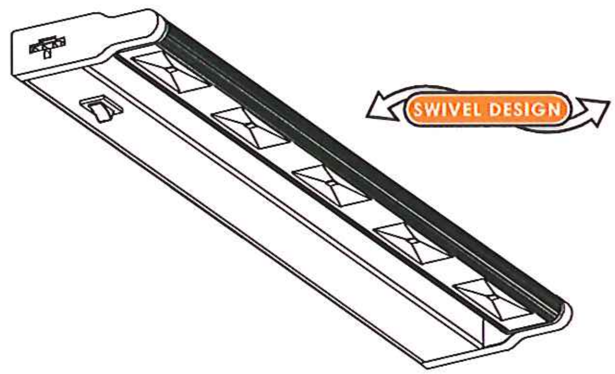
Note: Specifications are subject to change without notice.

Indoor General Purpose

LED Cabinet Light

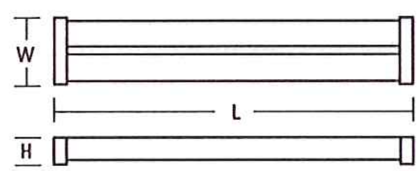
Linkable

MEETS TITLE 24 · LED lighting facts · ENERGY STAR · c UL us LISTED



Specifications

Length: UCLD 12 - 12 (30.5)
UCLD 18 - 18 (45.7)
UCLD 24 - 24 (60.9)
Width: 3-5/8 (9.2)
Height: 1 (2.5)



All dimensions are inches (centimeters)

ORDERING INFORMATION For shortest lead times, configure products using **bolded options.**

Example: UCLD 12 WH

Series		Driver		Color temperature		Finish	
UCLD 12	12" long with 3 LEDs	**(blank)**	120V dimmable driver	**(blank)**	3000 K	**WH**	White
UCLD 18	18" long with 5 LEDs			2700	2700 K	BZ	Bronze
UCLD 24	24" long with 7 LEDs					BN	Brushed nickel

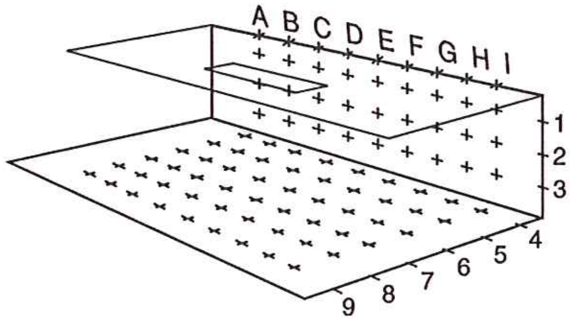
Accessories: *Order as separate catalog number.*	
UCD JB	Splice box - allows for quick and easy direct wiring
UC ERC	1-1/8" row connector for end-to-end connections
UC ERC24	24" connector cord for longer length connections

PHOTOMETRIC DIAGRAMS

Photometry derived in accordance with IESNA LM41 procedure. Vertical and horizontal illuminance is calculated with fixture mounted 17" from work surface.
Full photometric data report available within 2 weeks from request. Consult factory.

UCLD 12 Report LTL 21648
Initial Point Illuminance on wall and horizontal work surface. (fc)
X and Y coordinates are on 6" centers.

	X	A	B	C	D	E	F	G	H	I	
Vertical	1	1	1	2	4	6	4	2	1	1	Avg.=4 fc
	2	1	3	6	12	16	12	6	3	1	Max.=16 fc; Min.=1 fc
	3	2	3	6	11	13	11	6	3	2	Max. to min. ratio =16
Horizontal	4	3	5	9	15	18	15	9	5	3	
	5	3	6	13	22	27	22	13	6	3	Avg.=6 fc
	6	3	6	13	22	27	22	13	6	3	Max.=27 fc; Min.=1 fc
	7	3	5	9	14	17	14	9	5	3	Max. to min. ratio =27
	8	2	3	5	8	9	8	5	3	2	
	9	1	2	3	4	4	4	3	2	1	



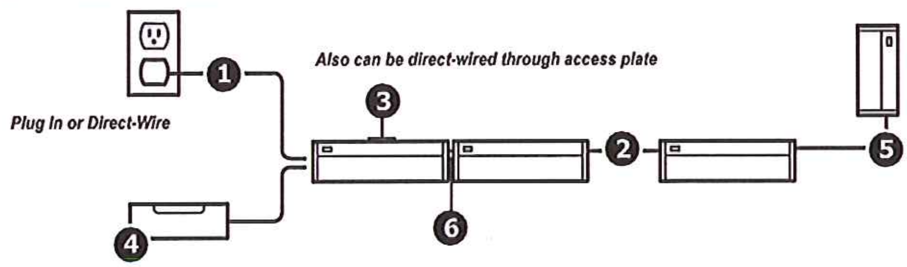
UCLD 18 Report LTL 21649
Initial Point Illuminance on wall and horizontal work surface. (fc)
X and Y coordinates are on 6" centers.

	X	A	B	C	D	E	F	G	H	I	
Vertical	1	1	2	4	7	8	7	4	2	1	Avg.=7 fc
	2	3	5	11	19	23	19	11	5	3	Max.=23 fc; Min.=2 fc
	3	3	6	11	17	20	17	11	6	3	Max. to min. ratio =11.5
Horizontal	4	5	9	16	25	28	25	16	9	5	
	5	6	12	23	36	42	36	23	12	6	Avg.=11 fc
	6	6	12	23	35	41	35	23	12	6	Max.=42 fc; Min.=1 fc
	7	5	9	16	23	27	23	16	9	5	Max. to min. ratio =42
	8	3	5	9	12	14	12	9	5	3	
	9	2	3	5	6	7	6	5	3	2	

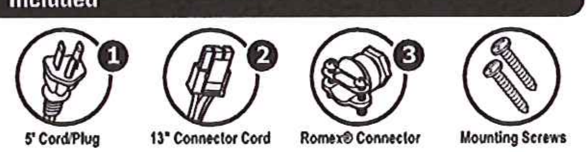
UCLD 24 Report LTL 21650
Initial Point Illuminance on wall and horizontal work surface. (fc)
X and Y coordinates are on 6" centers.

	X	A	B	C	D	E	F	G	H	I	
Vertical	1	2	3	6	9	10	9	6	3	2	Avg.=10 fc
	2	4	8	16	25	28	25	16	8	4	Max.=28 fc; Min.=2 fc
	3	5	9	16	23	25	23	16	9	5	Max. to min. ratio =14
Horizontal	4	7	14	23	32	36	32	23	14	7	
	5	9	18	32	46	52	46	32	18	9	Avg.=15 fc
	6	9	18	32	46	52	46	32	18	9	Max.=52 fc; Min.=2 fc
	7	7	13	22	30	34	30	22	13	7	Max. to min. ratio =26
	8	5	8	12	16	18	16	12	8	5	
	9	3	5	6	8	9	8	6	5	3	

Installation



Included



Accessories
sold separately

Suggested Dimmers

This fixture is designed to operate with most standard Triac Based (Forward Phase-Control or Leading Edge) dimmer and is not compatible with 0-10v dimming systems.
Noted below is a listing of dimmers that have been tested with this fixture. This list of dimmers does not imply any guarantee or warranty of compatibility with a particular application.
Dimmers that are not listed do not imply non-compatibility.

Lutron Diva DV-600P
Lutron SkyLark S-600P (Slide & On-Off Switch)
Lutron Ariadni AY-600P
Lutron Ariadni TG-603P
Lutron Maestro MA-600 (Digital Fade Dimmer)
Leviton IllumaTech IPI06-1LX
Leviton ToggleTouch TGI06-1LW (Digital Control)
Lutron MAELV-600BL (Digital Trailing Edge)
Lutron DVELV-300P-WH (Trailing Edge)

Note: When the installation exceeds 10 fixtures on a single dimmer or distribution lengths exceed 100 feet, please confirm that the end product performs properly.
This is caused by a high degree of variability in the triac dimmers.

LITHONIA LIGHTING®
An Acuity Brands Company

DECORATIVE INDOOR & OUTDOOR: One Lithonia Way Conyers, GA 30012 Phone: 800-748-5070 Fax: 770-860-3903 www.lithonia.com © 2012-2013 Acuity Brands Lighting, Inc. All rights reserved. Rev. 09/09/13

UCLD LED Cabinet Light

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	226
Watts	5.2
Lumens per Watt (Efficacy)	43
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2981 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-GNGSNF (1/27/2012)
Model Number: UCLD 12
Type: Under-cabinet or Shelf-mounted light

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	377
Watts	8.6
Lumens per Watt (Efficacy)	44
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2970 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-K628XK (2/7/2012)
Model Number: UCLD 18
Type: Under-cabinet or Shelf-mounted light

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	504
Watts	11.8
Lumens per Watt (Efficacy)	43
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2996 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-JZ3EZQ (1/27/2012)
Model Number: UCLD 24
Type: Under-cabinet or Shelf-mounted light

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	211
Watts	5.2
Lumens per Watt (Efficacy)	41
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2700 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-HAGFJ1 (2/28/2013)
Model Number: UCLD 12 2700
Type: Under-cabinet or Shelf-mounted light

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	347
Watts	8
Lumens per Watt (Efficacy)	43
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2700 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-G26WY3 (2/13/2013)
Model Number: UCLD 18 2700
Type: Luminaire - Desk/Task

LED **lighting facts**® A Program of the U.S. DOE — Lithonia Lighting

Light Output (Lumens)	472
Watts	11
Lumens per Watt (Efficacy)	43
Color Accuracy Color Rendering Index (CRI)	83
Light Color Correlated Color Temperature (CCT)	2700 (Warm White)

Warm White · Bright White · Daylight
2700K · 3000K · 4500K · 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting*. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide*.

Registration Number: NJSM-5VTLE5 (2/13/2013)
Model Number: UCLD 24 2700
Type: Luminaire - Desk/Task

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LITHONIA LIGHTING®

Catalog Number	WL4 40L EZ1 LP840 EL14L
Notes	
Type	L

FEATURES & SPECIFICATIONS

INTENDED USE — For wall or ceiling mounting, vertical or horizontal. The WL combines digital LED lighting and controls technologies with high-performance optical design to offer the most advanced wall-mount luminaire for general ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Housing is roll formed from code-gauge steel.

Refractor is retained in die cast ends providing secure installation and easy maintenance.

Decorative die-cast end caps provide added durability.

Finish: All metal parts are post-painted in white polyester powder coat for smooth, finished edges and uniform light distribution.

OPTICS — Impact modified linear faceted refractor. Optically engineered for superior light distribution and maximum efficacy.

Crescent-shape linear faceted refractor system obscures and integrates individual LED images and uniformly washes fixture surface with light.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 90% LED lumen maintenance at 60,000 hours (L90/60,000). The LEDs have a CRI of 82.

eldoLED driver options deliver choice of dimming range and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Driver disconnect provided where required to comply with US and Canadian codes.

CONTROLS — Optional nLight™ embedded controls continuously monitor system performance and allow for constant lumen management function.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing energy waste created by the traditional practice of over-lighting.

Integral occupancy control: Integrated occupancy sensors allow luminaire to power off or dim to 10% or 50% output when space is unoccupied. Fixture designed to fail on.

The nES 7 is ideal for small rooms without obstructions or areas with primarily walking motion (e.g. corridors, stairwells). Additionally, the NES7ADCX includes an integrated photocell, which enables daylight harvesting.

For rooms like restrooms and private offices or any space with obstructions, the nES PDT 7 dual technology sensor is recommended. The nES PDT 7 utilizes both PIR (passive infrared) and Microphonics™ technologies to detect occupancy.

Wireless networking: XPoint™ Wireless technology creates a mesh network to ensure communication between fixtures, sensors and wall stations facility-wide. This option provides superior lighting management capabilities including granular control, configuration and custom grouping. This option enables sensors that detect motion to wirelessly communicate to neighboring fixtures — whether on different floors in a stairwell, to a corridor or hallway — illuminating the desired path.

LISTINGS — CSA certified to meet U.S. and Canadian standards. Suitable for damp location.

Patents pending. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

W SERIES

Wall bracket & Surface Mount LED

WL4

4'

LED

DLC · EDISON AWARDS 2013 NOMINEE · nLIGHT ENABLED · NGL'13 Best in Class · eldoLED

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: WL4 30L EZ1 LP840

Series	Lumens[1]	Voltage	Driver	Color temperature	Lumen management
WL4 — 4' wall-mount LED	20L — 2000 lumens 30L — 3000 lumens 40L — 4000 lumens	(blank) — MVOLT (120-277V) 347 — 347V	EZ1 — eldoLED dims to 1%, 0-10V EZB — eldoLED dims to dark, 0-10V SLD — Step-level dimming[2]	LP830 — 3000 K LP835 — 3500 K LP840 — 4000 K LP850 — 5000 K	(blank) — No nLight N80 — nLight with 80% lumen management N100 — nLight without lumen management N80EMG — nLight with 80% lumen management for use with generator supply emergency power[3] N100EMG — nLight without lumen management for use with generator supply emergency power[3]

Occupancy control[4]	Standby mode[10]	Options	Finish[12]
NES7 — Sensor Switch® nES 7 PIR integral occupancy sensor[5] NESPDT7 — Sensor Switch® nES PDT 7 dual technology integral occupancy control[5] NES7ADCX — Sensor Switch® nES 7 ADCX PIR integral occupancy sensor with automatic dimmng control photocell[5] XADS7 — XPoint™ Wireless controller and micro 360° PIR occupancy and photocell sensor[6,7] XADNS7 — XPoint™ Wireless controller and micro 360° PIR occupancy and photocell sensor (egress lighting)[6,7] MSD7 — Sensor Switch® MSD 7 PIR integral occupancy sensor[8,9]	(blank) — Fixture turns off when unoccupied DIM10 — Fixture dims to approximately 10% light output when unoccupied DIM50 — Fixture dims to approximately 50% light output when unoccupied[8]	EL7L — LED Emergency battery pack (nominal 700 lumens); see Life Safety section[11] EL14L — LED Emergency battery pack (nominal 1400 lumens); see Life Safety section[11] SC — Surface conduit end cap provisions	(blank) — White

Notes

1. Approximate lumen output.
2. Not available with XPoint™ Wireless or nLight options.
3. nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.
4. See integral occupancy control section in header.
5. Requires N80 or N100.
6. Select (blank) under "Lumen management" for this option.
7. Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
8. Not available with EZB or SLD.
9. Requires DIM10 or DIM50.
10. Requires occupancy control. For XPoint™ Wireless select (blank). Standby mode is programmed at time of commissioning.
11. Not available with 347V.
12. For additional paint finishes refer to Architectural Colors.

WL4 Wall Bracket & Surface Mount LED

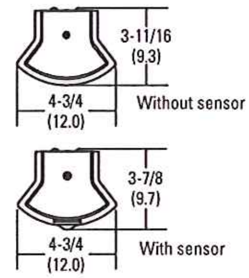
Performance Data			
Lumen package	**Input watts**	**Lumens**	**LPW**
20L LP830	18.7	2050	110
20L LP835	18.7	2152	115
20L LP840	18.7	2255	121
20L LP850	18.7	2410	129
30L LP830	28.2	2952	105
30L LP835	28.2	3095	110
30L LP840	28.2	3251	115
30L LP850	28.2	3239	115
40L LP830	39.5	3927	99
40L LP835	39.5	4124	104
40L LP840	39.5	4325	110
40L LP850	39.5	4571	116

DIMENSIONS

All dimensions are inches (centimeters) unless otherwise noted.

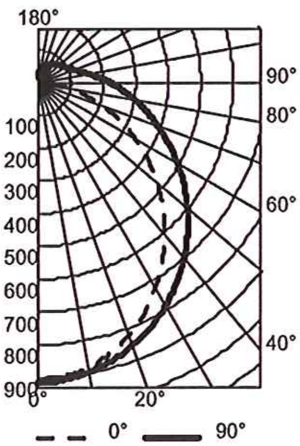
Specifications

Length: with sensor - 50-15/16 (129.40)
without sensor - 46-13/16 (118.90)
Height: with sensor - 3-11/16 (9.3)
without sensor - 3-7/8 (9.7)
Width: 4-3/4 (12.1)



PHOTOMETRICS

WL4 30L EZ1 LP840, 3250.8 delivered lumens, test no. LTL25482P5, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	912	912
5°	901	910
15°	856	879
25°	777	823
35°	666	745
45°	542	650
55°	412	549
65°	279	444
75°	151	346
85°	44	257
90	5	219

Coefficients of Utilization

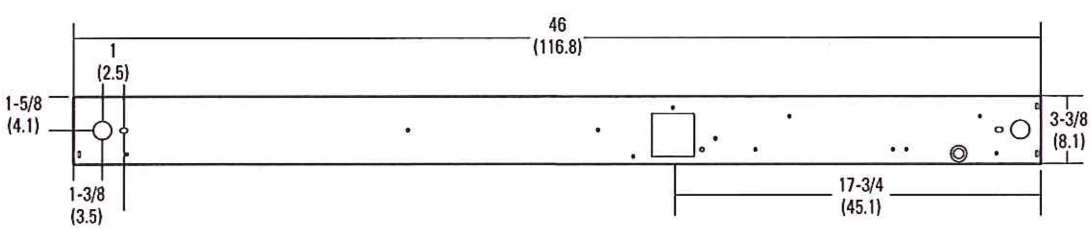
pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	116	116	116	112	112	112	104	104	104
1	104	99	94	95	91	87	88	85	81
2	94	85	78	82	75	70	76	71	66
3	85	74	66	72	64	57	67	60	55
4	78	66	56	63	55	48	59	52	46
5	72	58	49	57	48	42	53	46	40
6	66	52	43	51	42	36	48	40	35
7	61	47	39	46	38	32	43	36	31
8	57	43	35	42	34	28	40	32	27
9	53	40	31	39	31	25	36	29	25
10	50	37	29	36	28	23	34	27	22

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	701	21.6	21.6
0° - 40°	1143	35.2	35.2
0° - 60°	2032	62.5	62.5
0° - 90°	2829	87.0	87.0
90° - 120°	256	7.9	7.9
90° - 130°	310	9.5	9.5
90° - 150°	386	11.9	11.9
90° - 180°	421	13.0	13.0
0° - 180°	3251	100.0	100.0

MOUNTING DATA

For unit installation; surface ceiling or wall mounting.



LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 Fax: 770-929-8789 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	ZL2N L24 2000LM MDD MVOLT 40K 80CR
Notes	
Type	M2 & M4

Lensed LED Striplight

ZL2N

24" and 48" Lengths

FEATURES & SPECIFICATIONS

INTENDED USE — Sharing many popular Z Series elements, this solid-state strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge, cold-rolled steel. Improved easy "snap 'n' lock" end plates allow for quick attachment.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Replaceable medium diffuse lens (up to 10%) offer ingress protection from debris.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Internal pluggable wiring harness prevents wiring errors. Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard.** This fixture is designed to withstand a maximum line surge of 1.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide 83 CRI at 3000 K, 3500 K,4000 K or 5000 K.

Lumen output ranges from 2100 to 6000 lumens. Beam angle is 110 FWHM (full width at half maximum).

Lumen output up to 1,300 lumens per foot. In 86°F (30°C) ambient environments, L70 is predicted to be 100,000+ hours, L85 at 44,000 hours. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C). Ambient temperatures that exceed 86°F (30°C) will result in reduced life and will void warranty.

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface, pendant or stem mounted. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — UL Listed. CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 86°F (30°C).

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Actual wattage may differ by +/- 5% when operating between 120-277V +/- 10%.

Note: Specifications subject to change without notice.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL2N L48 3000LM MDD MVOLT 40K 80CRI WH

ZL2N			MDD					
Series	**Length**	**Nominal lumens[1]**	**Diffuser**	**Voltage**	**Color temperature**	**Color rendering index**	**Options**	**Paint finish**
ZL2N Lensed LED striplight	L24 24" L46 46" L48 48"	2000LM 2,000 lumens 2000LM 2,000 lumens 3000LM 3,000 lumens 5000LM 5,000 lumens	MDD Medium diffuse	MVOLT 120-277V HVOLT 347-480V[2]	40K 4000 K 30K 3000 K 35K 3500 K 50K 5000 K	80CRI 80 CRI 90CRI 90 CRI	PLR Plug-in wiring[3] BSL722 Emergency battery pack[4,5]	WH White GALV Galvanized MB Matte black SKGY Smoke gray

Accessories: *Order as separate catalog number.*	
ZACVH	Aircraft cable with hook
HC36	Hanger chain, 36"
ZSPRG	For 15/16" T-grid only
LSXR	Sensor Switch® LSXR occupancy sensor[3]

Replacement Lens	
LZL2 XX MDIF	Medium-diffuse lens. Specify length 24 or 48 (example: LZL2 24 MDIF)[6]

Notes

1 See Operational Data on page 2 for actual lumens.
2 Not available with L24, 24" fixture.
3 See ordering information on page 3.
4 Specify voltage; 120 or 277.
5 Output is 1400 lumens.
6 XX denotes length.

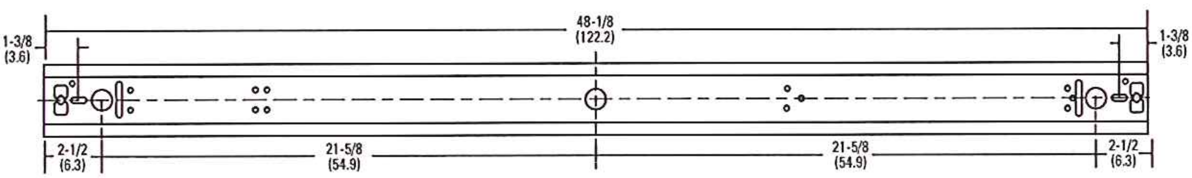
OPERATIONAL DATA							
Nominal lumen package	Length (inches)	Delivered lumens 3000 K CCT @ 77°F (25°C) ambient temperature	Delivered lumens 3500 K CCT @ 77°F (25°C) ambient temperature	Delivered lumens 4000 K CCT @ 77°F (25°C) ambient temperature	Delivered lumens 5000 K CCT @ 77°F (25°C) ambient temperature	Wattage @ 120V/277V	Comparable light source
2,000LM	24	2, 009	2,092	2,249	2,457	34W/32W	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
2,000LM	46 or 48	1,830	1,905	2,048	2,237	32W/31W	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
3,000LM	46 or 48	2,835	2,952	3,173	3,467	42W/41W	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
5,000LM	46 or 48	4,274	4,450	4,784	5,226	72W/70W	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID

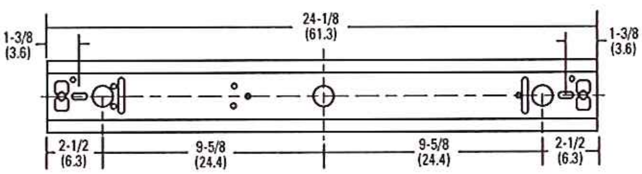
PROJECTED LUMEN MAINTENANCE								
Operating hours	0	10,000	20,000	30,000	40,000	50,000	60,000	100,000
Lumen maintenance factor	1	0.9466	0.9173	0.8888	0.8613	0.8346	0.8088	0.7131
Based on incomplete LM-80 data. Update expected Q1 2014.								

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

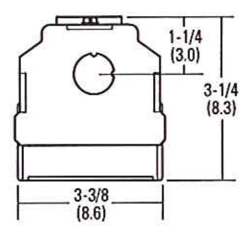
Specifications subject to change without notice.





KO SIZE = 7/8 (22) Dia

SLOT SIZE = 1/2 (12.7) X 1/8 (4.0)



PHOTOMETRICS

Please see www.lithonia.com.

PRODUCT INFORMATION

Wiring

PLR

Advanced 3-Circuit Plug-In

Advanced plug-in system with three-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and PLR33 (3-circuit) crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Ground	
PLR	(blank)	Not required for 22 or 33	Circuits to which ballast is connected		B	Red wire	(blank)	No ground in PLR
PLR22	1	Black	(blank)	Not required for 22 or 33	C	Blue wire	G	Ground. Maximum 2 circuits
PLR33	2	Black and red	A	Black wire				
	3	Black, red and blue						

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22) and 3-circuit (PLR 33)
- Multiple circuit with night-lights located along row as desired

TYPICAL APPLICATIONS										
PLR 3 C	PLR 3 C	PLR 3 C	PLR 3 C	PLR 2 B	PLR 2 B	PLR 2 B	PLR 2 B	PLR 1	PLR 1	PLR 1
(All PLR22)										
Circuit A	Circuit B	Circuit A	Circuit B	Circuit A	Circuit B	Circuit A	Circuit B	Circuit A	Circuit B	Circuit A
(All PLR33)										
Circuit A	Circuit B	Circuit C	Circuit A	Circuit B	Circuit C	Circuit A	Circuit B	Circuit C	Circuit A	Circuit B
PLR 3 A	PLR 3 A	PLR 3 A	PLR 3 C	PLR 3 B	PLR 3 B	PLR 3 B	PLR 3 C	PLR 3 A	PLR 3 A	PLR 3 A

PRODUCT INFORMATION

Passive Infrared Indoor Occupancy Sensor

LSXR

Single Relay

sensorswitch

A standard occupancy time delay is also present to ensure lights turn off (once minimum on timer has also elapsed) if no occupancy is detected.

This timer is factory set at 10 minutes to promote energy savings, but is adjustable between 30 seconds and 30 minutes. These adjustments may be done through the unit's push-button.

FEATURES

- Four interchangeable lenses - high mount 360°, low mount 360°, high mount aisleway, and small motion 360°.
- Integrated mounting bracket drops lens down 3" from chase nipple - no bracket accessory required.
- 100% digital PIR detection - provides excellent RF immunity

Note: Specifications subject to change without notice.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LSXR 10 ADC HVOLT 30M

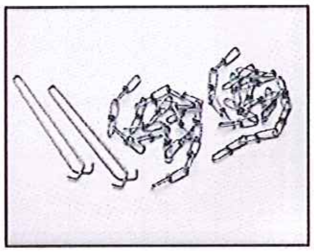
LSXR							
Series		**Lens option**				**Dimming/photocell**	
LSXR	Passive Infrared Indoor Occupancy Sensor	(blank)	No lens	610	High and low mount 360°	(blank)	None
		6	High mount, 360°	650	High mount 360° and aisleway	HL	High/low occupancy operation
		10	Low mount, 360°	3PK	High and low mount 360° and aisleway	P	Switching photocell (on/off)
		50	High mount aisleway	4PK	All lenses	ADC	Dimming and switching photocell
		9	Small motion, 360°			ANL	Dimming and switching photocell with high/low occupancy operation

Voltage		Max dim level		Min dim level		Lead length		Temp humidity		Default time delay	
(blank)	120-277 VAC (MVOLT)	(blank)	10 VDC	(blank)	Minimum dimming level of ballast	(blank)	14"	(blank)	None	(blank)	10 minutes (with minimum 15 minutes on time)
HVOLT	347-480 VAC	9H	9 VDC	1V	1 VDC	42L	42"	LT	Low temperature	5M	5 minutes (LED only)
		8H	8 VDC	2V	2 VDC					15M	15 minutes
		7H	7 VDC	3V	3 VDC					20M	20 minutes
				4V	4 VDC					30M	30 minutes
				5V	5 VDC						
				6V	6 VDC						

For additional information see www.lithonia.com

OPTIONS AND ACCESSORIES

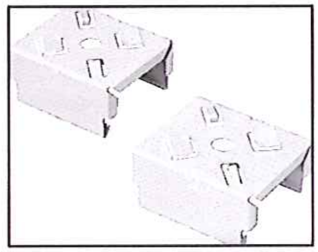
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.



HANGER CHAIN

36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER

Snap'n'lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:
ZSPRG

LITHONIA LIGHTING®
An Acuity Brands Company

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 Fax: 770-981-8191 www.lithonia.com
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LITHONIA LIGHTING®

Catalog Number	WL2 22L EZ1 LP840
Notes	
Type	R

FEATURES & SPECIFICATIONS

INTENDED USE — For wall or ceiling mounting, vertical or horizontal. The WL combines digital LED lighting and controls technologies with high-performance optical design to offer the most advanced wall-mount luminaire for general ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Housing is roll formed from code-gauge steel.

Refractor is retained in die cast ends providing secure installation and easy maintenance.

Decorative die-cast end caps provide added durability.

Finish: All metal parts are post-painted in white polyester powder coat for smooth, finished edges and uniform light distribution.

OPTICS — Impact modified linear faceted refractor. Optically engineered for superior light distribution and maximum efficacy.

Crescent-shape linear faceted refractor system obscures and integrates individual LED images and uniformly washes fixture surface with light.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 90% LED lumen maintenance at 60,000 hours (L90/60,000). The LEDs have a CRI of 82.

eldoLED driver options deliver choice of dimming range and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Driver disconnect provided where required to comply with US and Canadian codes.

CONTROLS — Optional nLight™ embedded controls continuously monitor system performance and allow for constant lumen management / compensation function.

Lumen Management: Unique lumen management system (option N80) provides onboard intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing energy waste created by the traditional practice of over-lighting.

Integral occupancy control: Integrated occupancy sensors allow luminaire to power off or dim to 10% or 50% output when space is unoccupied. Fixture designed to fail on.

The nES 7 is ideal for small rooms without obstructions or areas with primarily walking motion (e.g. corridors, stairwells). Additionally, the NES7ADCX includes an integrated photocell, which enables daylight harvesting.

For rooms like restrooms and private offices or any space with obstructions, the nES PDT 7 dual technology sensor is recommended. The nES PDT 7 utilizes both PIR (passive infrared) and Microphonics™ technologies to detect occupancy.

Wireless networking: XPoint™ Wireless technology creates a mesh network to ensure communication between fixtures, sensors and wall stations facility-wide. This option provides superior lighting management capabilities including granular control, configuration and custom grouping. This option enables sensors that detect motion to wirelessly communicate to neighboring fixtures — whether on different floors in a stairwell, to a corridor or hallway — illuminating the desired path.

LISTINGS — CSA certified to meet U.S. and Canadian standards. Suitable for damp location.

Patents pending.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

W SERIES

Wall bracket & Surface Mount LED

WL2

2'

LED

EDISON AWARDS 2013 NOMINEE nLIGHT ENABLED NGL'13 Best in Class eldoLED

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: WL2 18L EZ1 LP840

Series	Lumens[1]	Voltage	Driver	Color temperature	Lumen management
WL2					
WL2 2' wall-mount LED	08L 800 lumens 12L 1200 lumens 18L 1800 lumens 22L 2200 lumens	(blank) MVOLT (120 - 277V)	EZ1 eldoLED dims to 1%, 0-10V EZB eldoLED dims to dark, 0-10V SLD Step-level dimming[2]	LP830 3000 K LP835 3500 K LP840 4000 K LP850 5000 K	(blank) No nLight N80 nLight with 80% lumen management N100 nLight without lumen management N80EMG nLight with 80% lumen management for use with generator supply emergency power N100EMG nLight without lumen management for use with generator supply emergency power

Occupancy control[3]	Standby mode[7]	Options	Finish[9]
NES7 Sensor Switch® nES 7 PIR integral occupancy sensor[4] NESPDT7 Sensor Switch® nES PDT 7 dual technology integral occupancy control[4] NES7ADCX Sensor Switch® nES 7 ADCX PIR integral occupancy sensor with automatic dimmng control photocell[4] XADS7 XPoint™ Wireless controller and micro 360° PIR occupancy and photocell sensor[5,6] XADNS7 XPoint™ Wireless controller and micro 360° PIR occupancy and photocell sensor (egress lighting)[5,6] MSD7 Sensor Switch® MSD 7 PIR integral occupancy sensor	(blank) Fixture turns off when unoccupied DIM10 Fixture dims to approximately 10% light output when unoccupied DIM50 Fixture dims to approximately 50% light output when unoccupied[8]	SC Surface conduit end cap provisions	(blank) White

Notes

1 Approximate lumen output.
2 Not available with XPoint™ Wireless or nLight options.
3 See integral occupancy control section in header.
4 Requires N80 or N100.
5 Select (blank) under "Lumen management" for this option.
6 Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
7 Requires occupancy control. For XPoint™ Wireless select (blank). Standby mode is programmed at time of commissioning.
8 Not available with EZB.
9 For additional paint finishes refer to Architectural Colors.

WL2 Wall Bracket & Surface Mount LED

Performance Data			
Lumen package	Input watts[1]	Lumens	LPW
08L LP830	7.5	771	102.80
08L LP835	7.5	809	107.87
08L LP840	7.5	848	113.07
08L LP850	7.5	877	116.93
12L LP830	12.2	1190	97.54
12L LP835	12.2	1249	102.38
12L LP840	12.2	1311	107.46
12L LP850	12.2	1364	111.80
18L LP830	17.5	1711	97.77
18L LP835	17.5	1796	102.63
18L LP840	17.5	1889	107.94
18L LP850	17.5	1966	112.34
22L LP830	21.0	2086	99.33
22L LP835	21.0	2120.5	100.98
22L LP840	21.0	2189.4	104.26
22L LP850	21.0	2258.4	107.54

Notes

1 Acutal wattage may differ by +/- 5% when operating between 120-277V +/- 10%.

DIMENSIONS

All dimensions are inches (centimeters) unless otherwise noted.

Specifications

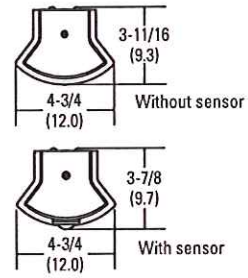
Length: with sensor - 25-7/8 (65.7)

without sensor - 23-3/8 (59.4)

Height: with sensor - 3-11/16 (9.3)

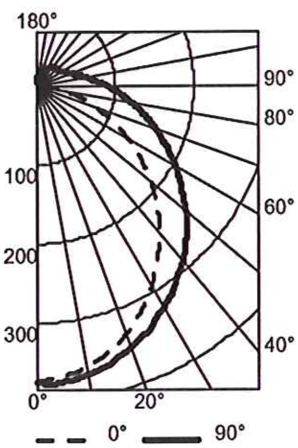
without sensor - 3-7/8 (9.7)

Width: 4-3/4 (12.1)



PHOTOMETRICS

WL2 12L EZ1 LP840, 1310.5 delivered lumens, test no. LTL25476P5, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	374	374
5°	367	376
15°	350	364
25°	315	340
35°	267	306
45°	216	269
55°	162	224
65°	109	182
75°	58	141
85°	17	105
90	2	88

Coefficients of Utilization

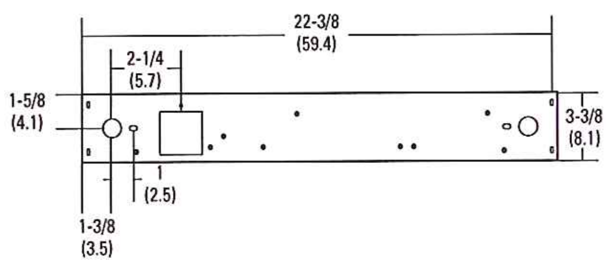
pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0	116	116	116	112	112	112	104	104	104
1	104	99	94	95	91	87	88	85	82
2	94	85	78	82	75	70	77	71	66
3	86	74	66	72	64	58	67	60	55
RCR 4	78	66	57	64	55	49	59	52	47
5	72	59	49	57	48	42	53	46	40
6	66	53	44	51	43	36	48	41	35
7	61	48	39	46	38	32	44	36	31
8	57	43	35	42	34	29	40	33	28
9	53	40	32	39	31	26	37	30	25
10	50	37	29	36	28	23	34	27	22

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	286	21.9	21.9
0° - 40°	466	35.6	35.6
0° - 60°	824	62.9	62.9
0° - 90°	1143	87.2	87.2
90° - 120°	101	7.7	7.7
90° - 130°	122	9.3	9.3
90° - 150°	154	11.7	11.7
90° - 180°	168	12.8	12.8
0° - 180°	1310	100.0	100.0

MOUNTING DATA

For unit installation; surface ceiling or wall mounting.



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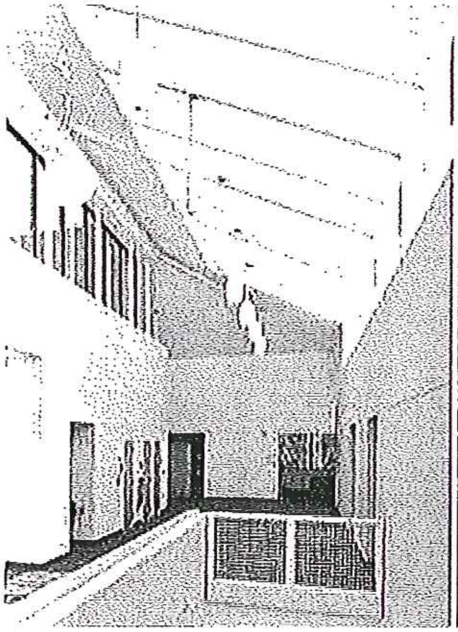
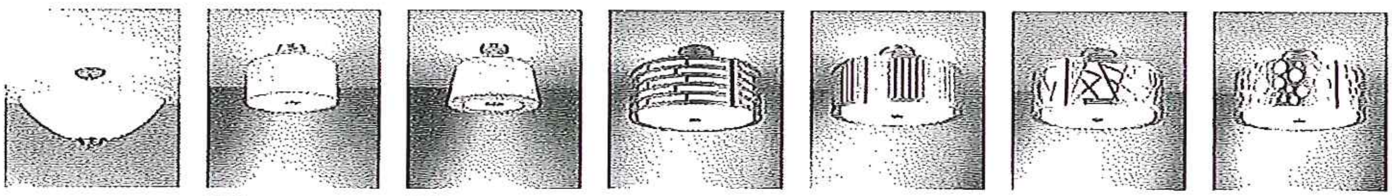


FIXTURE TYPE "S"

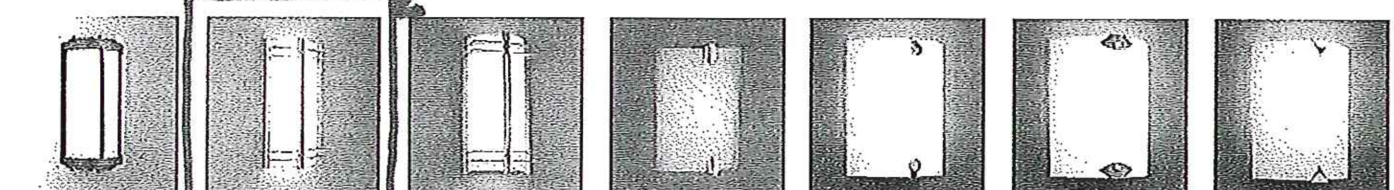
Ceiling Mount



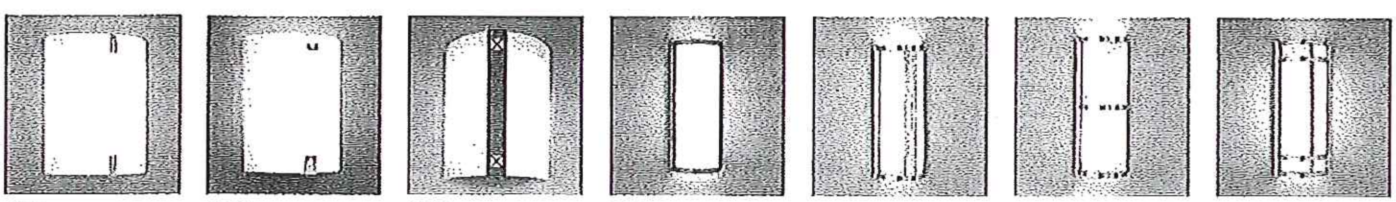
5801 5811 6131 6141 6151 6161

WINONA LIGHTING (LED)
WALL SCONCE IN CORRIDOR

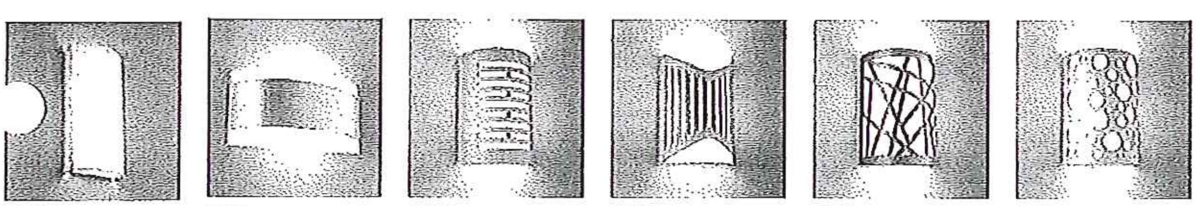
Wall Sconce



3703 3704-ADA 3704 4602 4612 4613 4614



4615 4616 4922 5250 5250-VB 5250-HB 5250-VHB



5803 6102 6132 6142 6152 6162

w

GE
Lighting

Evolve™ LED Area Light

Scalable Wall Pack (EWS2)

imagination at work

Product Features

The GE Evolve™ LED Scalable Wall Pack is optimized for customers looking for an efficient and reliable LED solution for wall mounted, site, area and general lighting applications.

Depending on the application, Evolve™ LED Scalable Wall Pack can yield up to a 75% reduction in system energy consumption compared with standard HID systems. This reliable system operates well in cold temperatures and offers more than 11 years of service life to reduce maintenance frequency and expense, based on a 50,000 hour rated life and 12 hours of operation per day. Containing no mercury or lead, this environmentally responsible product is RoHS compliant.

Applications

- Wall mounted, site, area and general lighting utilizing an advanced LED optical system providing uniformity, vertical light distribution, reduced offsite visibility, reduced on-site glare and effective security light levels.

Housing

- Die-cast aluminum housing.
- Sleek architectural design incorporating a heat sink directly into the unit ensuring maximum heat transfer and long LED life.
- Meets 1.5 G vibration standards per ANSI C136.31-2010.

LED & Optical Assembly

- Structured LED array for optimized area light photometric distribution.
- Evolve™ LED light engine utilizes reflective technology to optimize application efficiency and minimize glare.
- Utilizes high brightness LEDs, 70 CRI at 4000K & 5000K typical.
- LM-79 tests and reports are performed in accordance with IESNA standards.

Lumen Maintenance

- System rating is L85 at 50,000 hours. Contact manufacturer for Lxx rating (Lumen Depreciation) beyond 50,000 hours.

Ratings

- UL listed, suitable for wet locations.
- cUL listed with option code "J" SKUs.
- IP 65 rated optical enclosure per ANSI C136.25-2009.
- Title 24 compliant with motion sensor option.
- Temperature rated at -40° to 50°C. (35°C at high wattage 91W SKU).
- Upward Light Output Ratio (ULOR) = 0
- DLC Listed

Mounting

- Flush wall mount to "J" Box with inspection hole for IP 65.

Finish

- Corrosion resistant polyester powder paint, minimum 2.0 mil. thickness.
- Standard colors: Black and Dark Bronze.
- RAL & custom colors available.

Electrical

- 120-277 volt and 347-480 volt available.
- System power factor is >90% and THD <20%*.
- Integral surge protection:
  - Exceeds ANSI C136.2-2015 "Basic" (6kV/3kA) (120 strike)
- EMI: FCC Title 47 CFR Part 15 Class A.
- Motion sensor with dimming capability available with "H" option code.

** System THD <26% for 347-480v supply with A7 power level.*

Ordering Number Logic
Scalable Wall Pack (EWS2)

EWS2

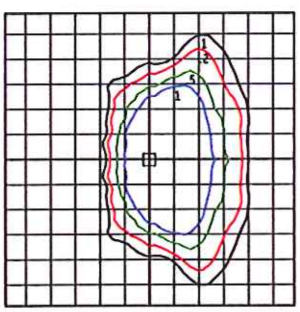
_ _ _ _   _   _ _   _ _   _ _   _   _ _ _ _   _ _ _

PROD. ID	VOLTAGE	POWER LEVEL	PHOTOMETRIC TYPE	LED COLOR TEMP	PE FUNCTION	COLOR	OPTIONS
E = Evolve W = Wallpack S = Scalable 2 = Product Generation	0 = 120-277 H = 347-480 1 = 120* 2 = 208* 3 = 240* 4 = 277* 5 = 480* D = 347* *Specify single voltage only if fuse option is selected.		D1 = Asymmetric Forward E1 = Asymmetric Medium	40 = 4000K 50 = 5000K	1 = None NOTE: Select "H" Option for PE functionality with Motion-Sensing Dimming Control.	BLCK = Black DKBZ = Dark Bronze GRAY = Gray WHTE = White Contact manufacturer for other colors.	F = Fusing H = Motion Sensor* J = cUL/Canada XXX = Special Options *Option H only available in 120-277V. Reference page 5 (under H Motion Sensing Option) for more details.

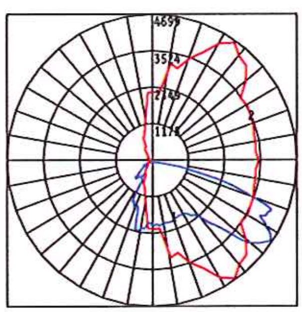
POWER LEVEL	PHOTOMETRIC TYPE	TYPICAL INITIAL LUMENS		TYPICAL SYSTEM WATTAGE		IES FILE NUMBERS 4000K	IES FILE NUMBERS 4000K	IES FILE NUMBERS 5000K	IES FILE NUMBERS 5000K	B-U-G RATING
		4000K	5000K	120-277V	347-480V	120-277V	347-480V	120-277V	347-480V	
A7	D1	3,100	3,100	29	34	EWS2_A7D140____-120-277V.IES	EWS2_A7D140____-347-480V.IES	EWS2_A7D150____-120-277V.IES	EWS2_A7D150____-347-480V.IES	1-0-1
	E1	3,100	3,100	29	34	EWS2_A7E140____-120-277V.IES	EWS2_A7E140____-347-480V.IES	EWS2_A7E150____-120-277V.IES	EWS2_A7E150____-347-480V.IES	1-0-1
B7	D1	3,900	3,900	39	44	EWS2_B7D140____-120-277V.IES	EWS2_B7D140____-347-480V.IES	EWS2_B7D150____-120-277V.IES	EWS2_B7D150____-347-480V.IES	1-0-1
	E1	4,000	4,000	39	44	EWS2_B7E140____-120-277V.IES	EWS2_B7E140____-347-480V.IES	EWS2_B7E150____-120-277V.IES	EWS2_B7E150____-347-480V.IES	1-0-1
C7	D1	4,800	4,800	51	55	EWS2_C7D140____-120-277V.IES	EWS2_C7D140____-347-480V.IES	EWS2_C7D150____-120-277V.IES	EWS2_C7D150____-347-480V.IES	1-0-1
	E1	4,900	4,900	51	55	EWS2_C7E140____-120-277V.IES	EWS2_C7E140____-347-480V.IES	EWS2_C7E150____-120-277V.IES	EWS2_C7E150____-347-480V.IES	1-0-1
D3	D1	6,700	6,700	70	70	EWS2_D3D140____.IES		EWS2_D3D150____.IES		1-0-1
	E1	7,000	7,000	70	70	EWS2_D3E140____.IES		EWS2_D3E150____.IES		2-0-1
E3	D1	8,400	8,400	91	91	EWS2_E3D140____.IES		EWS2_E3D150____.IES		2-0-2
	E1	8,500	8,500	91	91	EWS2_E3E140____.IES		EWS2_E3E150____.IES		2-0-1

Photometrics

EWS2 - Asymmetric Forward (D1)
8400 Lumens, 5000K (EWS2_E3D150_____.IES)

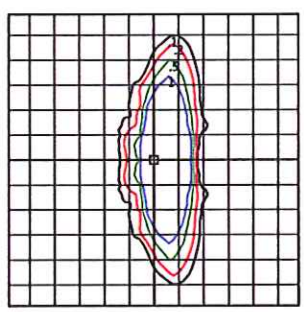


Grid Distance in Units of Mounting Height at 12'
Initial Footcandle Values at Grade

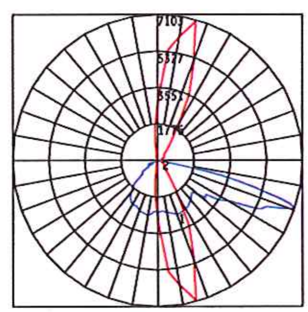


Polar Trace Vertical and Horizontal Plane through Horizontal Angle of Maximum Candlepower

EWS2-Asymmetric Medium (E1)
8500 Lumens, 5000K (EWS2_E3E150_____.IES)



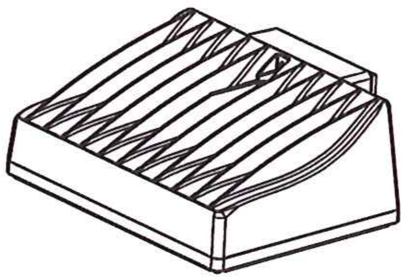
Grid Distance in Units of Mounting Height at 12'
Initial Footcandle Values at Grade



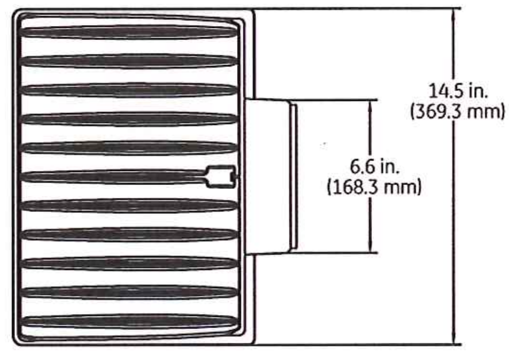
Polar Trace Vertical and Horizontal Plane through Horizontal Angle of Maximum Candlepower

Product Dimensions

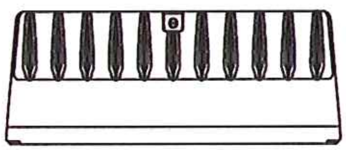
Top/Side View



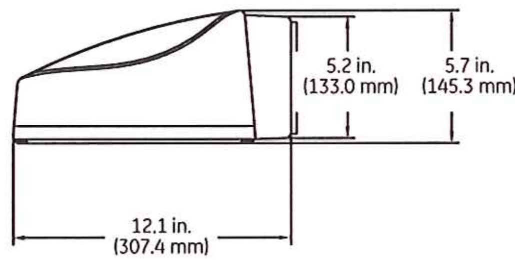
Top View



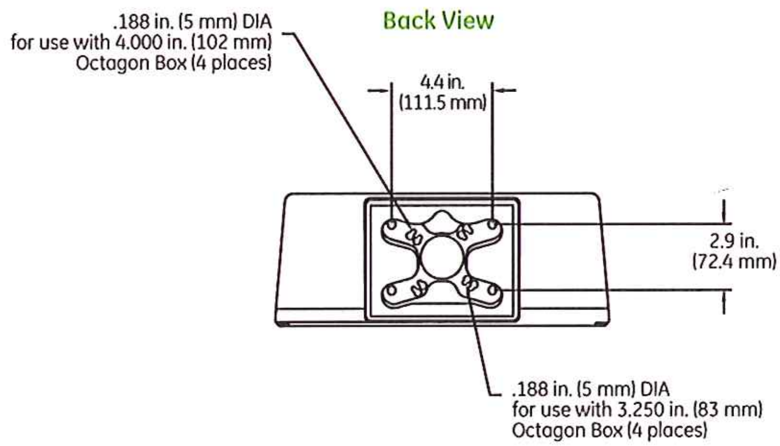
Front View



Side View



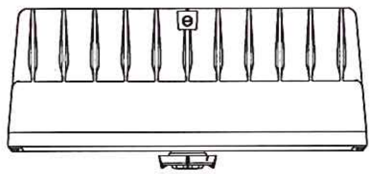
Back View



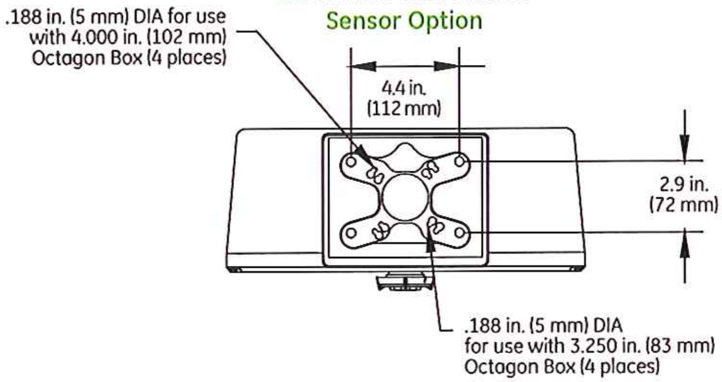
DATA	
	• Approximate Net Weight: 21 lbs (9.53 kgs)

Product Dimensions

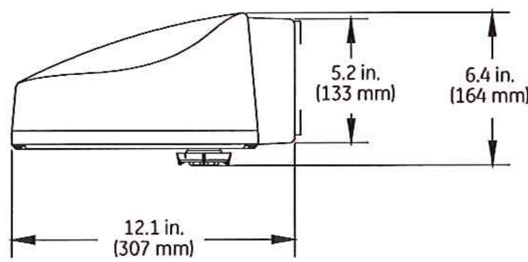
Front View with Motion Sensor Option



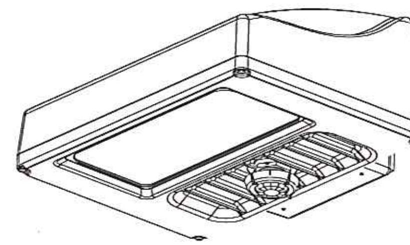
Back View with Motion Sensor Option



Side View with Motion Sensor Option



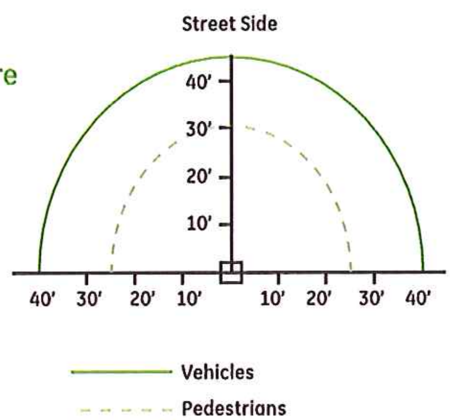
H-Motion Sensing Option:



- Intended for 8-25ft mounting heights.
- Provides a coverage area radius for walking motion of 25-30ft.
- Provides 180° of coverage (~180° is blocked by the wall).
- Factory preset to 50% dimming with no occupancy.
- May be reprogrammed using additional remote programmer.
  Remote Programmer part number: WS FSIR-100 PROGRAMMER (197634)
- Photoelectric control is integrated through the motion sensor, and is offered as standard.

Sensor Pattern:

Sensing Pattern Wall Pack Fixture Up to 25ft.



www.gelighting.com

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OLP3092 (Rev 09/23/15)

LITHONIA LIGHTING®

Catalog Number	LQMSW3G 120/277 EL N SD
Notes	
Type	X & X2

QUANTUM®

Thermoplastic Exits

LQM

LED LAMPS

NEMA Premium

LED

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal for applications requiring attractive, quick-installation exit signs and low energy consumption.

CONSTRUCTION — Engineering-grade thermoplastic housing is impact-resistant, scratch-resistant, and corrosion-proof. UL94V-0 flame rating. UV-stable resin resists discoloration from natural and man-made light sources.

Rugged unibody housing snaps together with no additional mechanical fasteners. Faceplate and back cover are interchangeable on housing. Positive snap-fit tabs hold faceplate securely, yet easily removable for lamp compartment access.

Universal directional Chevron inserts are easily removed and reinserted. Uniform illumination without shadows or hot spots. Reinforced, impact-resistant color panels. Letters 6" high with 3/4" stroke, with 100 ft. viewing distance rating, based upon UL924 standards.

U.S. Patent No. 5,526,251; 5,611,163; 5,739,639; 5,954,423; 5,988,825; 6,152,581; D383,501 ; D495,751 and 6,502,044. Other patents pending.

OPTICS — LEDs mounted on printed circuit boards. Low energy consumption – less than one watt. LED lamp operates in normal (AC input) and emergency (DC input) modes.

The typical life of the exit LED lamp is 10 years.

ELECTRICAL — Low-voltage disconnect prevents excessively deep discharge that can permanently damage battery. Conveniently located test switch and LED provide visual and manual means of monitoring system.

Constant-current series charger minimizes energy consumption and provides low operating costs. Printed circuit boards are 100% quality tested during manufacturing. Current-limiting charger circuitry protects printed circuit boards from shorts.

AC/LV reset (line latch) allows battery connection before AC power is applied and aids in preventing battery damage from deep discharge.

Crystal oscillator timing system with watchdog protection for precision accuracy.

Brownout protection is automatically switched to emergency mode when supply voltage drops below 80% of nominal.

Battery: Sealed, maintenance-free nickel-cadmium battery delivers 90-minutes capacity to emergency lamps. Two-state constant-current charge maximizes battery life and automatically recharges after battery discharge.

Diagnostics: Single-point microcomputer control for all electronic features.

Single multi-chromatic LED indicator to display two-state charging, test activation and three-state diagnostic status.

Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection. Self-diagnostic testing for five minutes every 30 days and 30 minutes every six months and 90 mins annually with WRS.

Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition. Continuously monitors AC functionality.

INSTALLATION — Universal (top-, end-, or back-) mounting. Easily removed mounting knockouts. J-box pattern on back panel. Housing snaps to canopy with four positive-locking tabs. Cam-locking pin tightly secures housing to canopy.

Ships standard with additional face plate.

LISTINGS — UL damp location listed 50°-104°F (10°-40°C) standard. NOM Certified (see options). Meets UL924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards. NEMA Premium certified. Meets all applicable FCC requirements.

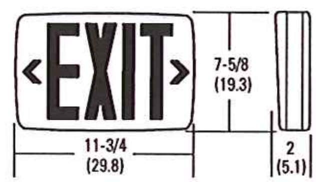
Specifications

Length: 11-3/4 (29.8)

Depth: 2 (5.1)

Height: 7-5/8 (19.3)

Weight: 2.6 lbs (1.2 kgs)



All dimensions are inches (centimeters) unless otherwise specified.

WARRANTY — 5-year limited warranty. (Battery is prorated.) Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

ORDERING INFORMATION For shortest lead times, configure product using **bolded options.**

Example: LQM S W 3 R 120/277 EL N

LQM							
Family	**Face type**	**Housing color**	**Number of faces**	**Letter color**	**Input voltage[2]**	**Operation**	**Options**
LQM	**S** Stencil P Panel[1]	**(blank)** Black **W** White	**3** Single face with extra faceplate and color panel	**R** Red **G** Green	**120/277** Dual voltage	**(blank)** AC only **X2** Primary and secondary AC inputs provided[3] **EL N** Nickel cadmium battery	**(blank)** None NOM NOM certified for Mexico[4] SD Self-diagnostics[5] SDFIFA Self-diagnostics, fire alarm flashing interface and flashing emergency operation and intermittent audible alarm (one flash/one second)[5]

Accessories: Order as separate item.

ELA WG1	Back-mount wireguard[6]	ELA WGEXE	End-mount wireguard[6]
ELA WGEXT	Top-mount wireguard[6]	ELA LQMUS12	12" stem kit[7]

Notes

1 Only available in custom signage. See spec sheet, Custom-Signage.
2 Some special voltages available. Consult factory.
3 Must specify input voltage 120 or 277. Not available with other options.
4 Available with stencil or panel faces in white housing.
5 Only available with EL N operation.
6 See spec sheet ELA-WG.
7 See spec sheet ELA-Stemkits.

SPECIFICATIONS

ELECTRICAL				
Primary Circuit				
Type[1]	**Typical LED life**[2]	**Supply voltage**	**Input watts**	**Max. amps**
Red LED AC Only	10 years	120	.62	.05
		277	.69	.06
Green LED AC Only	10 years	120	.62	.05
		277	.74	.06
Red LED Emergency	10 years	120	.71	.05
		277	.92	.06
Green LED Emergency	10 years	120	.66	.05
		277	.70	.06

BATTERY				
Nickel Cadmium				
Voltage	**Shelf life**[3]	**Typical life**[3]	**Maintenance**[4]	**Optimum temperature**[5]
1.2	3 years	7-9 years	none	50°F - 104°F (10°C - 40°C)

Notes

1 LED lamps operate in normal (AC input) and emergency (DC input) modes.

2 Based on continuous operation. The typical life of the exit LED lamp is 10 years.

3 At 77°F (25°C).

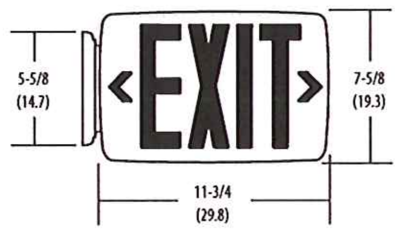
4 All life safety equipment, including emergency lighting for path of egress must be maintained, serviced and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.

5 Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

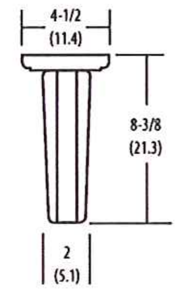
MOUNTING

All dimensions are inches (centimeters) unless otherwise specified.
Shipping weight: 2.6 lbs. (1.2 kgs.)

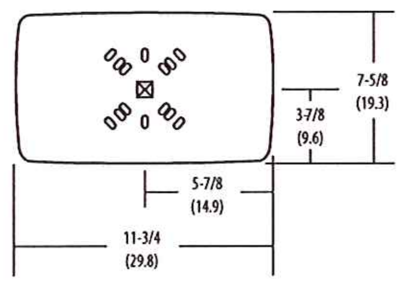
End Mounting



Top Mounting



Back Mounting



LITHONIA LIGHTING®
An Acuity Brands Company
EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 Fax: 770.981.8141 www.lithonia.com ©1993-2015 Acuity Brands Lighting, Inc. All rights reserved. Rev. 06/30/15

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APPENDIX B – COST ESTIMATE

ESTIMATE MODEL OF PROBABLE COST

Project: DMP-Renovate Dorm 276	**Ready to Advertise Final Estimate Revised**				
Location: Minot AFB, North Dakota					
Date: February 29, 2016					
Project # : 310528.00.0179.01.700					

Project Assumptions:

Project Escalation:

Project Construction to be Complete by May-17

- **Escalation Based on Mid Point of Construction:**	**Tri-Services Index:**				
Database Index based on October 2015:	2772				
Midpoint of Construction Index based on December 2016:	2816				
Market Factor Applied in Addition to Tri-Services Index:					
Date of Cost Data: October-15					
Bid Award Date of March-16	**5.0 Mo.**	**From Date of Cost Database**			
Substantial Completion: May-17	**10.0 Mo.**	**Construction Duration**			
Months to Midpoint of Construction Date of December-16	10.0 Mo.				
Tri-Services Index Factor =	**1.59%**				
Total Escalation Allowance =	**1.59%**				
Estimate Exclusions:					
- Building Equipment					
Force Protection Features To Be Incorporated Into Project:					
- Structure To Be Resistant to Progressive Collapse.	**No**				
- Laminated Glass Used To Resist Shrapnel Blow Out	**Yes**	**New**			
- Physical Controlled Vehicle Setback Required.	**Yes**		**82 LF**		
- Exterior Wall Blast Resistance Required at A Specified Standoff.	**No**		**82 LF**		
Building Configuration Assumptions:					
- Number of Building:	1	EA With A:	**10,708**	**GSF Footprint**	
- Number of Floors	3	Ea.			
- Shape of Buildings: regular	Rectangles				
- Quality of Exterior Materials: Good					
- Quality of Interior Materials: Class A					
Public Areas: High					
Office Areas: Class A					
Total Area Configuration Calculations:					
Footprint:	**GSF Area:**	**HVAC?**	**Struct'd Floor:**	**Roof W/Slope:**	**Slab on Grade:**
Basement		A/C & Heat			
Existing Building					
First Floor	10,519 SF	Heat & A/C			10,519 SF
Second Floor	10,542 SF	Heat & A/C	10,542 SF		
Third Floor	10,542 SF	Heat & A/C	10,542 SF		
Roofing				10,542 SF	
Total Gross Square Footage:	**31,603 SF**	**30,468 SF**	**21,084 SF**	**10,542 SF**	**10,519 SF**
Total New Air Conditioned Space:	**31,603 SF**	**less Stairs**			
Total New Heated Space:	**31,603 SF**				
Total New Ventilated Space:					

ESTIMATE MODEL OF PROBABLE COST

	Remodel Construction Elements			
	CSI Division Recap		**Division Amounts**	
1	**General Requirements**	For detail backup see pg. 21-22	**$587,000**	
2	**Existing Conditions**		**300,964**	
2a	**Existing Conditions - Asbestos & LBP Abatement**		**125,573**	
3	**Concrete**		**19,059**	
4	**Masonry**		**6,666**	
5	**Metals**		**26,220**	
6	**Wood, Plastics & Composites**		**187,788**	
7	**Thermal & Moisture Protection**		**77,287**	
8	**Openings**		**680,354**	
9	**Finishes**		**987,913**	
10	**Specialties**		**104,137**	
11	**Equipment**		**103,610**	
12	**Furnishings**		**-**	
13	**Special Construction**		**-**	
14	**Conveying Systems**		**-**	
21	**Fire Suppression**		**137,789**	
22	**Plumbing**		**837,092**	
23	**HVAC**		**1,210,222**	
25	**Integrated Automation**		**-**	
26	**Electrical**		**949,979**	
27	**Communications & TV Pre-wire**		**224,860**	
28	**Electronic Safety & Security**		**217,979**	
31	**Earthwork**		**-**	
32	**Exterior Improvements**		**54,151**	
33	**Utilities**		**219,782**	
(1) Total Amount for Construction - {Total of all Divisions}			**$7,058,425**	
	General Contractor Profit @ 7.00%		$494,000	
	General Contractor Bonds @ 1.00%		$76,000	
Total Probable Current Const. Cost:			**$7,628,425**	
	Design Contingency @ 2.00%		$153,000	
	Escalation @ 1.59%		$124,000	
Total Probable Const. Cost (rounded):			**$7,905,000**	

ESTIMATE MODEL OF PROBABLE COST

		GSF Area Total:	31,603 SF				
		COST SUMMARY BY UNIFORMAT II - LEVELS 2 & 3	$/Remodel SF	Level 3 $	Level 2 $	%/Tot	
A10		**FOUNDATIONS**	**$-**		**$-**	**0%**	**none**
A20		**BASEMENT CONSTRUCTION**	**$-**		**$-**	**0%**	**none**
B10		**SUPERSTRUCTURE**	**$-**		**$-**	**0%**	**none**
B20		**EXTERIOR ENCLOSURE**	**$4.46**		**$140,838**	**2.2%**	
	B2010	Exterior Walls	$-	$-		0%	
	B2020	Exterior Windows	$4.08	$128,894		2.0%	
	B2030	Exterior Doors	$.38	$11,944		0.2%	
B30		**ROOFING**	**$.15**		**$4,634**	**0.1%**	
	B3020	Roof Openings	$.15	$4,634		0.1%	
C10		**INTERIOR CONSTRUCTION**	**$42.14**		**$1,331,864**	**20.6%**	
	C1010	Partitions	$15.15	$478,705		7.4%	
	C1020	Interior Doors	$16.18	$511,334		7.9%	
	C1030	Specialties	$10.82	$341,825		5.3%	
C20		**STAIRS**	**$1.19**		**$37,750**	**0.6%**	
	C2010	Stair Construction	$.86	$27,115		0.4%	
	C2020	Stair Finishes	$.34	$10,635		0.2%	
C30		**INTERIOR FINISHES**	**$18.05**		**$570,331**	**8.8%**	
	C3010	Wall Finishes	$5.35	$168,942		2.6%	
	C3020	Floor Finishes	$6.52	$206,075		3.2%	
	C3030	Ceiling Finishes	$6.18	$195,314		3.0%	
D10		**CONVEYING**	**$-**		**$-**	**0%**	
D20		**PLUMBING**	**$26.47**		**$836,417**	**12.9%**	
	D2010	Plumbing Fixtures	$26.47	$836,417		12.9%	
D30		**HVAC**	**$38.51**		**$1,216,888**	**18.8%**	
	D3010	Energy Supply	$6.61	$209,027		3.2%	
	D3040	Distribution Systems	$10.70	$338,272		5.2%	
	D3050	Terminal & Package Units	$15.33	$484,402		7.5%	
	D3060	Controls & Instrumentation	$2.61	$82,555		1.3%	
	D3080	Systems Testing & Balancing	$3.25	$102,632		1.6%	
D40		**FIRE PROTECTION**	**$4.36**		**$137,789**	**2.1%**	
	D4010	Fire Protection Sprinkler Systems	$4.36	$137,789		2.1%	
D50		**ELECTRICAL**	**$43.67**		**$1,380,218**	**21.3%**	
	D5010	Electrical Service & Distribution	$7.56	$238,874		3.7%	
	D5020	Lighting & Branch Wiring	$19.81	$625,902		9.7%	
	D5030	Communications & TV Pre-wire	$8.77	$277,085		4.3%	
	D5040	Special Electrical Systems	$7.54	$238,357		3.7%	Security Sys. NIC
E10		**EQUIPMENT**	**$3.28**		**$103,610**	**1.6%**	
	E1010	Equipment - Residential Appliances	$3.28	$103,610		1.6%	
E20		**FURNISHINGS**	**$-**		**$-**	**0%**	**none**
F10		**SPECIAL CONSTRUCTION**	**$-**		**$-**	**0%**	**none**
F20		**SELECTIVE BUILDING DEMOLITION**	**$13.81**		**$436,478**	**6.7%**	
	F2010	Building Elements Demolition	$9.84	$310,905		4.8%	
	F2020	Hazardous Components Abatement	$3.97	$125,573		1.9%	
G10		**SITE PREPARATION**	**$-**		**$-**	**0%**	**none**
G20		**SITE IMPROVEMENTS**	**$1.61**		**$50,860**	**0.8%**	
	G2050	Landscaping	$1.61	$50,860		0.8%	
G30		**SITE MECHANICAL UTILITIES**	**$.05**		**$1,693**	**0.0%**	
	G3010	Water Supply	$.05	$1,693		0.0%	
G40		**SITE ELECTRICAL UTILITIES**	**$7.03**		**$222,055**	**3.4%**	**none**
	G4010	Electrical Distribution	$1.72	$54,233		0.8%	
	G4030	Site Communications & Security	$5.31	$167,822		2.6%	
	Total Project Direct Cost:		**$204.77**		**$6,471,425**	**100%**	
	****10 'GENERAL CONTRACTOR MARKUPS @ 17.87%**						
		10 Total Project OH & Profit	**$36.61**		**$1,157,000**		
		General Contractor Overhead @ 9.07%	$18.57		$587,000	For detail backup see pg. 21-22	
		General Contractor Profit @ 7.00%	$15.63		$494,000		
		General Contractor Bonds @ 1.00%	$2.40		$76,000		
	Total Probable Current Const. Cost:		**$241.38**		**$7,628,425**		
		Design Bidding Contingency @ 2.00%	$4.84		$153,000		
		Escalation @ 1.59%	$3.92		$124,000		
	Total Probable Const. Cost (rounded):		**$250.13**		**$7,905,000**		
		**** Includes All General Conditions, Profit & Overhead**					
		*****Estimate Does Not Include Land Cost, or Any Offsite Work**					

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
B20		**EXTERIOR ENCLOSURE**			**SUBTOTAL:**	**$140,838**	**$4.46 /SF**
	B2020	**Exterior Windows**					
		Window walls, aluminum, stock, including glazing					
8	-	Windows, aluminum, commercial grade, stock units, double hung, insulating glass, ATFP compliant 3'-2" x 4'-3" typical opening, incl. frame, screens, and glazing	$94.00	1,079.0	S.F.	$101,426	
8	-	Windows, aluminum, commercial grade, stock units, double hung, insulating glass, ATFP compliant 3'-9" x 4'-8" typical opening, mulled together incl. frame, screens, and glazing	$95.00	245.2	S.F.	$23,292	
8	-	Windows, aluminum, commercial grade, stock units, fixed, insulating glass, ATFP compliant 3'-2" x 3'-11" typical opening, incl. frame and glazing	$87.00	48.0	S.F.	$4,176	
					Exterior Windows Subtotal:	**$128,894**	
	B2030	**Exterior Doors**					
		Aluminum and Glass					
8	-	Doors, aluminum, commercial entrance, flush panel doors, single, 3'-0" x 7'-0", incl. hinges, push/pull, deadlock, cylinder, threshold, excl. glazing	$1,825.00	2.0	Ea.	$3,650	
8	-	Insulating Glass, heat reflective, film on weather side, clear, 1" thick unit	$51.00	42.0	S.F.	$2,142	
8	-	Add for ATFP Laminated glass, clear float, .03" vinyl, 1/4" thick	$4.57	42.0	S.F.	$192	
		HM Doors					
8	-	Frames, steel, knock down, hollow metal, single, 16 ga., up to 5-3/4" deep, 7'-0" h x 3'-0" w	$289.00	3.0	Ea.	$867	
8	-	Frames, steel, knock down, hollow metal, for welded frames, add	$82.50	3.0	Ea.	$248	
8	-	Doors, commercial, steel, insulated, full panel, 18 ga., 3'-0" x 7'-0" x 1-3/4" thick	$745.00	3.0	Ea.	$2,235	
8	-	Exterior Single Door Hardware Set Allowance	$870.00	3.0	Ea.	$2,610	
					Exterior Doors Subtotal:	**$11,944**	
B30		**ROOFING**	**None**		**SUBTOTAL:**	**$4,634**	**$0.15 /SF**
	B3020	**Roof Openings**					
7	-	Roof Mounted Exhaust fans, selective demolition	$112.00	7.0	System	$784	
7	-	Repair holes left from fan removal, flat seam sheet metal roofing, stainless steel, minimum labor/equipment charge	$550.00	7.0	EA location	$3,850	
					Roof Openings Subtotal:	**$4,634**	
C10		**INTERIOR CONSTRUCTION**			**SUBTOTAL:**	**$1,331,864**	**$42.14 /SF**
	C1010	**Partitions**					
		Partition Furring	2,085.0	LF			
		Partition Rated Furring ea. side CMU STC Rated	582.0	LF			
		Partition Sound Rated STC 55	1,241.0	LF			
		Partition Standard Non rated	1,415.0	LF			
		Partitions Corridor 1hr.	1,366.0	LF			
		Drywall Partitions					
9	-	Metal stud partition, non-load bearing, galvanized, 10' high, 3-5/8" wide,25 gauge, 16" O.C., includes top & bottom track	$2.08	60,201.0	S.F.	$125,218	9.0 Ft.
9	-	Gypsum wallboard, on walls, standard, taped & finished (level 4 finish), 5/8" thick	$1.72	92,064.0	S.F.	$158,350	
9	-	Gypsum wallboard, on walls, fire core, taped & finished (level 4 finish), 5/8" thick	$1.74	24,588.0	S.F.	$42,783	
9	-	Accessories Allowance	$0.18	116,652.0	S.F.	$20,997	
9	-	Sound Attenuation Blankets, 3" thick	$1.50	13,788.0	S.F.	$20,682	
9	-	Joint sealants, caulking and sealants, acoustical sealants, elastomeric, cartridges, 1/4" x 1/2"	$3.28	11,592.0	L.F.	$38,022	
7	-	Firestopping, mineral wool construction joints, floor slab to drywall partition, fluted joint (not engineered)	$7.10	2,686.0	L.F.	$19,071	
		Exterior Added Insulation					
7	-	Insulation, polyurethane foam, 2#/CF density, 3" thick, R19.5, sprayed	$2.91	10,225.8	S.F.	$29,757	
7	-	Blanket insulation, for walls or ceilings, unfaced fiberglass, 6" thick, R21, 23" wide	$1.13	21,084.0	S.F.	$23,825	2 layers
					Partitions Subtotal:	**$478,705**	

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
	C1020	**Interior Doors**					
		Interior Doors					
		Interior Wood Door					
8	-	Wood 3'-0" x 7'-0" Doors	$360.00	31.0	Ea.	$11,160	
8	-	Wood 2'-4" to 2'-6" x 7'-0" Doors	$360.00	165.0	Ea.	$59,400	
8	-	Pair Wood 2'-0" x 7'-0" Doors	$390.00	26.0	Ea.	$10,140	
8	-	Doors, hollow metal, commercial, steel, flush, shelter door 16 ga., 3'-0" x 7'-0"	$1,075.00	5.0	Ea.	$5,375	
		Interior Frames					
8	-	Frames, steel, knock down, single, 16 ga.	$289.00	227.0	Ea.	$65,603	
8	-	Frames, steel, knock down, hollow metal, for welded frames, add	$82.50	227.0	Ea.	$18,728	
		Interior Door Hardware Sets					
8	-	Single door Hardware Set Allowance	$705.00	143.0	Ea.	$100,815	
8	-	Single door Hardware Less Lock Set, card access d'rs	$410.00	84.0	Ea.	$34,440	
		Stanley BEST Wi-Q Card Access System (GSA Material Pricing)					**$205,673**
		BEST 45HQ Wireless Mortise Locks With Stanley Wi-Q					
8		45HQ- Single Keyed Deadbolt W/BEST Key cylinder	$1,350.00	84.0	Ea.	$113,400	
8		For Keypad in addition to card Reader	$131.00	84.0	Ea.	$11,004	
8		Door wiring w/electric hinge & door prep	$183.00	84.0	Ea.	$15,372	
26		Conduit & Back Box Allowance Per Door	$150.00	84.0	Ea.	$12,600	
8		Stanley ID Express Station™ - Kiosk configuration with 17" Touchscreen monitor, magnetic stripe card dispenser/enrollment station, verification CCTV and Uninterruptible Power Supply, (includes regarding shipping/crating costs)	$27,300.00	1.0	Ea.	$27,300	Make bid option
8		Turn-key installation for BASD-SDL	$5,980.52	1.0	LS	$5,981	
8		Portal Gateway with enclosure, power supply and wall mount directional antenna.	$1,375.00	6.0	Ea.	$8,250	
8		Wireless Access Controller in Nema enclosure with power supply and exterior omni-directional antenna	$1,300.00	1.0	Ea.	$1,300	
8		Wireless Access Controller sign-on keypad	$210.00	1.0	Ea.	$210	
8		Turn-key installation for BASD-SDL	$5,980.52	1.0	LS	$5,981	
8		Wireless Access Controller Survey Kit	$4,275.00	1.0	Ea.	$4,275	
				Interior Doors Subtotal:		**$511,334**	
	C1030	**Specialties**					
		Commercial Toilet Room Compartments					
10	-	Bath, module tub and showerwall surround, molded fiberglass, 5' long x 30" wide x 66" high	$790.00	55.0	Ea.	$43,450	
		Commercial Toilet Room Accessories					
10	-	Toilet Accessories, curtain rod, stainless steel, 1" diameter x 3' long	$107.00	55.0	Ea.	$5,885	
10	-	Toilet Accessories, for vinyl curtain, add	$1.49	1,650.0	S.F.	$2,459	
10	-	Toilet Accessories, mirror, 36" x 24", with 5" stainless steel shelf & stainless steel 3/4" square frame	$315.00	55.0	Ea.	$17,325	
10	-	Toilet Accessories, mop holder strip, stainless steel, 5 holders, 48" long	$151.00	2.0	Ea.	$302	
10	-	Toilet Accessories, robe hook, regular, single	$49.00	55.0	Ea.	$2,695	
10	-	Toilet Accessories, toilet tissue dispenser, stainless steel, surface mounted, single roll	$48.00	55.0	Ea.	$2,640	
10	-	Toilet Accessories, towel bar, stainless steel, 18" long	$85.00	55.0	Ea.	$4,675	
		Millwork					
		Base Cabinets & Countertops					
6	-	Millwork, base cabinets, hardwood or plastic laminate, custom fabricated, 24" deep, 32" high	$365.00	195.0	L.F.	$71,175	
6	-	Millwork, wall cabinets, hardwood or plastic laminate, custom fabricated, 12" deep, 30" high	$267.00	104.0	L.F.	$27,768	
6	-	Solid Surface Countertops, acrylic polymer, solid colors, with hard seam attached 4" backsplash, pricing for orders of 100 LF or more, 25" wide	$131.00	195.0	L.F.	$25,545	
6	-	Millwork, vanity base & front cabinets, hardwood or plastic laminate, custom fabricated, 17" deep, 24" high	$240.00	112.0	L.F.	$26,880	
6	-	Solid Surface Window stools, acrylic polymer, solid colors, pricing for orders of 100 LF or more, 8" wide	$36.00	333.0	L.F.	$11,988	
6	-	Wood Shelving, adjustable closet rod and shelf, 12" wide	$17.35	336.0	L.F.	$5,830	
		Fire Protection Specialties					
10	-	Fire equipment cabinets, portable extinguisher, single, steel box, recessed, D.S. glass in door, steel door & frame, 8" x 12" x 27", excludes equipment	$291.00	9.0	Ea.	$2,619	

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Mailboxes					
10	-	Mailboxes, horizontal, key lock, aluminum, front loading, 5" h x 6" w x 15" deep	$68.50	55.0	Ea.	$3,768	
10	-	Collection Mailbox	$284.00	1.0	Ea.	$284	corrected per comments
		Signage					**$10,800**
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 9" x 6" Type A	$122.00	25.0	Ea.	$3,050	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 9" x 3" Type B.	$70.50	18.0	Ea.	$1,269	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 13.5" x 4" Type B1	$122.00	11.0	Ea.	$1,342	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 9" x 13" Type C	$242.00	9.0	Ea.	$2,178	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 10" x 10" Type D	$210.00	1.0	Ea.	$210	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 9" x 11" Type E	$208.00	3.0	Ea.	$624	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 9" x 3" Type F	$70.50	2.0	Ea.	$141	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 24" x 8" Type G	$385.00	3.0	Ea.	$1,155	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 18" x 30" Type J	$111.00	3.0	Ea.	$333	
10	-	Signs, acrylic sign, adhesive back, w/Braille, mixed letters, 14" x 19.5" Type K	$83.00	6.0	Ea.	$498	
10	-	Signs, stock signs, reflectorized, 18" x 24", excludes posts	$101.00	3.0	Ea.	$303	
10	-	Signs, 10'-0", add to above for steel posts, galvanized, upright, bolted	$69.50	3.0	Ea.	$209	
		Corner Guards					
10	-	Corner protection, clear plastic, screw mounted, 2-1/2" leg	$6.75	996.0	L.F.	$6,723	corrected per
		6 in each Kitchen Area	4 lf ht.	26 EA	624 Lf		comments
		31 in each corridor @ each floor	4 lf ht.	3 EA	372 Lf		
		Access Doors					
8	-	Doors, specialty, access, recessed door for drywall, metal, 12" x 12"	$233.00	34.0	Ea.	$7,922	
8	-	Doors, specialty, access, recessed door for drywall, metal, 24" x 24"	$310.00	106.0	Ea.	$32,860	
6	-	Doors, specialty, access, millwork door, 24" x 84"	$194.00	89.0	Ea.	$17,266	
	>	**6"Slab on Grade Assembly**	**$19.82**	**407.0**	**S.F.**		**$8,065**
2	-	Concrete sawing, concrete slabs, rod reinforced, up to 3" deep	$2.51	723.0	L.F.	$1,815	
2	-	Concrete sawing, concrete, existing slab, rod reinforced, for each additional inch of depth over 3"	$0.84	2,169.0	L.F.	$1,822	
3	-	Slabs, bedding sand, 2" thick	$0.62	407.0	S.F.	$252	
3	-	Vapor Retarders, building paper, polyethylene vapor barrier, standard, .010" thick	$30.00	4.9	Sq.	$147	+20% for laps
3	-	Base course drainage layers, aggregate base course for slabs, crushed stone,compacted, 3/4"	$53.50	7.5	E.C.Y.	$403	6 in. deep
3	-	Fine grade, fine grade for slab on grade, machine	$1.77	49.7	S.Y.	$88	10% Over-grading
3	-	Reinforcing steel in slab on grade, in place	$1.48	449.7	Lb.	$666	1.1 lbs/S.F.
3	-	Structural concrete, normal weight, 4000 PSI	$135.00	7.9	C.Y.	$1,068	5.00% Waste
3	-	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes strike off & consolidation, excludes material	$28.00	7.9	C.Y.	$222	
3	-	Concrete finishing, floors, for specified Random Access Floors in ACI Classes 1, 2, 3 and 4, to achieve a Composite Overall Floor Flatness & Levelness value up to F35/F25, bull float, machine float & steel trowel (walk-behind), excludes placing, striking	$1.01	407.0	S.F.	$411	
3	-	Concrete surface treatment, curing, sprayed membrane compound	$22.50	4.1	C.S.F.	$92	
	>	**4" Equipment Pads**	**$9.69**	**357.9**	**S.F.**		**$3,468**
3	-	Fine grading, fine grade for slab on grade, hand grading	$2.29	43.7	S.Y.	$100	10% Over-grading
3	-	C.I.P. concrete forms, slab on grade, depressed, edge, wood, to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	$10.45	80.0	L.F.	$836	
3	-	Curing, burlap/poly blanket, 2 ply	$40.00	3.6	C.S.F.	$143	
3	-	Reinforcing steel in slab on grade, in place	$1.48	776.7	Lb.	$1,150	2.2 lbs/S.F.
3	-	Structural concrete, normal weight, 4000 PSI	$135.00	4.6	C.Y.	$626	5.00% Waste
3	-	Structural concrete, placing, slab on grade, direct chute, up to 6" thick, includes vibrating, excludes material	$29.50	4.6	C.Y.	$137	

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
3	-	Concrete finishing, floors, manual screed, bull float, manual float, broom finish	$0.91	357.9	S.F.	$326	
3	-	Concrete impact drilling, for anchors, up to 4" D, 3/8" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	$12.25	8.0	Ea.	$98	
3	-	Wedge anchor, carbon steel, 3/8" dia x 5" L, in concrete, brick or stone, excl layout & drilling	$6.50	8.0	Ea.	$52	
					Specialties Subtotal:	**$341,825**	
C20		**STAIRS**			**SUBTOTAL:**	**$37,750**	**$1.19 /SF**
	C2010	**Stair Construction**					
5	-	Railing, pipe, steel, wall rail, primed, 1-1/4" dia, shop fabricated	$38.00	90.0	L.F.	$3,420	
5	-	2-line pipe rail with pickets and attached handrail, steel, primed, 1-1/2" pipe, 1/2" pickets @ 4-1/2" O.C., 42" high, shop fabricated, straight & level	$190.00	120.0	L.F.	$22,800	
9	-	Paints & coatings, miscellaneous interior, balustrades, paint 2 coats, oil base, brushwork	$2.26	396.0	S.F.	$895	
					Stair Construction Subtotal:	**$27,115**	
	C2020	**Stair Finishes**					
9	-	Stair Treads & Risers, rubber, molded tread, colors, 12" w, 5/16" thick	$24.00	335.9	L.F.	$8,061	
9	-	Stair Treads & Risers, landings, smooth sheet rubber, 1/8" thick	$14.30	180.0	S.F.	$2,574	
					Stair Finishes Subtotal:	**$10,635**	
C30		**INTERIOR FINISHES**			**SUBTOTAL:**	**$570,331**	**$18.05 /SF**
	C3010	**Wall Finishes**					
9	-	Paints & Coatings, walls & ceilings, interior, concrete, drywall or plaster, zero voc latex, 3 coats, smooth finish, roller	$1.33	101,430.0	S.F.	$134,902	
9	-	Paints & Coatings, interior, alkyd (oil base), flush door w/frame, primer + 3 coats, brushwork, 3' x 7'	$148.00	230.0	Ea.	$34,040	
					Wall Finishes Subtotal:	**$168,942**	
	C3020	**Floor Finishes**					
		Floor Finishes					
9	-	Carpet Tile, tufted nylon, 24 oz., 18" x 18" or 24" x 24"	$45.00	1,760.0	S.Y.	$79,200	
9	-	Resilient flooring, linoleum sheet goods	$7.45	9,490.0	S.F.	$70,701	
9	-	Sealed Concrete finishing, floor, dustproofing, solvent-based, 2 coats	$1.80	2,830.0	S.F.	$5,094	
9	-	Porcelain or Ceramic tile, floors, glazed, thin set, color group 1, 16" x 16"	$11.70	520.0	S.F.	$6,084	
		Base Finishes					
9	-	Cove base, rubber or vinyl, standard colors, 4" h, 0.080" thick	$3.47	12,430.0	L.F.	$43,132	
9	-	Porcelain of Ceramic tile, cove base, thin set, 4-1/4" h	$11.65	160.0	L.F.	$1,864	
					Floor Finishes Subtotal:	**$206,075**	
	C3030	**Ceiling Finishes**					
		Drywall Ceilings	**$7.50**	**25,360 SF**	**520LF**	**of drop face**	**$190,101**
9	-	Suspended Ceiling System, 1-1/2" carriers, 24" O.C. with 7/8" channels, 16" O.C., incl. carriers	$3.06	25,360.0	S.F.	$77,602	
9	-	Metal stud partition, non-load bearing, galvanized, fur down, 3-5/8" wide, 25 gauge, 16" O.C., includes top & bottom track	$1.79	260.0	S.F.	$465	0.5 ' fur down depth
9	-	Accessories, Gypsum Board, casing bead, galv. steel	$296.00	5.2	C.L.F.	$1,539	
9	-	Accessories, Gypsum Board, corner bead, galvanized steel, 1" x 1"	$211.00	5.2	C.L.F.	$1,097	
9	-	Gypsum wallboard, on ceilings, standard, w/compound skim coat (level 5 finish), 5/8" thick	$2.94	25,620.0	S.F.	$75,323	
9	-	Paints & Coatings, walls & ceilings, interior, concrete, drywall or plaster, zero voc latex, 3 coats, smooth finish,	$1.33	25,620.0	S.F.	$34,075	
		Painted Exposed Ceiling	**$1.44**	**3,620 SF**			**$5,213**
9	-	Dry fall painting, ceilings, structural steel, bar joists or metal deck, one coat, spray	$0.48	10,860.0	S.F.	$5,213	3.0 surface factor
					Ceiling Finishes Subtotal:	**$195,314**	

		Description	Unit $	Qty.	Unit	Total $	Notes
D20		**PLUMBING**			**SUBTOTAL:**	**$836,417**	**$26.47 /SF**
	D2010	**Plumbing Fixtures**		196.0	Fixtures		
22	-	Water closet, bowl only, floor mounted, tankless, with floor outlet, 1.28 gpf, includes flush valve and seat	$1,075.00	56.0	Ea.	$60,200	$565,765
22	-	Water closet, floor mounted, tankless, rough-in, supply, waste and vent	$1,075.00	56.0	Ea.	$60,200	
22	-	Lavatory, molded with solid surface top, single bowl, 19" x 17", includes trim	$475.00	56.0	Ea.	$26,600	
22	-	Faucets/fittings, lavatory faucet, self-closing center set, commercial	$264.00	56.0	Ea.	$14,784	
22	-	Lavatory, wall hung, rough-in, supply, waste and vent	$1,550.00	56.0	Ea.	$86,800	
22	-	Sink, service, mop, molded stone, 24" x 36", includes drain & rough-in	$585.00	3.0	Ea.	$1,755	
22	-	Faucets/fittings, service sink faucet, cast spout, pail hook, hose end	$171.00	3.0	Ea.	$513	
22	-	Bath, tub, recessed porcelain enamel on cast iron, mat bottom, 5' long, includes trim	$1,675.00	55.0	Ea.	$92,125	
22	-	Shower, stall, rough-in, supply, waste and vent for above shower	$1,450.00	55.0	Ea.	$79,750	
22	-	Shower, built-in head and arm, 2.5 GPM valve	$335.00	55.0	Ea.	$18,425	
22	-	Sink, kitchen, counter top style, stainless steel, self rimming, double bowl, 33" x 22", includes faucet and drain	$1,575.00	26.0	Ea.	$40,950	
22	-	Sink, kitchen, counter top style, rough-in, supply, waste and vent	$1,250.00	26.0	Ea.	$32,500	
22	-	Ice Maker Hookup	$233.00	26.0	Ea.	$6,058	
22	-	Faucets/fittings, replacement diaphragm washer assy for ballcock valve	$80.50	26.0	Ea.	$2,093	
22	-	Washer dryer accessories, valves ball type single lever, solder, 1/2" diam.	$104.00	26.0	Ea.	$2,704	
22	-	Washer dryer accessories, recessed box, two hose valves and drain, 16 gauge, 1/2" size, 1-1/2" drain	$163.00	26.0	Ea.	$4,238	
		New Hot Water Heaters					$36,070
22	-	Water heater, gas fired, A. O. Smith BTH-300(A), 119 gallon, 300,000 btuh, 96% efficient	$14,500.00	2.0	Ea.	$29,000	
22	-	Pump, circulating, bronze, heated water application, in line, flanged joints, 1/20 H.P., 3/4" to 1-1/2" size	$970.00	1.0	Ea.	$970	
22	-	Expansion tanks, Amtrol ST-20V-C, 8 gallon, ASME	$2,225.00	1.0	Ea.	$2,225	
22	-	Mixing Valve, Symmons 7-900A	$3,675.00	1.0	Ea.	$3,675	
22		PVC Vent Pipe Allowance	$200.00	1.0	LS	$200	
		Hot & Cold Water					$130,798
22	-	Pipe, copper, tubing, solder, 1/2" diameter, type L, includes coupling & clevis hanger assembly 10' O.C.	$17.10	675.0	L.F.	$11,543	
22	-	Pipe, copper, tubing, solder, 3/4" diameter, type K, includes coupling & fitting allowance	$25.00	1,763.0	L.F.	$44,075	
22	-	Pipe, copper, tubing, solder, 1" diameter, type K, includes coupling & clevis hanger assembly 10' O.C.	$31.00	251.0	L.F.	$7,781	
22	-	Pipe, copper, tubing, solder, 1-1/2" diameter, type K, includes coupling & clevis hanger assembly 10' O.C.	$46.00	364.0	L.F.	$16,744	
22	-	Pipe, copper, tubing, solder, 2" diameter, type K, includes coupling & clevis hanger assembly 10' O.C.	$65.00	222.0	L.F.	$14,430	
22	-	Pipe, copper, tubing, solder, 2-1/2" diameter, type K, includes coupling & clevis hanger assembly 10' O.C.	$92.00	119.0	L.F.	$10,948	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 1/2" iron pipe size	$6.55	2,438.0	L.F.	$15,969	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 3/4" iron pipe size	$6.85	251.0	L.F.	$1,719	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 1-1/4" iron pipe size	$7.60	364.0	L.F.	$2,766	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 1-1/2" iron pipe size	$7.75	222.0	L.F.	$1,721	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 2" iron pipe size	$8.15	119.0	L.F.	$970	
22	-	Valves, bronze, ball, 150 lb., 3/4", soldered	$82.00	26.0	Ea.	$2,132	
		Floor Drains					$2,025
22	-	Cleanout, cast iron, drainage special, threaded, , 4" pipe size	$405.00	5.0	Ea.	$2,025	

		Description	Unit $	Qty.	Unit	Total $	Notes
		Waste					$137,829
22	-	Pipe, cast iron soil, single hub, service weight, 2" diameter, push-on gasket joints 10' OC, includes clevis hanger assemblies 5' O.C.	$38.00	239.0	L.F.	$9,082	
22	-	Pipe, cast iron soil, single hub, service weight, 3" diameter, push-on gasket joints 10' OC, includes clevis hanger assemblies 5' O.C.	$43.50	12.0	L.F.	$522	
22	-	Pipe, cast iron soil, single hub, service weight, 4" diameter, push-on gasket joints 10' OC, includes clevis hanger assemblies 5' O.C.	$51.00	502.0	L.F.	$25,602	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 2" iron pipe size	$8.15	239.0	L.F.	$1,948	
22	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 4" iron pipe size	$11.35	514.0	L.F.	$5,834	
22	-	For Underslab instalation add to cut slab, excavate, backfill, and replace slab	$50.00	677.0	L.F.	$33,850	
		Vent					
22	-	Pipe, cast iron soil, no hub, 2" diameter, includes couplings 10' O.C., clevis hanger assemblies 5' O.C.	$37.00	674.0	L.F.	$24,938	
22	-	Pipe, cast iron soil, no hub, 3" diameter, includes couplings 10' O.C., clevis hanger assemblies 5' O.C.	$42.50	463.0	L.F.	$19,678	
22	-	Connections to Existing Vent Piping	$50.00	14.0	Ea.	$700	
		Gas Meter					
22	-	Control Components/DDC Systems, subcontractor's quote incl. material & labor, status readings, digital outputs (avg. 50' run in 1/2" EMT)	$675.00	1.0	Ea.	$675	
		Connection Fees					
22	-	Water & Sewer Connection Fee	$15,000.00	1.0	LS	$15,000	
				Plumbing Fixtures Subtotal:		**$836,417**	
D30		**HVAC**			**SUBTOTAL:**	**$1,216,888**	**$38.51 /SF**
	D3010	**Energy Supply**					
		GEOTHERMAL COOLING & HEATING WELL FIELD		based on typical earth transfer rates.			
		Typical Well Field Calculation:	200 VLF per ton	+5' inactive	7,560 VLF	36 wells @	205 LF Deep
		Wells					**$207,527**
		Required Well Field Area @ 15' oc	0.2 Acres				
23	-	Wells: drill, case, and install well "U" pipe and packing	$20.00	7,560.0	VLF	$151,200	
		Well Piping					
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 3/4" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$0.82	15,120.0	L.F.	$12,398	
		Well Headers & Connection Piping					
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 3/4" or 1" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$0.82	408.0	L.F.	$335	
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 1-1/2" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$1.03	272.0	L.F.	$280	
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 2" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$1.72	648.0	L.F.	$1,115	
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 2" diam., DR 11, add 1 weld per joint, layed in utility tunnel under building.	$1.72	680.0	L.F.	$1,170	
23	-	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 3" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$2.08	784.0	L.F.	$1,631	
23	-	Elbow, 90 Deg., plastic, high density polyethylene (HDPE), single wall, welded, 3/4" or 1" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$6.35	80.0	Ea.	$508	

		Description	Unit $	Qty.	Unit	Total $	Notes
23	-	Elbow, 90 Deg., plastic, high density polyethylene (HDPE), single wall, welded, 2" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$7.90	16.0	Ea.	$126	
23	-	Elbow, 90 Deg., plastic, high density polyethylene (HDPE), single wall, welded, 3" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$15.90	16.0	Ea.	$254	
23	-	Tee, plastic, high density polyethylene (HDPE), single wall, welded, 1" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$8.30	16.0	Ea.	$133	
23	-	Tee, plastic, high density polyethylene (HDPE), single wall, welded, 1-1/2" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$11.55	24.0	Ea.	$277	
23	-	Tee, plastic, high density polyethylene (HDPE), single wall, welded, 2" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	$9.95	28.0	Ea.	$279	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 1" pipe size, weld, excludes welding machine	$11.60	96.0	Ea.	$1,114	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 1-1/2" pipe size, weld, excludes welding machine	$18.10	24.0	Ea.	$434	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 2" pipe size, weld, excludes welding machine	$25.00	44.0	Ea.	$1,100	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 3" pipe size, weld, excludes welding machine	$31.50	16.0	Ea.	$504	
23	-	Flange adapter, plastic, high density polyethylene (HDPE), single wall, welded, 3" diam., DR 17, add 1 weld per joint, includes back-up ring and 1/2 cost of plated bolt set, excludes hangers, trenching, backfill, hoisting or digging equipment.	$23.00	4.0	Ea.	$92	
23	-	3" Header	$1,350.00	1.0	Ea.	$1,350	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 1" pipe size, weld, excludes welding machine	$11.60	586.0	Ea.	$6,798	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 1-1/2" pipe size, weld, excludes welding machine	$18.10	79.0	Ea.	$1,430	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 2" pipe size, weld, excludes welding machine	$25.00	132.0	Ea.	$3,300	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, labor per joint, cost based on the thickest wall for each diameter, 3" pipe size, weld, excludes welding machine	$31.50	56.0	Ea.	$1,764	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, machine, rental per day based on diam. capacity, 1" thru 2" diameter, weld	$44.50	3.0	Ea.	$134	
23	-	Welding, plastic, high density polyethylene (HDPE), single wall, machine, rental per day based on diam. capacity, 3" thru 4" diameter, weld	$50.50	2.0	Ea.	$101	
		Circulating Pump & Heat Recovery Pumps					
23	-	Pump, general utility, centrifugal, in-line, vertical mount, iron body, 125 lb. flanged, 1750 RPM, single stage, 70 GPM, 7.5 H.P., 1-1/2" discharge, includes TEFC motor	$3,150.00	2.0	Ea.	$6,300	
23	-	Pump, general utility, centrifugal, in-line, vertical mount, iron body, 125 lb. flanged, 1750 RPM, single stage, 30 GPM, 0.5 H.P., 1-1/2" discharge, includes TEFC motor	$1,900.00	2.0	Ea.	$3,800	
23	-	Expansion tanks, steel, liquid expansion, galvanized, 15 gallon capacity, ASME	$1,475.00	1.0	Ea.	$1,475	
23	-	Expansion tanks, steel, liquid expansion, galvanized, 40 gallon capacity, ASME	$2,100.00	1.0	Ea.	$2,100	
23	-	Control Valves & Fittings Allow	$5,000.00	1.0	EA	$5,000	
23	-	Chemical feeder	$1,025.00	1.0	Ea.	$1,025	
23	-	Reverse osmosis system for humidifier	$1,500.00	1.0	Ea.	$1,500	
				Energy Supply Subtotal:		**$209,027**	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
	D3040	Distribution Systems					
		AIR SYSTEMS					
		Heat Recovery Equipment					
23	-	Heat recovery package, air to air, enthalpy recovery wheel, 2500 max CFM	$13,300.00	1.0	Ea.	$13,300	
23	-	Humidifier, steam, room or duct, filter, regulators, automatic controls, 220 V, 22 lb. per hour, includes blower, filter, regulator and standard controls	$5,425.00	1.0	Ea.	$5,425	
23	-	Humidifier Piping Allowance	$500.00	1.0	LS	$500	
		Makeup Air Supply Ductwork					
23	-	Metal Ductwork, fabricated rectangular, galvanized steel, over 5000 lb., includes fittings, joints, supports and allowance for a flexible connection, excludes insulation	$8.20	10,739.0	Lb.	$88,060	
		Heat Recovery Ductwork					
23	-	Metal Ductwork, fabricated rectangular, galvanized steel, over 5000 lb., includes fittings, joints, supports and allowance for a flexible connection, excludes insulation	$8.20	853.0	Lb.	$6,995	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 6" diameter, 26 Ga.	$7.35	815.0	L.F.	$5,990	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 8" diameter, 26 Ga.	$10.15	48.0	L.F.	$487	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 10" diameter, 26 Ga.	$12.70	43.0	L.F.	$546	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 12" diameter, 26Ga.	$16.30	53.0	L.F.	$864	
		Exhaust					
23	-	Metal Ductwork, fabricated rectangular, galvanized steel, over 5000 lb., includes fittings, joints, supports and allowance for a flexible connection, excludes insulation	$8.20	7,355.0	Lb.	$60,311	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 4" diameter, 26 Ga.	$6.30	585.0	L.F.	$3,686	
23	-	Metal Ductwork, spiral preformed, steel, galvanized, straight lengths, max. 10" S.P.W.G., 6" diameter, 26 Ga.	$7.35	845.0	L.F.	$6,211	
		Duct Accessories					
4	-	Selective demolition, cut holes in masonry wall for vent opening	$102.00	52.0	Ea.	$5,304	
4	-	Lintel angle, structural, unpainted, under 500 lb., shop fabricated	$2.62	520.0	Lb.	$1,362	
23	-	Kitchen Exhaust Hood w/damper	$172.00	26.0	Ea.	$4,472	
23	-	Dryer Exhaust Hood w/damper	$129.00	26.0	Ea.	$3,354	
23	-	Duct accessories, dampers	$56.00	27.0	Ea.	$1,512	1 per 3 air devices
23	-	Duct accessories, fire damper, curtain type, vertical, 24" x 24", U.L. label, 1-1/2 hour rated	$186.00	50.0	Ea.	$9,300	for rated wall/floor penetrations
		Ductwork Insulation					
23	-	Duct thermal insulation, blanket type, fiberglass, flexible, FSK facing, 1.5 lb. density, 1-1/2" thick	$4.78	6,752.0	S.F.	$32,275	
23	-	Wall Insulation, Rigid, isocyanurate, foil faced, both sides, 4' x 8' sheet , 4" thick	$3.67	576.0	S.F.	$2,114	
23	-	PVC jacket	$0.41	576.0	S.F.	$236	
23	-	Duct thermal insulation, blanket type, fiberglass, flexible, FSK vapor barrier wrap, .75 lb. density, 4" thick	$6.10	1,656.0	S.F.	$10,102	
		Air Devices					
23	-	Diffuser, aluminum, ceiling, size, 8" x 8", includes opposed blade damper	$92.50	81.0	Ea.	$7,493	
23	-	Return Grille, aluminum, eggcrate, lay-in, T-bar system, 24" x 24"	$107.00	4.0	Ea.	$428	
23	-	Louver, aluminum, extruded, with screen, mill finish, dual combination, automatic, intake or exhaust	$118.00	133.3	S.F.	$15,733	
23	-	Louver, finishes, applied by manufacturer at additional cost, available in colors, fluoropolymer finish coating, add	$24.50	133.3	S.F.	$3,267	
		Exhaust Fans					
23	-	Fans, wall exhauster, centrifugal, auto damper, direct drive, 1/8" S.P., 250 CFM, 1/20 H.P.	$515.00	3.0	Ea.	$1,545	

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Unit Heaters					
23	-	Electric heating, cabinet unit heaters, recessed, 208 to 480 volt, three pole, 2 kW	$2,800.00	6.0	Ea.	$16,800	
23	-	Electric heating, cabinet unit heaters, ceiling mount, 208 to 480 volt, three pole, 3 kW	$3,050.00	6.0	Ea.	$18,300	
23	-	Electric heating, cabinet unit heaters, wall mounted, 208 to 480 volt, three pole, 5 kW	$3,075.00	4.0	Ea.	$12,300	
			Distribution Systems Subtotal:			**$338,272**	
	D3050	**Terminal & Package Units**					
		WATER SOURCE HEAT PUMPS					
23	-	Heat pump, water source to air, single package, 3/4 ton cooling, 13 MBH heat @ 75Deg.F, excludes water supply	$2,425.00	86.0	Ea.	$208,550	
23	-	Heat pump, water source to air, single package, 1 ton cooling, 13 MBH heat @ 75Deg.F, excludes water supply	$2,425.00	3.0	Ea.	$7,275	
23	-	Heat pump, water source to air, single package, 7.5 ton cooling, 35 MBH heat @ 75Deg.F, excludes water supply	$11,500.00	1.0	Ea.	$11,500	
23	-	Pipe, plastic, PVC, 1" diameter, schedule 40, includes couplings 10' OC, and hangers 3 per 10'	$25.00	1,350.0	L.F.	$33,750	
		Interior Condenser Loop Piping (Insulated)					
23	-	Pipe, steel, black, threaded, 3/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	$22.00	185.0	L.F.	$4,070	
23	-	Pipe, steel, black, threaded, 1" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	$27.50	270.0	L.F.	$7,425	
23	-	Pipe, steel, black, threaded, 1-1/2" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	$35.50	2,807.0	L.F.	$99,649	
23	-	Pipe, steel, black, threaded, 2" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	$45.50	274.0	L.F.	$12,467	
23	-	Pipe, steel, black, threaded, 2-1/2" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	$63.50	48.0	L.F.	$3,048	
23	-	Fittings Allowance	$126,659.00	0.25	%	$31,665	
23	-	Valves, bronze, ball, 150 psi, 1", threaded	$86.00	180.0	Ea.	$15,480	two per unit
23	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 3/4" iron pipe size	$6.85	185.0	L.F.	$1,267	
23	-	(Optional) Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 1" iron pipe size	$7.20	270.0	L.F.	$1,944	Pipe length + 1'/fitting
23	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 1-1/2" iron pipe size	$7.75	2,807.0	L.F.	$21,754	
23	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 2" iron pipe size	$8.15	274.0	L.F.	$2,233	
23	-	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 2-1/2" iron pipe size	$8.75	48.0	L.F.	$420	
23	-	Hydronic Specialties Allowance	5%	438,090.0	$	$21,905	
			Terminal & Package Units Subtotal:			**$484,402**	
	D3060	**Controls & Instrumentation**					
		TYPICAL DORM SYSTEMS					
23	-	ATC/DDC	$2.00	31,603.0	SF	$63,206	
23	-	EMCS	$0.61	31,603.0	SF	$19,349	
			Controls & Instrumentation Subtotal:			**$82,555**	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
	D3080	**Systems Testing & Balancing**					
23	-	Balancing, air, heating and ventilating equipment, propeller and wall fan, (Subcontractor's quote including material & labor)	$25.00	3.0	Ea.	$75	
23	-	Balancing, air conditioning equipment, supply, return, exhaust, registers and diffusers, average ceiling height, (Subcontractor's quote including material & labor)	$68.50	81.0	Ea.	$5,549	
23	-	Balancing, air, heating and ventilating equipment, heat pump, (Subcontractor's quote including material & labor)	$200.00	90.0	Ea.	$18,000	
23	-	Basic Commisioning	$2.50	31,603.0	SF	$79,008	
			Systems Testing & Balancing Subtotal:			**$102,632**	
D40		**FIRE PROTECTION**			**SUBTOTAL:**	**$137,789**	**$4.36 /SF**
	D4010	**Fire Protection Sprinkler Systems**					
21	-	Install New Wet pipe Sprinkler System	$4.36	31,603.0	S.F.	$137,789	
		Fire Protection Sprinkler Systems Subtotal:				**$137,789**	
D50		**ELECTRICAL**			**SUBTOTAL:**	**$1,380,218**	**$43.67 /SF**
	D5010	**Electrical Service & Distribution**					
		WORK AT SERVICE TRANSFORMER					
26	-	CT cabinet, water & dust tight,NEMA 3r	$4,275.00	1.0	Ea.	$4,275	
26	-	Transformer Pad Extension	$2,000.00	1.0	Ea.	$2,000	
		SERVICE SWITCHBOARDS					
26	-	Switchboards, transition section between switchboard and transformer or motor control center, 4 wire copper bus, 2000 amp	$8,800.00	1.0	Ea.	$8,800	
26	-	Switchboards, distribution section, copper bus bars, 4 W, 120/208 or 277/480 V, 2000 amp, excl breakers	$10,800.00	1.0	Ea.	$10,800	
		for branch circuit breakers add to above:					
26	-	Circuit breaker, 3 pole, 120/208 V, 125 to 400 amp, LA frame, for feeder section	$3,850.00	1.0	Ea.	$3,850	
26	-	Circuit breaker, 3 pole, 120/208 V, 450 to 600 amp, MA frame, for feeder section	$6,725.00	3.0	Ea.	$20,175	
26	-	Circuit breaker, 3 pole, 120/208 V, 70 to 225 amp, KA frame, for feeder section	$1,800.00	1.0	Ea.	$1,800	
26	-	Circuit breakers, 3 pole, 120/208 V, 15 to 60 amp, FA frame, for feeder section	$620.00	1.0	Ea.	$620	
		PANELBOARDS WITH BREAKERS -					
26	-	Load centers, 1 phase, 3 wire, main lugs, indoor, 120/240 V, 200 amp, 30 circuits, incl 20 A 1 pole plug-in breakers	$1,925.00	26.0	Ea.	$50,050	All DS Panels
26	-	Circuit breakers,plug-in, 10 k A I.C., 2 pole, 120 volt, 50 amp	$77.50	26.0	Ea.	$2,015	
26		**for bolt-on circuit breakers add to above panels:**	$370.00	26.0	Ea. Panel	$9,620	
	-	Circuit breakers, plug-in, 1 pole, 120/240 volt	$87.50	(20.0)	Ea.		($1,750)
	-	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15 to 50 amp	$106.00	20.0	Ea.		$2,120
26	-	Panelboards, 3 phase 4 wire, main lugs, 120/208 V, 225 amp, 42 circuits, NQOD, incl 20 A 1 pole plug-in breakers	$4,350.00	1.0	Ea.	$4,350	LM1
26		**for bolt-on circuit breakers add to above panels:**	$777.00	1.0	Ea. Panel	$777	
	-	Circuit breakers, plug-in, 1 pole, 120/240 volt	$87.50	(42.0)	Ea.		($3,675)
	-	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15 to 50 amp	$106.00	42.0	Ea.		$4,452
26	-	Panelboards, 3 phase 4 wire, main lugs, 120/208 V, 225 amp, 42 circuits, NQOD, incl 20 A 1 pole plug-in breakers	$4,350.00	1.0	Ea.	$4,350	LM2
26		**for bolt-on circuit breakers add to above panels:**	$777.00	1.0	Ea. Panel	$777	
	-	Circuit breakers, plug-in, 1 pole, 120/240 volt	$87.50	(42.0)	Ea.		($3,675)
	-	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15 to 50 amp	$106.00	42.0	Ea.		$4,452
26	-	Panelboards, 3 pole 4 wire, main lugs, 120/208 V, 600 amp, no main breaker	$2,600.00	3.0	Ea.	$7,800	DP1, 2 and 3
		for branch circuit breakers add to above:					
26	-	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15 to 50 amp	$106.00	126.0	Ea.	$13,356	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		SAFETY SWITCHES					
26	-	Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 600 amp, NEMA 3R	$7,625.00	3.0	Ea.	$22,875	
26	-	Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 400 amp, NEMA 3R	$4,025.00	1.0	Ea.	$4,025	
26	-	Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 200 amp, NEMA 3R	$1,900.00	1.0	Ea.	$1,900	
26	-	Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 20 amp, NEMA 3R	$680.00	1.0	Ea.	$680	
		FEEDERS					
		Feeder 600A, 120/208V	**$84.41 /LF**	**120.0**	**LF**		
26	-	Wire, copper, stranded, 600 volt, 350 kcmil, type THWN-THHN, in raceway	$1,450.00	4.0	C.L.F.	$5,742	3 Runs
26	-	Wire, copper, stranded, 600 volt, #1, type THWN-THHN, in raceway	$460.00	1.3	C.L.F.	$607	1 Run ground
26	-	Electric metallic tubing (EMT), 2-1/2" diameter, to 15' high, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	$31.50	120.0	L.F.	$3,780	1 Run
		Feeder 400A, 120/208V	**$718.40 /LF**	**20.0**	**LF**		
26	-	Wire, copper, stranded, 600 volt, 3/0, type THWN-THHN, in raceway	$810.00	0.7	C.L.F.	$535	3 Runs
26	-	Wire, copper, stranded, 600 volt, #3, type THWN-THHN, in raceway	$325.00	0.2	C.L.F.	$72	1 Run ground
26	-	Electric metallic tubing (EMT), 2" diameter, to 15' high, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	$18.00	20.0	L.F.	$360	1 Run
		Feeder 100A, 120/208V	**$25.31 /LF**	**1,080.0**	**LF**		
26	-	Wire, copper, stranded, 600 volt, #3, type THWN-THHN, in raceway	$325.00	35.6	C.L.F.	$11,583	3 Runs
26	-	Wire, copper, stranded, 600 volt, #8, type THWN-THHN, in raceway	$153.00	11.9	C.L.F.	$1,818	1 Run ground
26	-	Electric metallic tubing (EMT), 1-1/4" diameter, to 15' high, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	$12.90	1,080.0	L.F.	$13,932	1 Run
		Feeder 30A, 120/208V	**$13.12 /LF**	**1,040.0**	**LF**		
26	-	Wire, copper, solid, 600 volt, #10, type THWN-THHN, in raceway	$113.00	34.3	C.L.F.	$3,878	3 Runs
26	-	Wire, copper, solid, 600 volt, #10, type THWN-THHN, in raceway	$113.00	11.4	C.L.F.	$1,293	1 Run ground
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	1,040.0	L.F.	$8,476	1 Run
		Feeder 30A, 120V	**$11.88 /LF**	**260.0**	**LF**		
26	-	Wire, copper, solid, 600 volt, #10, type THWN-THHN, in raceway	$113.00	5.7	C.L.F.	$646	2 Runs
26	-	Wire, copper, solid, 600 volt, #10, type THWN-THHN, in raceway	$113.00	2.9	C.L.F.	$323	1 Run ground
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	260.0	L.F.	$2,119	1 Run
		Feeder 20A, 120V	**$11.30 /LF**	**780.0**	**LF**		
26	-	Wire, copper, solid, 600 volt, #12, type THWN-THHN, in raceway	$95.50	17.2	C.L.F.	$1,639	2 Runs
26	-	Wire, copper, solid, 600 volt, #12, type THWN-THHN, in raceway	$95.50	8.6	C.L.F.	$819	1 Run ground
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	780.0	L.F.	$6,357	1 Run
		Electrical Service & Distribution Subtotal:				**$238,874**	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
	D5020	**Lighting & Branch Wiring**					
		Fixtures					
26	-	LED fixtures, surface mounted,2' x 4', white acrylic lens, 50 watt, incl lamps, mounting hardware and connections	$500.00	1.0	Ea.	$500	Type A
26	-	LED fixtures, interior, recess mounted, 40 watt, 12" x 12", incl lamps, mounting hardware and connections	$425.00	55.0	Ea.	$23,375	Type B
26	-	LED fixtures, interior, recess mounted, 40 watt, 12" x 12", incl lamps, mounting hardware and connections w/emergency battery	$585.00	34.0	Ea.	$19,890	Type B2
26	-	LED fixtures, interior, round, surface mounted, 15 watt, incl lamps, mounting hardware and connections	$253.00	356.0	Ea.	$90,068	Type C
26	-	LED fixtures, interior, 7" Versi-Lite, Flush mount with Matte Acrylic Duffuser and 4000K LEDS, incl lamps, mounting hardware and connections	$253.00	55.0	Ea.	$13,915	Type D
26	-	Emergency lighting units, lead battery operated, twin sealed beam light, 25 W, 6 V each	$380.00	32.0	Ea.	$12,160	Type EM
26	-	Emergency lighting units, additional remote mount, sealed beam, 25 W 6 V	$66.50	3.0	Ea.	$200	Type EMR
26	-	LED fixtures, interior, strip, under counter mounted, 5 watt, one light bar 1' long, incl lamps, mounting hardware and connections	$246.00	78.0	Ea.	$19,188	Type K
26	-	LED fixtures, interior, strip, wall mounted, 40 watt, 4' long, incl lamps, mounting hardware and connections	$266.00	9.0	Ea.	$2,394	Type L
26	-	LED fixtures, interior, striplight, 2000 Lumens 80CRI, 34 watt, one light bar 2' long, incl lamps, mounting hardware and connections	$246.00	3.0	Ea.	$738	Type M2
26	-	LED fixtures, interior, striplight, 3000 Lumens 80CRI, 72 watt, one light bar 4' long, incl lamps, mounting hardware and connections	$298.00	18.0	Ea.	$5,364	Type M4
26	-	LED fixtures, interior, strip, wall mounted, 21 watt, 2' long, incl lamps, mounting hardware and connections	$266.00	55.0	Ea.	$14,630	Type R
26	-	LED fixtures, interior, Colonnade 17in 4 Bar Trim ADA, incl lamps, mounting hardware and connections	$370.00	27.0	Ea.	$9,990	Type S
26	-	Exterior LED Wall Pack/Area light, 5700K, Dark Bronze Finish	$675.00	5.0	Ea.	$3,375	Type W
26	-	Exit lighting, L.E.D. w/ battery unit, single face, ceiling or wall mount	$365.00	7.0	Ea.	$2,555	Type X
26	-	Exit lighting, L.E.D. w/ battery unit, double face, ceiling or wall mount	$385.00	3.0	Ea.	$1,155	Type X2
		Fixture Wiring					
26	-	Junction boxes, steel channel	$135.00	50.0	Ea.	$6,750	
26	-	Occupancy sensors, dual technology, ceiling mounted	$365.00	12.0	Ea.	$4,380	
26	-	Wire, copper, solid, 600 volt, #12, type THWN-THHN, in raceway	$95.50	244.5	C.L.F.	$23,353	3 Runs
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	7,410.0	L.F.	$60,392	10 LF/Fixture
		Device Wiring					
26	-	Outlet boxes, pressed steel, concealed	$38.50	1,187.0	Ea.	$45,700	
26	-	Outlet boxes, pressed steel, extension rings	$23.50	1,187.0	Ea.	$27,895	
26	-	Toggle switch, quiet type, single pole, 20 amp	$42.00	249.0	Ea.	$10,458	
26	-	3 way switch, 20 amp	$60.50	110.0	Ea.	$6,655	
26	-	4 way switch, 20 amp	$133.00	26.0	Ea.	$3,458	
26	-	Duplex receptacle, grounded, 120 volt, 20 amp	$27.00	385.0	Ea.	$10,395	
26	-	Duplex receptacle, ground fault interrupting, 20 amp	$94.50	159.0	Ea.	$15,026	
26	-	Quad receptacle, surge suppressor, 20 amp	$162.00	78.0	Ea.	$12,636	
26	-	Receptacle, Appliances, 50 Amp	$98.50	52.0	Ea.	$5,122	
26	-	Motor connections, flexible conduit and fittings, 1 phase, 115 volt, 3 HP motor	$180.00	128.0	Ea.	$23,040	
26	-	Wire, copper, solid, 600 volt, #12, type THWN-THHN, in raceway	$95.50	391.7	C.L.F.	$37,408	3 Runs
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	11,870.0	L.F.	$96,741	10 LF/Device

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Doorbell System					
26	-	Doorbell system, door chime, 2 note, minimum	$93.50	55.0	Ea.	$5,143	
26	-	Doorbell system, doorbell 2 or 3 push button only	$79.00	26.0	Ea.	$2,054	
26	-	Outlet boxes, pressed steel, concealed	$38.50	26.0	Ea.	$1,001	
26	-	Outlet boxes, pressed steel, extension rings	$23.50	26.0	Ea.	$611	
26	-	Doorbell system, transformer	$86.00	26.0	Ea.	$2,236	
26	-	Electric metallic tubing (EMT), 3/4" diameter, to 15' high, incl 2 terminations, 2 field bend elbows, 11 beam clamps, and 11 couplings per 100 LF	$8.15	156.0	L.F.	$1,271	
26	-	Doorbell cable, jacket plenum rated, #18-4 conductor	$180.00	26.0	C.L.F.	$4,680	
			Lighting & Branch Wiring Subtotal:			**$625,902**	
	D5030	**Communications & TV Prewire**					
		Communications & TV Pre-wire					
		HORIZONTAL INFRASTRUCTURE					**$36,222**
27		CAT6 PLENUM RATED CABLE	$0.89	37,530.0	FT	$33,335	
27		CAT 6 JACK	$11.89	130.0	EA	$1,546	
27		1-PORT SINGLE-GANG FACEPLATE	$3.14	113.0	EA	$355	
27		4-PORT SINGLE-GANG FACEPLATE	$3.14	65.0	EA	$204	
27		WALL PHONE PLATES	$20.82	9.0	EA	$187	
27		TESTING CABLES	$4.28	139.0	EA	$595	
		Backbone					**$22,360**
27		100 PAIR, 24AWG CMR	$7.13	150.0	FT	$1,069	
27		110 BIOCKS 300 PAIR EACH WITH C-5 CLIPS	$100.05	3.0	EA	$300	
27		6 STRAND MM PLENUM	$3.93	200.0	FT	$787	
27		BREAKOUT FIBER KITS (6F)	$80.35	4.0	LS	$321	
27		144 STRAND SM OSP GEL-FREE ARMORED	$6.34	2,300.0	FT	$14,576	
27		12 STRAND SM OSP Armored	$3.09	1,300.0	FT	$4,012	
27		12 STRAND SM PLENUM Armored	$12.95	100.0	FT	$1,295	
27		OSP FIBER SPLICE CASE	$677.93	1.0	EA	$678	
27		SM BREAKOUT FIBER KITS (12F)	$232.99	2.0	EA	$466	
27		FIBER TEST OTDR BI-DIRECTIONAL	$15.96	150.0	EA	$2,394	
27		3" X 3 CELL MAXCELL - DETECTABLE	$8.15	3,900.0	FT	$31,794	
27		100 PAIR LIGHTING PROTECTOR	$404.28	1.0	EA	$404	
27		PROTECTOR MODULES	$7.03	50.0	EA	$352	
		TR's					**$52,385**
27		CAT6 PATCH PANEL - 48 PORT	$403.56	9.0	EA	$3,632	
27		CAT6 7FT PATCH CORD	$10.19	100.0	Ea	$1,019	
27		84" X 19" X 27"D FREE STANDING CABINET	$4,736.91	3.0	EA	$14,211	
27		84" X 19" X 30"D CO-LOCATION CABINET	$6,457.36	3.0	EA	$19,372	
27		2 RU (RMS) HORIZONTAL WIRE MANAGEMENT	$136.67	9.0	EA	$1,230	
27		RACK MOUNTED INTERCONNECT CENTER	$330.81	3.0	EA	$992	
27		6 DUPLEX SC ADAPTERS	$99.01	28.0	EA	$2,772	
27		SC FIELD TERM CONNECTOR (MM)	$20.27	24.0	EA	$487	
27		SC FIELD TERM CONNECTOR (SM)	$23.57	144.0	EA	$3,394	
27		RACK MOUNTED INTERCONNECT CENTER	$845.38	1.0	EA	$845	
27		CAT6 5FT PATCH CORD	$9.17	50.0	Ea	$459	
27		SM DUPLEX SC-SC 3M PATCH CORD	$45.18	24.0	EA	$1,084	
27		MM DUPLEX SC-SC 3M PATCH CORD	$42.85	48.0	EA	$2,057	
27		WIREWAY 36"X8"X8" (NEMA12)	$379.58	1.0	EA	$380	
27		30"Hx24"Wx8"D ENCLOSURE (NEMA4)	$451.17	1.0	EA	$451	
		INSTALLATION HARDWARE					**$1,165**
27		FIRE STOP	$116.47	10.0	EA	$1,165	
		CATV					**$55,911**
27		RG 6 QUAD SHIELD PLENUM COAXIAL CABLE	$1.10	45,900.0	EA	$50,446	
27		F-CONNECTOR	$14.96	340.0	EA	$5,086	
27		1-PORT SINGLE-GANG FACEPLATE	$3.61	105.0	EA	$379	
		Materials & Expenses:					**$19,439**
27		Equipment Contingency:	$3,077.86	1.0	LS	$3,078	2%
27		Parts Warranty:	$1,538.93	1.0	LS	$1,539	1%
27		Shipping	$3,077.86	1.0	LS	$3,078	2%
27		Taxes:	$9,233.59	1.0	LS	$9,234	6%
27		Labor Contingency:	$1,254.73	1.0	LS	$1,255	2%
27		Labor Warranty:	$1,254.73	1.0	LS	$1,255	2%

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Conduit & Back Boxes					**$53,515**
26	-	Cable tray, snake wire basket type, galvanized steel, 5" deep, 5" wide, to 15' elevation, incl fittings & supports	$19.65	1,157.0	L.F.	$22,735	
		Each floor will have around 90 Comm outlet locations. Each location will consist of: (1) 1" conduit; (1) 4-11/16" x 4-11/16" x 2-1/8" electrical backbox with a single-gang extension. The 1" conduit will be piped from the comm location to the corridor. On average the runs will be 25'					
26	-	Electric metallic tubing (EMT), 1" diameter, to 15' high, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	$10.10	2,250.0	L.F.	$22,725	
26	-	Outlet boxes, pressed steel, 4-11/16" square, 2-1/8" deep, 3/4" to 1-1/4" KO	$59.00	90.0	Ea.	$5,310	
26	-	Outlet boxes, pressed steel, covers, raised device, 4-11/16" square	$30.50	90.0	Ea.	$2,745	
		Communications & Security Systems Subtotal:				**$277,085**	
	D5040	**Special Electrical Systems**					
26		**Building Grounding System Renovation Only**	**$0.10**	**31,603.0**	**SF**	$3,160	
		Lightning Protection System	**$0.21**	**31,603.0**	**SF**		**$6,730**
28	-	Grounding rod, copper clad, 10' long, 1/2" diameter	$209.00	2.0	Ea.	$418	
28	-	Air terminal and base, copper, 1/2" dia x 36"	$177.00	12.0	Ea.	$2,124	
		Wiring & Accessories for Lightning Protection					
28	-	Ground wire, copper wire, bare solid, #2	$365.00	0.5	C.L.F.	$183	
28	-	Ground wire, copper wire, bare stranded, 4/0	$855.00	2.9	C.L.F.	$2,480	
28	-	PVC conduit, schedule 40, 1" diameter, to 15' H, incl terminations, fittings, & support	$9.95	80.0	L.F.	$796	
28	-	Exothermic weld, wire to ground rod	$139.00	2.0	Ea.	$278	
28	-	Exothermic weld, wire to building steel	$136.00	2.0	Ea.	$272	
28	-	Exothermic weld, mold reusable for above	$179.00	1.0	Ea.	$179	
		Fire Alarm System (misc allowance)					**$90,924**
28	-	Detection Systems, heat detector, smoke detector, ceiling type, excl. wires & conduit	$305.00	53.0	Ea.	$16,165	
28	-	Detection Systems, Double Action Fire Alarm Manual Pull Station, excluding wires & conduits	$215.00	8.0	Ea.	$1,720	
28	-	Detection Systems, Wall Mounted Fire Alarm Speaker, excluding wires & conduits	$360.00	36.0	Ea.	$12,960	
28	-	Detection Systems, Ceiling Mounted Fire Alarm Speaker, excluding wires & conduits	$360.00	33.0	Ea.	$11,880	
28	-	Detection Systems, Ceiling Mounted Fire Alarm Speaker Strobe with red body and clear lens, excluding wires & conduits	$395.00	14.0	Ea.	$5,530	
28	-	Detection Systems, Ceiling Mtd Photoelectric smoke detector, addressable type, excl. wires & conduit	$425.00	5.0	Ea.	$2,125	
28	-	Sprinkler System Components, tamper switch, (valve supervisory switch)	$163.00	3.0	Ea.	$489	
28	-	Sprinkler System Components, Fire Sprinkler Flow switch, includes swing check & flow control valves with required trim	$5,850.00	2.0	Ea.	$11,700	
28	-	Detection Systems, Wall mtd Fire Alarm Horn Speaker; 3W WP (for external use only), excluding wires & conduits	$455.00	1.0	Ea.	$455	
28	-	Detection systems, Ceiling mounted carbon monoxide Detector, excluding wires & conduits	$600.00	1.0	Ea.	$600	
28	-	Detection Systems, fire alarm control panel, 12 zone, excluding wires & conduits	$5,650.00	3.0	Ea.	$16,950	
28	-	Control Components/DDC Systems, subcontractor's quote incl. material & labor, status (alarms), digital inputs	$675.00	2.0	Ea.	$1,350	
28	-	Wire & Conduit, Permit, Testing Allowance.	$9,000.00	1.0	LS	$9,000	
28		**Mass Notification System (misc allowance)**					**$57,450**
28	-	Mass notification system, Addressable Monitor Module	$3,100.00	5.0	Ea.	$15,500	
28	-	Mass notification system, Addressable Relay Module	$3,100.00	5.0	Ea.	$15,500	
28	-	Detection Systems, Ceiling Mounted Mass Notification Strobe with white body and amber lens, excluding wires &	$395.00	15.0	Ea.	$5,925	
28	-	Mass notification system, antenna VHF or UHF, for high-power transmitter, incl. mounting bracket	$1,275.00	1.0	Ea.	$1,275	
28	-	Mass notification system, transmitter, 100 watt	$9,250.00	1.0	Ea.	$9,250	
28	-	Wire & Conduit, Permit, Testing Allowance.	$10,000.00	1.0	LS	$10,000	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Security CCTV System					**$80,093**
28	-	Video surveillance cameras, internet protocol (IP) network, day/night, color, includes power supply	$1,875.00	25.0	Ea.	$46,875	
28	-	Exterior Video surveillance cameras, internet protocol (IP) network, day/night, color, includes power supply	$3,175.00	4.0	Ea.	$12,700	
28	-	Digital video recorders	$1,650.00	2.0	Ea.	$3,300	
26	-	Electric metallic tubing (EMT), 1" diameter, to 15' high, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	$10.10	1,320.0	L.F.	$13,332	
27		CAT6 PLENUM RATED CABLE	$0.89	1,452.0	FT	$1,290	
26	-	Outlet boxes, pressed steel, 4-11/16" square, 2-1/8" deep, 3/4" to 1-1/4" KO	$59.00	29.0	Ea.	$1,711	
26	-	Outlet boxes, pressed steel, covers, raised device, 4-11/16" square	$30.50	29.0	Ea.	$885	
			Special Electrical Systems Subtotal:			**$238,357**	
E10		**EQUIPMENT**			**SUBTOTAL:**	**$103,610**	**$3.28 /SF**
	E1010	**Equipment - Residential Appliances**					
11	-	Cooking range: RA820DD – Hotpoint 20" Free-Standing Electric Range	$690.00	26.0	Ea.	$17,940	Internte Materil Quote W/15% Quantity Discount
11	-	Range hood/Microwave oven, 30" Under-Cabinet Range Hood with 190 CFM Internal Blower, 2-Speed Rocker Control, Dishwasher-Safe Aluminum Grease Filter and Convertible To Recirculating: White	$865.00	26.0	Ea.	$22,490	Internte Materil Quote W/Quantity Discount
11	-	Refrigerator, Frigidaire Model # FFHT1814QW,18 cu. ft. Top Freezer Refrigerator in White	$780.00	26.0	Ea.	$20,280	Internte Materil Quote W/15% Quantity Discount
11	-	Combination Stacked Washing machine/Dryer: Whirlpool Model # WET3300XQ Thin Twin 2.5 cu. ft. Washer and 5.9 cu. ft. Electric Dryer in White	$1,650.00	26.0	Ea.	$42,900	Internte Materil Quote W/15% Quantity Discount
			Commercial Equipment Subtotal:			**$103,610**	
E20		**FURNISHINGS**			**SUBTOTAL:**	**$0**	**$0.00 /SF**
F20		**SELECTIVE BUILDING DEMOLITION**			**SUBTOTAL:**	**$436,478**	**$13.81 /SF**
	F2010	**Building Elements Demolition**					
		Temporary Fencing					
2	-	Temporary Fencing, chain link, rented up to 12 months, 6' high, 11 ga, over 1000'	$8.35	1,400.0	L.F.	$11,690	
2	-	Temporary Fencing, chain link gates, rented up to 12 months, 6' high, 11 ga,	$16.10	36.0	L.F.	$580	
		Gutting Finishes, Mech,, Plumbing, & Electrical					
2	-	Selective demolition, gutting, building interior, commercial building, includes disposal, excludes dumpster fees	$8.90	30,468.0	SF Flr.	$271,165	2,300 CY
2	-	Selective demolition, rubbish handling, dumpster, alternate pricing method, haul, average for all sizes, includes one dump per week, cost to be added to demolition cost.	$261.00	52.0	Ea.	$13,572	45yd Dumpster
		Elevated Slab Cutouts & Opening Reinforcing					
2	-	Concrete sawing, concrete slabs, rod reinforced, up to 3"	$2.51	21.6	L.F.	$54	
2	-	Concrete sawing, concrete, existing slab, rod reinforced, for each additional inch of depth over 3"	$0.84	64.9	L.F.	$55	
2	-	Selective demolition, cutout, concrete elevated slab, light reinforcing, under 6 C.F., excludes loading and disposal	$51.00	4.1	C.F.	$211	
6	-	Angle framing, structural steel, 3"x3"x3/8", field fabricated, incl cutting & welding	$53.50	17.4	L.F.	$932	
6	-	Concrete impact drilling, for anchors, up to 4" D, 5/8" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	$16.10	12.0	Ea.	$193	
6	-	Concrete impact drilling, for anchors, 5/8" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor, for each additional inch of depth, add	$3.23	24.0	Ea.	$78	
6	-	Wedge anchor, carbon steel, 5/8" dia x 6" L, in concrete, excl layout & drilling	$11.10	12.0	Ea.	$133	

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
		Elevated Slab Infill					
3	-	Chemical anchor, 1/2" dia x 17" L, in concrete, incl layout, drilling, #4 dowel & epoxy cartridge	$67.50	14.0	Ea.	$945	
3	-	C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 1 use, includes shoring, erecting, bracing, stripping and cleaning	$12.10	32.0	S.F.	$387	
3	-	Reinforcing Steel, in place, beams and girders, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	$2.41	20.0	Lb.	$48	
3	-	Structural concrete, in place, elevated slab (4000 psi), 6" slab, includes finishing, excl forms, reinforcing	$4.39	14.0	S.F.	$62	
3	-	Structural concrete, in place, patch floor holes up to 6" round (3000 psi),includes forms, reinforcing steel, concrete, placing and finishing	$36.00	300.0	Ea.	$10,800	
			Building Elements Demolition Subtotal:			**$310,905**	
	F2020	**Hazardous Components Abatement**					
		Based on Terracon Consultants, Inc. Reprot Dated 7/28/2015					
		Asbestos Remediation					
2a	-	Asbestos Remediation, plans and Methods, lead Abatement Remediation Plan	$1,325.00	1.0	Ea.	$1,325	
2a	-	*Bulk Asbestos Removal, remove VAT from floor by machine, incl. disp. tools & 4 suits & resp./day/worker*	$1.50	-	S.F.	$0	No flooring tile tested positive
2a	-	Bulk Asbestos Removal, duct or AHU insulation, incl. disp. tools & 4 suits & resp./day/worker	$8.10	384.0	S.F.	$3,110	
2a	-	Bulk Asbestos Removal, pipe insulation, air cell type, up to 4" diameter pipe, incl. disp. tools & 4 suits & resp./day/worker	$7.95	5,520.0	L.F.	$43,884	
2a	-	Bulk Asbestos Removal, pipe fitting insulation, up to 4" diameter pipe, incl. disp. tools & 4 suits & resp./day/worker	$22.50	1,380.0	Ea.	$31,050	Found on pipe joints
		PCB Light Ballast disposal					
2a	-	PCB Light Ballast disposal	$3.59	281.0	Ea.	$1,009	
		Lead Paint Abatement					
2a	-	Protection during removal of lead-based paint containing stair railings	$25.00	120.0	L.F.	$3,000	
2a	-	Lead Paint Remediation, plans and Methods, lead Abatement Remediation Plan	$1,325.00	1.0	Ea.	$1,325	
2a	-	Removal of lead-based paint, by chemicals, per application, CMU	$8.70	3,100.0	S.F.	$26,970	
		General Abatement Costs					
2a	-	Air Testing, final cleanup and disposal allowance	$13,900.00	1.0	LS	$13,900	
		Hazardous Components Abatement Subtotal:				**$125,573**	
G10		**SITE PREPARATION**			**SUBTOTAL:**	**$0**	**$0.00 /SF**
G20		**SITE IMPROVEMENTS**			**SUBTOTAL:**	**$50,860**	**$1.61 /SF**
	G2050	**Landscaping**					
32	-	Selective clearing and grubbing, up to 6" diameter, remove selective trees, on site using chain saws and chipper, excludes stumps	$270.00	10.0	Ea.	$2,700	
32	-	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 4" to 6" diameter, stump removal on site by hydraulic excavator	$48.50	10.0	Ea.	$485	
32	-	Sodding, bent grass sod, on level ground, 3 M.S.F.	$1,050.00	37.5	M.S.F.	$39,375	
32	-	Deciduous trees, oak, balled & burlapped (B&B), 2-1/2"-3" caliper, in prepared beds	$830.00	10.0	Ea.	$8,300	
				Landscaping Subtotal:		**$50,860**	

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ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
G30		SITE MECHANICAL UTILITIES			SUBTOTAL:	$1,693	$0.05 /SF
	G3010	Water Supply					
		Utility Trench, 48" wide x 60" deep		**60**	**L.F.**		
33	-	Excavating, 4' to 6' deep, machine excavation	$5.65	62	B.C.Y.	$350	
33	-	Crushed gravel bedding, excludes compaction	$47.50	5	L.C.Y.	$222	6 in deep bed
33	-	Compaction for bedding	$6.15	4	E.C.Y.	$27	5.00% Shrink
33	-	Backfill, structural, common earth, dozer, 300' haul	$4.28	60	L.C.Y.	$259	
33	-	Compaction, structural, 6" lifts, vibratory plate	$2.72	57	E.C.Y.	$156	5.00% Shrink
33	-	Utility Line Signs, Markers, and Flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill	$6.75	0.6	C.L.F.	$4	
22	-	Water supply distribution piping, polyvinyl chloride pressure pipe, 4", ASTM D2241, class 200, SDR 21, excludes excavation or backfill	$11.25	60.0	L.F.	$675	
				Water Supply Subtotal:		$1,693	
G40		SITE ELECTRICAL UTILITIES			SUBTOTAL:	$222,055	$7.03 /SF
	G4010	Electrical Distribution					
		2 x 4 Concrete Encased Ductbank with 4 in. Conduit					
		Utility Trench, 28" wide x 36" deep		**75**	**L.F.**		
33	-	Excavating, 4' to 6' deep, machine excavation	$5.65	26	B.C.Y.	$145	
33	-	Crushed gravel bedding, excludes compaction	$47.50	3	L.C.Y.	$162	6 in deep bed
33	-	Compaction for bedding	$6.15	3	E.C.Y.	$20	5.00% Shrink
33	-	Backfill, structural, common earth, dozer, 300' haul	$4.28	16	L.C.Y.	$69	
33	-	Compaction, structural, 6" lifts, vibratory plate	$2.72	15	E.C.Y.	$42	5.00% Shrink
33	-	Utility Line Signs, Markers, and Flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill	$6.75	0.8	C.L.F.	$5	
		Duct Bank		**75**	**L.F.**		
33	-	3000 psi. concrete for duct bank	$133.00	7	C.Y.	$936	5.00% Waste
33	-	Electrical Underground Ducts and Manholes, PVC, conduit with coupling, 4" diameter, schedule 40, installed by direct burial in slab or duct bank	$17.60	600	L.F.	$10,560	
33	-	PVC conduit elbows, 4" diameter, to 15' H	$182.00	12.0	Ea.	$2,184	
33	-	Base Spacers	$23.00	15	Ea.	$345	
33	-	Intermediate Spacers	$23.00	45	Ea.	$1,035	
33	-	Electric and telephone, nylon pull rope, 1/4"	$1.01	600	L.F.	$606	
33	-	2" underground detection tape, aluminum foil core	$6.15	2	C.L.F.	$9	
33	-	Wire, copper, stranded, 600 volt, 500 kcmil, type THWN-THHN, in raceway	$1,925.00	19.8	C.L.F.	$38,115	
			Electrical Distribution Subtotal:			$54,233	
	G4030	Site Communications & Security					
		DIRECT BURIAL DUCTBANK					**$151,613**
		New Communications Manholes					
33	-	New MH-176A Electrical Underground Manhole, precast w/iron racks & pulling irons, C.I. frame and cover, 6' x 12' x 7' deep, excludes excavation, backfill and cast in place concrete	$9,425.00	3.0	Ea.	$28,275	
33	-	Pull boxes, cast iron, water & dust tight, 24" L x 24" W x 10" D, NEMA 4, surface mounting	$7,875.00	1.0	Ea.	$7,875	
		Utility Trench (three way), 21" wide x 46" deep		**154**	**L.F.**		
33	-	Excavating, 4' to 6' deep, machine excavation	$5.65	59	B.C.Y.	$335	
33	-	Crushed gravel bedding, excludes compaction	$47.50	2	L.C.Y.	$95	2 in deep bed
33	-	Compaction for bedding	$6.15	2	E.C.Y.	$12	5.00% Shrink
33	-	Backfill, structural, common earth, dozer, 300' haul	$4.28	60	L.C.Y.	$258	
33	-	Compaction, structural, 6" lifts, vibratory plate	$2.72	57	E.C.Y.	$156	5.00% Shrink
33	-	Equipment Standing Time For Small Earthwork Project	$856.00	60%	%	$514	
		Duct Bank		**154**	**L.F.**		
33	-	Electrical Underground Ducts and Manholes, PVC, conduit with coupling, 4" diameter, schedule 40, installed by direct burial in slab or duct bank	$17.60	462	L.F.	$8,131	
33	-	Base Spacers	$23.00	93	Ea.	$2,139	
33	-	Intermediate or Top Spacers	$23.00	93	Ea.	$2,139	
33	-	Electric and telephone, nylon pull rope, 1/4"	$1.01	462	L.F.	$467	
33	-	2" underground detection tape, aluminum foil core	$6.15	1.5	C.L.F.	$9	
33	-	Electrical Underground Ducts and Manholes, hand holes, precast concrete, with concrete cover, 4' x 4' x 4' deep	$3,200.00	1.0	Ea.	$3,200	
		Utility Trench (two way), 15.5" wide x 46" deep		**11**	**L.F.**		

ESTIMATE MODEL OF PROBABLE COST

		Description	Unit $	Qty.	Unit	Total $	Notes
33	-	Excavating, 4' to 6' deep, machine excavation	$5.65	4	B.C.Y.	$20	
33	-	Crushed gravel bedding, excludes compaction	$47.50	0	L.C.Y.	$4	2 in deep bed
33	-	Compaction for bedding	$6.15	0	E.C.Y.	$1	5.00% Shrink
33	-	Backfill, structural, common earth, dozer, 300' haul	$4.28	4	L.C.Y.	$15	
33	-	Compaction, structural, 6" lifts, vibratory plate	$2.72	3	E.C.Y.	$9	5.00% Shrink
33	-	Equipment Standing Time For Small Earthwork Project	$49.00	60%	%	$29	
		Duct Bank		**11**	**L.F.**		
33	-	Electrical Underground Ducts and Manholes, PVC, conduit with coupling, 4" diameter, schedule 40, installed by direct burial in slab or duct bank	$17.60	22	L.F.	$387	
33	-	Base Spacers	$23.00	5	Ea.	$115	
33	-	Top or Intermediate Spacers	$23.00	5	Ea.	$115	
33	-	Electric and telephone, nylon pull rope, 1/4"	$1.01	22	L.F.	$22	
33	-	2" underground detection tape, aluminum foil core	$6.15	0.11	C.L.F.	$1	
		Utility Trench (four way), 15.5" wide x 46" deep		**857**	**L.F.**		
33	-	Excavating, 4' to 6' deep, machine excavation	$5.65	274	B.C.Y.	$1,547	
33	-	Crushed gravel bedding, excludes compaction	$47.50	7	L.C.Y.	$341	2 in deep bed
33	-	Compaction for bedding	$6.15	7	E.C.Y.	$42	5.00% Shrink
33	-	Backfill, structural, common earth, dozer, 300' haul	$4.28	280	L.C.Y.	$1,200	
33	-	Compaction, structural, 6" lifts, vibratory plate	$2.72	266	E.C.Y.	$724	5.00% Shrink
33	-	Equipment Standing Time For Small Earthwork Project	$3,854.00	60%	%	$2,312	
		Duct Bank		**857**	**L.F.**		
33	-	Electrical Underground Ducts and Manholes, PVC, conduit with coupling, 4" diameter, schedule 40, installed by direct burial in slab or duct bank	$17.60	3,428	L.F.	$60,333	
33	-	Base Spacers	$23.00	343	Ea.	$7,889	
33	-	Top or Intermediate Spacers	$23.00	686	Ea.	$15,778	
33	-	Electric and telephone, nylon pull rope, 1/4"	$1.01	3,428	L.F.	$3,462	
33	-	2" underground detection tape, aluminum foil core	$6.15	17	C.L.F.	$105	
		Surface Demo. & Damage Repairs					
33	-	Demo sidewalks, plain concrete, 4" thick, excludes disposal costs and dump fees	$6.65	40.0	S.F.	$266	
32	-	Selective demolition, saw cutting, paving, up to 3" deep	$2.18	120.0	L.F.	$262	
32	-	Selective demolition, saw cutting, each additional inch of depth over 3"	$1.16	280.0	L.F.	$325	
32	-	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	$5.10	40.0	S.F.	$204	
32	-	Sidewalks, driveways, and patios, bedding for brick or stone, sand, 4" thick, excludes base	$1.24	40.0	S.F.	$50	
32	-	Concrete paving surface treatment, 4500 psi, fixed form, unreinforced, 12' pass, 8" thick,small area, includes joints, finishing, and curing	$43.50	41.1	S.Y.	$1,788	
32	-	Concrete paving surface treatment, reinforcing steel for rigid paving, 18 lbs/SY	$16.10	41.1	S.Y.	$662	
		BORED DUCTBANK					**$16,209**
		Directional Boring Individual 4" HDPE Concuit		**432**	**L.F. of Duck Bank Run**		
33	-	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit	$1,125.00	1.0	Ea.	$1,125	
33	-	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit setup per drill, excluding cost of conduit	$560.00	6.0	Ea.	$3,360	
33	-	Directional drilling, small equipment to 300', per linear feet, gravel, sand & silt, up to 4" dia, 100' minimum, excluding cost of conduit	$7.55	440.0	L.F.	$3,322	
33	-	HDPE Conduit, butt fusion joints, 40' lengths, 4" diameter, SDR 13.5 orange	$15.70	440.0	L.F.	$6,908	
33	-	Electrical Underground Ducts and Manholes, PVC, adapters, 4" diameter, schedule 40, installed by direct burial in slab or duct bank	$73.50	4.0	Ea.	$294	
33	-	Bore through and connect 4 conduits at existing communications manhole MH-176	$1,200.00	1.0	LS	$1,200	
		Site Communications & Security Subtotal:				**$167,822**	

Project: DMP-Renovate Dorm 276							
Location: Minot AFB, North Dakota							
Date: February 29, 2016							
Project # : 310528.00.0179.01.700							
			PROJECT DURATION:				
		GC GENERAL CONDITION BACUP SUMMARY	**10.0 Mo.**		Level 3 $	Level 2 $	%/Tot
H10		**GENERAL CONDITIONS**				**$587,000**	**100.0%**
	H1010	Detail Backup Summary			$587,234		100.0%
	Total Project Direct Cost For GC General Conditions Based on Duration:					**$587,000**	**100%**
	Total Direct Cost For All Projects Base Bid Items:				**$6,471,425**		
	Gerneral Conditions as a Percent of Direct Cost:					**9.07%**	
	Markup Guide Lines Based On Bidding Experience:		General Condition (including home office OH)		Project Direct Cost		Profit
			15.0%		$1,000,000	or less	**15.0%**
			12.0%		$1,000,100	to $2,500,000	**10.0%**
			10.0%		$2,500,100	to $5,000,000	**8.0%**
			8.0%		$5,000,100	to $10,000,000	**7.0%**
			7.0%		$10,000,001	to $20,000,000	**5.0%**
			7.0%		$20,000,001	to $100,000,000	**4.0%**
		For 8a and other small business setasides add:	**10% to 15%**				
		For high security sites or sites with difficult access add:	**1% to 2%**	**<use 1%+ for remote site.**			
		For accelerated or extended schedules add:	**2% to 10%**				
		For large projects over $100,000,000 deduct:	**-2% to -5%**	**from direct cost**			
		Description	**Unit $**	**Qty.**	**Unit**	**Total $**	**Notes**
H10		**GENERAL CONDITIONS**			**SUBTOTAL:**	**$587,234**	
	H1010	**Detail Backup Summary**					
		Field Personnel					
01	0131132	Field personnel, project manager, average	$3,322.00	21.7	Week	$71,977	1/2 time
01	0131132	Field personnel, superintendent, average	$3,103.00	43.3	Week	$134,463	
01	0131132	Field personnel, clerk, average	$657.00	43.3	Week	$28,470	
01	0131132	Field personnel, field engineer, safety	$2,044.00	32.5	Week	$66,430	3/4 time
01	0131132	Field personnel, field engineer, quality control & coordination	$2,044.00	43.3	Week	$88,573	
01	0131132	Field personnel, general purpose laborer, average	$2,190.00	32.5	Week	$71,175	3/4 time
		Testing Allowance					
01	0145235	Field testing	$4,000.00	1.0	Project	$4,000	
		Home Office Overhead					
01	0131000	Home Office Project Assistance	$800.00	43.3	Week	$34,667	
		Winter Operations Allowance					
01	0145235	Show Removal for Access & Protection of Work	$20,000.00	1.0	Project	$20,000	
		Field Facilities					
01	0152132	Office trailer, furnished, rent per month, 50' x 10', excl. hookups	$515.40	10.0	Month	$5,154	1 Ea.
01	0152132	Office trailer, excl. hookups, air conditioning, rent per month, add	$73.52	10.0	Month	$735	1 Ea.
01	0152132	Modular office building, delivery, each way	$303.18	1.0	Ea.	$303	1 Ea.
01	0152132	Storage boxes, rent per month, 20' x 8'	$125.06	10.0	Month	$1,251	1 Ea.
01	0152134	Field office expense, office equipment rental, average	$303.18	10.0	Month	$3,032	1 Ea.
01	0152134	Field office expense, office supplies, average	$121.27	10.0	Month	$1,213	1 Ea.
01	0152134	Field office expense, telephone bill; average bill/month, incl. long distance	$128.86	10.0	Month	$1,289	1 Ea.
01	0152134	Field office expense, field office lights & HVAC	$242.54	10.0	Month	$2,425	1 Ea.
01	0154365	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	$177.12	20.0	Ea.	$3,542	
01	0158135	Project signs, sign	$1,858.08	1.0	Ea.	$1,858	
01	0132135	CPM scheduling, small job	$9,534.20	1.0	LS	$9,534	

		Description	Unit $	Qty.	Unit	Total $	Notes
		Construction Aids					
01	0156231	Barricades, wood, movable, 3 rail, 5' high, 3 rail @ 2" x 8", movable	$44.01	50.0	L.F.	$2,201	
01	0156231	Detour sign, reflective aluminum, MUTCD, 24" x 24", post mounted	$25.49	2.0	Ea.	$51	
01	0154334	Equipment rental reflectorized barrels 1 to 99 barrels, Incl. Hourly	$44.67	100.0	Month	$4,467	10 Ea.
01	0154334	Rent toilet portable chemical, Incl. Hourly Oper. Cost.	$198.78	40.0	Month	$7,951	4 Ea.
01	0154334	Rent truck pickup 3/4 ton	$600.00	10.0	Month	$6,000	1 Ea.
01	0154334	Bob Cat	$1,200.00	10.0	Month	$12,000	1 Ea.
		Site Cleanup					
01	0174132	Cleaning up, cleanup of floor area, continuous, per day, during construction	$46.89	31.6	M.S.F.	$1,482	
01	0174132	Cleaning up, cleanup of floor area, final by GC at end of job	$94.65	31.6	M.S.F.	$2,991	
		Standard Foundations Subtotal:				**$587,234**	

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
Date: February 29, 2016
Project # : 310528.00.0179.01.700

INTERIOR FINISHES

					FLOORING				BASE		WALL	CEILING		New Doors					
					CARPET TILE	RESILIENT SHEET FLOORING	PORCELAIN FLOOR TILE	SEALED CONCRETE FINISHING	RESILIENT BASE	PORCELAIN TILE BASE	PAINT ON DRYWALL	GWB PAINTED	OPEN TO STRUCTURE						
Rm #	Name	Perim	Area	Ht.	CPT1	SL	PFT1	SC1	RB1	PWB1	PT1	GWB	OPEN	card acc	wd 3-0	wd 2-4/6	wd pr. 1-6	hm 3-0	Pr. Alum.
	First Floor																		
1 S1-1	Stair 1	53	143	9.3	-	143	-	-	53	-	494	-	-	1				2	
1 S2-1	Stair 2	73	216	9.3	-	-	216	-	-	73	681	-	-					1	
1 S3-1	Stair 3	53	143	9.3	-	143	-	-	53	-	494	-	-	1				2	
1000	Vestibule	35	68	9.3	-	-	68	-	-	35	327	-	-	1					2
1001	Corridor	458.3	1,173	7.5	1,057	-	116	-	458	-	3,437	1,173	-						
1002	ADAToilet Room	35	58	7.5	58	58	-	-	35	-	263	58	-		1				
1003	Comm Room	35	76	9.0	-	-	-	76	35	-	315	-	76		1				
1004	Janitor	23	29	7.5	-	-	-	-	23	-	173	29	-		1				
1005	Office	34	68	7.5	68	-	-	-	34	-	255	68	-		1				
1006	Boiler Room	67	242	9.0	-	-	-	242	67	-	603	-	242					1	
1007	Day Room	81	327	8.0	327	-	-	-	81	-	648	327	-						
1008	Recycling	46	125	7.5	-	-	-	125	46	-	345	125	-		1				
1009	Mail Room	40	89	9.3	-	-	89	-	-	40	373	-	-						
1010	Mechanical	50	150	9.0	-	-	-	150	50	-	450	-	150					1	
1011	Main Elect.	46	119	9.0	-	-	-	119	46	-	414	-	119					1	
1101	Shared Kitchen/Entry	45	81	8.0	-	81	-	-	45	-	360	81	-	1	1				
1101	Shared Room	53	143	8.0	-	143	-	-	53	-	424	143	-						
1102	Laundry	14	10	8.0	-	10	-	-	14	-	112	10	-				1		
1103	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1103	Bedroom	51	155	8.0	155	-	-	-	51	-	408	155	-	1		1			
1103	Closet	18	19	8.0	19	-	-	-	18	-	144	19	-			1			
1106	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
1106	Bedroom	53	159	8.0	159	-	-	-	53	-	424	159	-	1		1			
1106	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1200	Shared Kitchen/Entry	45	82	8.0	-	82	-	-	45	-	360	82	-	1	1				
1201	Shared Room	53	146	8.0	-	146	-	-	53	-	424	146	-						
1202	Laundry	25	20	8.0	-	20	-	-	25	-	200	20	-				1		
1203	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1203	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
1203	Closet	18	19	8.0	19	-	-	-	18	-	144	19	-			1			
1206	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
1206	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			
1206	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1300	Shared Kitchen/Entry	47	87	8.0	-	87	-	-	47	-	376	87	-	1	1				
1301	Shared Room	64	150	7.8	-	150	-	-	64	-	501	150	-						
1301	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
1303	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1303	Bedroom	54	166	8.0	166	-	-	-	54	-	432	166	-	1		1			
1303	Closet	21	25	7.8	25	-	-	-	21	-	165	25	-			1			
1306	Bath	26	36	8.0	-	36	-	-	26	-	208	36	-			1			
1306	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
1306	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
1400	Shared Kitchen/Entry	126	307	8.0	-	307	-	-	126	-	1,008	307	-	1	1				
1401	Shared Room	53	145	8.0	-	145	-	-	53	-	424	145	-						
1401	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
1403	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1403	Bedroom	52	159	8.0	159	-	-	-	52	-	416	159	-	1		1			
1403	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
1406	Bath	91	234	8.0	-	234	-	-	91	-	728	234	-			1			
1406	Bedroom	53	159	8.0	159	-	-	-	53	-	424	159	-	1		1			
1406	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1600	Shared Kitchen/Entry	45	79	8.0	-	79	-	-	45	-	360	79	-	1	1				
1601	Shared Room	54	145	8.0	-	145	-	-	54	-	432	145	-						
1602	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
1603	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1603	Bedroom	52	158	8.0	158	-	-	-	52	-	416	158	-	1		1			
1603	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
1606	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
1606	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
1606	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1701	Shared Kitchen/Entry	45	93	7.8	-	93	-	-	45	-	353	93	-	1	1				
1702	Shared Room	52	140	8.0	-	140	-	-	52	-	416	140	-						
1701	Laundry	13	9	8.0	-	9	-	-	13	-	104	9	-				1		
1703	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1703	Bedroom	59	148	8.0	148	-	-	-	59	-	472	148	-	1		1			
1703	Closet	17	18	8.0	18	-	-	-	17	-	136	18	-			1			
1706	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1706	Bedroom	48	123	8.0	123	-	-	-	48	-	384	123	-	1		1			

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
Date: February 29, 2016
Project # : 310528.00.0179.01.700

INTERIOR FINISHES

					FLOORING				BASE		WALL	CEILING		New Doors					
					CARPET TILE	RESILIENT SHEET FLOORING	PORCELAIN FLOOR TILE	SEALED CONCRETE FINISHING	RESILIENT BASE	PORCELAIN TILE BASE	PAINT ON DRYWALL	GWB PAINTED	OPEN TO STRUCTURE						
Rm #	Name	Perim	Area	Ht.	CPT1	SL	PFT1	SC1	RB1	PWB1	PT1	GWB	OPEN	card acc	wd 3-0	wd 2-4/6	wd pr. 1-6	hm 3-0	Pr. Alum.
1706	Closet	16	16	8.0	16	-	-	-	16	-	128	16	-			1			
1709	Bath	25	35	7.8	-	35	-	-	25	-	196	35	-			1			
1709	Bedroom	54	169	8.0	169	-	-	-	54	-	432	169	-	1		1			
1709	Closet	21	25	8.0	25	-	-	-	21	-	168	25	-			1			
1712	Hall	46	67	8.0	-	67	-	-	46	-	368	67	-						
1800	Shared Kitchen/Entry	45	81	8.0	-	81	-	-	45	-	360	81	-	1	1				
1801	Shared Room	54	145	8.0	-	145	-	-	54	-	432	145	-						
1802	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
1803	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1803	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			
1803	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1806	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1806	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
1806	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
1900	Shared Kitchen/Entry	45	82	8.0	-	82	-	-	45	-	360	82	-	1	1				
1901	Shared Room	51	146	8.0	-	146	-	-	51	-	408	146	-						
1901	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
1903	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1903	Bedroom	53	159	8.0	159	-	-	-	53	-	424	159	-	1		1			
1903	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
1906	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
1906	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
1906	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
			9,033																
	Second Floor																		
2 S1-2	Stair 1	51	139	9.3	-	-	-	-	51	-	476	-	139						
2 S2-2	Stair 2	56	163	9.3	-	-	-	-	56	-	522	-	163						
2 S3-2	Stair 3	51	139	9.3	-	-	-	-	51	-	476	-	139						
2001	Corridor	476.3	1,161	7.5	1,161	-	-	-	476	-	3,572	1,161	-						
2002	Comm Room	65	128	9.0	-	-	-	128	65	-	585	-	128						
2003	Elect./Fire Alarm	79	183	9.0	-	-	-	183	79	-	711	-	183						
2004	Day Room	164	779	8.0	779	-	-	-	164	-	1,312	779	-						
2005	Janitor	42	52	7.5	-	-	-	-	42	-	315	52	-						
2006	Mechanical	193	677	9.0	-	-	-	677	193	-	1,737	-	677						
2100	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2101	Shared Room	52	142	8.0	-	142	-	-	52	-	416	142	-						
2101	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2103	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2103	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
2103	Closet	18	20	8.0	20	-	-	-	18	-	144	20	-			1			
2106	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
2106	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			
2106	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2200	Shared Kitchen/Entry	45	79	8.0	-	79	-	-	45	-	360	79	-	1	1				
2201	Shared Room	54	147	8.0	-	147	-	-	54	-	432	147	-						
2201	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2203	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2203	Bedroom	52	154	8.0	154	-	-	-	52	-	416	154	-	1		1			
2203	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2206	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2206	Bedroom	52	158	8.0	158	-	-	-	52	-	416	158	-	1		1			
2206	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
2300	Shared Kitchen/Entry	46	84	8.0	-	84	-	-	46	-	368	84	-	1	1				
2301	Shared Room	54	149	7.8	-	149	-	-	54	-	423	149	-						
2301	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2303	Bath	25	35	7.8	-	35	-	-	25	-	196	35	-			1			
2303	Bedroom	54	167	8.0	167	-	-	-	54	-	432	167	-	1		1			
2303	Closet	20	25	8.0	25	-	-	-	20	-	160	25	-			1			
2306	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2306	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
2306	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2400	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2401	Shared Room	53	145	8.0	-	145	-	-	53	-	424	145	-						
2401	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2403	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2403	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			
2403	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
2406	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2406	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
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Project # : 310528.00.0179.01.700

INTERIOR FINISHES

Rm #	Name	Perim	Area	Ht.	FLOORING: CARPET TILE CPT1	FLOORING: RESILIENT SHEET FLOORING SL	FLOORING: PORCELAIN FLOOR TILE PFT1	FLOORING: SEALED CONCRETE FINISHING SC1	BASE: RESILIENT BASE RB1	BASE: PORCELAIN TILE BASE PWB1	WALL: PAINT ON DRYWALL PT1	CEILING: GWB PAINTED GWB	CEILING: OPEN TO STRUCTURE OPEN	New Doors: card acc	New Doors: wd 3-0	New Doors: wd 2-4/6	New Doors: wd pr. 1-6	New Doors: hm 3-0	New Doors: Pr. Alum.
2406	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2500	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2501	Shared Room	52	140	8.0	-	140	-	-	52	-	416	140	-						
2501	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2503	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2503	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
2503	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2506	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2506	Bedroom	53	159	8.0	159	-	-	-	53	-	424	159	-	1		1			
2506	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2600	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2601	Shared Room	53	144	8.0	-	144	-	-	53	-	424	144	-						
2601	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2603	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2603	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
2603	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
2606	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2606	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
2606	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
2700	Shared Kitchen/Entry	45	93	8.0	-	93	-	-	45	-	360	93	-	1	1				
2701	Shared Room	53	140	7.8	-	140	-	-	53	-	415	140	-						
2701	Laundry	13	9	8.0	-	9	-	-	13	-	104	9	-				1		
2703	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
2703	Bedroom	59	148	8.0	148	-	-	-	59	-	472	148	-	1		1			
2703	Closet	17	18	8.0	18	-	-	-	17	-	136	18	-			1			
2706	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2706	Bedroom	48	125	8.0	125	-	-	-	48	-	384	125	-	1		1			
2706	Closet	16	16	8.0	16	-	-	-	16	-	128	16	-			1			
2709	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2709	Bedroom	53	165	7.8	165	-	-	-	53	-	415	165	-	1		1			
2709	Closet	20	25	8.0	25	-	-	-	20	-	160	25	-			1			
2712	Hall	46	63	8.0	-	63	-	-	46	-	368	63	-						
2800	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2801	Shared Room	53	143	8.0	-	143	-	-	53	-	424	143	-						
2801	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2803	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2803	Bedroom	52	156	8.0	156	-	-	-	52	-	416	156	-	1		1			
2803	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
2806	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
2806	Bedroom	52	153	8.0	153	-	-	-	52	-	416	153	-	1		1			
2806	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
2900	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
2901	Shared Room	54	145	8.0	-	145	-	-	54	-	432	145	-						
2901	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
2903	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2903	Bedroom	52	158	8.0	158	-	-	-	52	-	416	158	-	1		1			
2903	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
2906	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
2906	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
2906	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
			9,608																
	Third Floor																		
3 S1-3	Stair 1	51	139	9.3	-	-	-	-	51	-	476	-	139						
3 S2-3	Stair 2	56	163	9.3	-	-	-	-	56	-	522	-	163						
3 S3-3	Stair 3	51	139	9.3	-	-	-	-	51	-	476	-	139						
3001	Corridor	476.3	1,161	7.5	1,161	-	-	-	476	-	3,572	1,161	-						
3002	Comm Room	65	128	9.0	-	-	-	128	65	-	585	-	128						
3003	Elect./Fire Alarm	79	183	9.0	-	-	-	183	79	-	711	-	183						
3004	Day Room	164	779	8.0	779	-	-	-	164	-	1,312	779	-						
3005	Janitor	42	52	7.5	-	-	-	-	42	-	315	52	-						
3006	Mechanical	193	677	9.0	-	-	-	677	193	-	1,737	-	677						
3100	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3101	Shared Room	52	142	8.0	-	142	-	-	52	-	416	142	-						
3101	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3103	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3103	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
3103	Closet	18	20	8.0	20	-	-	-	18	-	144	20	-			1			
3106	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
3106	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
Date: February 29, 2016
Project # : 310528.00.0179.01.700

INTERIOR FINISHES

					FLOORING				BASE		WALL	CEILING		New Doors					
					CARPET TILE	RESILIENT SHEET FLOORING	PORCELAIN FLOOR TILE	SEALED CONCRETE FINISHING	RESILIENT BASE	PORCELAIN TILE BASE	PAINT ON DRYWALL	GWB PAINTED	OPEN TO STRUCTURE						
Rm #	Name	Perim	Area	Ht.	CPT1	SL	PFT1	SC1	RB1	PWB1	PT1	GWB	OPEN	card acc	wd 3-0	wd 2-4/6	wd pr. 1-6	hm 3-0	Pr. Alum.
3106	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3200	Shared Kitchen/Entry	45	79	8.0	-	79	-	-	45	-	360	79	-	1	1				
3201	Shared Room	54	147	8.0	-	147	-	-	54	-	432	147	-						
3201	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3203	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3203	Bedroom	52	154	8.0	154	-	-	-	52	-	416	154	-	1		1			
3203	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3206	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3206	Bedroom	52	158	8.0	158	-	-	-	52	-	416	158	-	1		1			
3206	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
3300	Shared Kitchen/Entry	46	84	8.0	-	84	-	-	46	-	368	84	-	1	1				
3301	Shared Room	54	149	8.0	-	149	-	-	54	-	432	149	-						
3301	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3303	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3303	Bedroom	54	167	8.0	167	-	-	-	54	-	432	167	-	1		1			
3303	Closet	20	25	8.0	25	-	-	-	20	-	160	25	-			1			
3306	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3306	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
3306	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3400	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3401	Shared Room	53	145	8.0	-	145	-	-	53	-	424	145	-						
3401	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3403	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3403	Bedroom	53	158	8.0	158	-	-	-	53	-	424	158	-	1		1			
3403	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
3406	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3406	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
3406	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3500	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3501	Shared Room	52	140	8.0	-	140	-	-	52	-	416	140	-						
3501	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3503	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3503	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
3503	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3506	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3506	Bedroom	53	159	8.0	159	-	-	-	53	-	424	159	-	1		1			
3506	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
3600	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3601	Shared Room	53	144	8.0	-	144	-	-	53	-	424	144	-						
3601	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3603	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3603	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
3603	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
3606	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3606	Bedroom	52	157	8.0	157	-	-	-	52	-	416	157	-	1		1			
3606	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
3700	Shared Kitchen/Entry	45	93	8.0	-	93	-	-	45	-	360	93	-	1	1				
3701	Shared Room	53	140	8.0	-	140	-	-	53	-	424	140	-						
3701	Laundry	13	9	8.0	-	9	-	-	13	-	104	9	-				1		
3703	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
3703	Bedroom	59	148	8.0	148	-	-	-	59	-	472	148	-	1		1			
3703	Closet	17	18	8.0	18	-	-	-	17	-	136	18	-			1			
3706	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3706	Bedroom	48	125	8.0	125	-	-	-	48	-	384	125	-	1		1			
3706	Closet	16	16	8.0	16	-	-	-	16	-	128	16	-			1			
3709	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3709	Bedroom	53	165	8.0	165	-	-	-	53	-	424	165	-	1		1			
3709	Closet	20	25	8.0	25	-	-	-	20	-	160	25	-			1			
3712	Hall	46	63	8.0	-	63	-	-	46	-	368	63	-						
3800	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3801	Shared Room	53	143	8.0	-	143	-	-	53	-	424	143	-						
3801	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3803	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3803	Bedroom	52	156	8.0	156	-	-	-	52	-	416	156	-	1		1			
3803	Closet	19	22	8.0	22	-	-	-	19	-	152	22	-			1			
3806	Bath	26	35	8.0	-	35	-	-	26	-	208	35	-			1			
3806	Bedroom	52	153	8.0	153	-	-	-	52	-	416	153	-	1		1			
3806	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
Date: February 29, 2016
Project # : 310528.00.0179.01.700

INTERIOR FINISHES

					CARPET TILE	RESILIENT SHEET FLOORING	PORCELAIN FLOOR TILE	SEALED CONCRETE FINISHING	RESILIENT BASE	PORCELAIN TILE BASE	PAINT ON DRYWALL	GWB PAINTED	OPEN TO STRUCTURE						
					FLOORING				**BASE**		**WALL**	**CEILING**		**New Doors**					
Rm #	Name	Perim	Area	Ht.	CPT1	SL	PFT1	SC1	RB1	PWB1	PT1	GWB	OPEN	card acc	wd 3-0	wd 2-4/6	wd pr. 1-6	hm 3-0	Pr. Alum.
3900	Shared Kitchen/Entry	44	79	8.0	-	79	-	-	44	-	352	79	-	1	1				
3901	Shared Room	54	145	8.0	-	145	-	-	54	-	432	145	-						
3901	Laundry	13	10	8.0	-	10	-	-	13	-	104	10	-				1		
3903	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3903	Bedroom	52	158	8.0	158	-	-	-	52	-	416	158	-	1		1			
3903	Closet	19	21	8.0	21	-	-	-	19	-	152	21	-			1			
3906	Bath	25	35	8.0	-	35	-	-	25	-	200	35	-			1			
3906	Bedroom	52	155	8.0	155	-	-	-	52	-	416	155	-	1		1			
3906	Closet	19	20	8.0	20	-	-	-	19	-	152	20	-			1			
			9,608																
Total	Total		28,249		15,084	9,031	489	2,688	11,832	148	96,597	24,145	3,445	84	31	165	26	8	2
			SF		SF	SF	SF	SF	LF	LF	SF	SF	SF	EA	EA	EA	EA	EA	EA
Waste @	Waste @	5%			754	452	24	134	592	7	4,830	1,207	172						
Total	Total				15,840	9,490	520	2,830	12,430	160	101,430	25,360	3,620						
					SF	SF	SF	SF	LF	LF	SF	SF	SF						
					1,760														
					SY														

PARTITIONS				
Partition Furring 1st	LF	637		
Partition Furring 2/3	LF	724	**2085**	**Total**
Partition Rated Furring 1 ea. side CMU	LF	206		
Partition Rated Furring 2/3 ea. side CMU	LF	188	**582**	**Total**
Partition Sound Rated 1	LF	397		
Partition Sound Rated 2/3	LF	422	**1241**	**Total**
Partition Standard Non rated 1	LF	457		
Partition Standard Non rated 2/3	LF	479	**1415**	**Total**
Partitions Level 1 Corridor	LF	476		
Partitions Level 2/3 Corridor	LF	445	**1366**	**Total**

SIGNAGE TAKEOFF					
Sign Type A	25	EA	9"	X	6"
Sign Type B	18	EA	9"	X	3"
Sign Type B1	11	EA	13.5"	X	4"
Sign Type C	9	EA	9"	X	13"
Sign Type D	1	EA	10"	X	10"
Sign Type E	3	EA	9"	X	11"
Sign Type F	2	EA	9"	X	3"
Sign Type G	3	EA	24"	X	8"
Sign Type J	3	EA	18"	X	30"
Sign Type K	6	EA	14"	X	19.5"
TOTAL ALL SIGNS	81				

Project: DMP-Renovate Dorm 276
Location: Minot AFB, North Dakota
Date: February 29, 2016
Project # : 310528.00.0179.01.700

HVAC TAKEOFF

31,603 GSF or Served Area

Supply Air	Low Pressure Duct L'	Long Side"	Short Side"	Diam.	Liner "thick	Area SF	sum H+W	lb/ LF	Weight	Spiral Duct Info. Weight	Insulation Rect.	Round	Spiral Spiral 4"	6"	8"	10"	12"
Floor 1-3					Enter "0" For Outside Insulated			0.34 lbs/SF									
Galvanized Duct	92	10	4		-	215	14	4	359		215						
Galvanized Duct	69	16	4		-	230	20	5	359		230						
Galvanized Duct	552	6	4		-	920	10	3	1,656		920						
Galvanized Duct	115	8	4		-	230	12	3	391		230						
Galvanized Duct	24	18	4		-	88	22	6	134		88						
Galvanized Duct	123	6	4		-	205	10	3	369		205						
Galvanized Duct	48	8	4		-	96	12	3	163		96						
Galvanized Duct	9	12	4		-	24	16	4	39		24						
Galvanized Duct	60	14	6		-	200	20	5	312		200						
Galvanized Duct	216	14	8		-	792	22	6	1,210		792						
Galvanized Duct	87	16	4		-	290	20	5	452		290						
Galvanized Duct	327	24	8		-	1,744	32	8	2,551		1,744						
Galvanized Duct	15	4	4		-	20	8	3	39		20						
Galvanized Duct	36	50	8		-	348	58	16	558		348						
Spiral Duct				8				5		-		-	-	-	-	-	-
Spiral Duct				16				10		-		-	-	-	-	-	-
Spiral Duct				14				9		-		-	-	-	-	-	-
Subtotal:						5,402			8,592	-	5,402	-	-	-	-	-	-
25.00% Fittings						1,350			2,148	-	1,350	-	-	-	-	-	-
TOTAL:						**6,752**			**10,739**	-	**6,752**	**-**	**-**	**-**	**-**	**-**	**-**
						S.F.			**Lbs.**	Lbs.	**S.F.**	**S.F.**	**L.F.**	**L.F.**	**L.F.**	**L.F.**	**L.F.**

Heat Recovery Duct	Low Pressure Duct L'	Long Side"	Short Side"	Diam.	Liner "thick	Area SF	sum H+W	lb/ LF	Weight	Spiral Duct Info. Weight	Insulation if specified Rect.	Round	Spiral Spiral 4"	6"	8"	10"	12"
Floor 1-3					Enter "0" For Outside Insulated			0.16 lbs/SF									
Galvanized Duct	65	12	14		-	282	26	7	423		282						
Galvanized Duct	17	12	16		-	79	28	7	117		79						
Galvanized Duct	15	28	12		-	100	40	10	143		100						
Spiral Duct	652			6		-	-	4		2,530		1,024	-	652	-	-	-
Spiral Duct	38			8		-	-	5		196		80	-	-	38	-	-
Spiral Duct	34			10		-	-	6		220		89	-	-	-	34	-
Spiral Duct	42			12		-	-	8		326		132	-	-	-	-	42
Subtotal:						461			682	3,272	461	1,325	-	652	38	34	42
25.00% Fittings						115			171	818	115	331	-	163	10	9	11
TOTAL:						**576**			**853**	4,090	**576**	**1,656**	**-**	**815**	**48**	**43**	**53**
						S.F.			**Lbs.**	Lbs.	**S.F.**	**S.F.**	**L.F.**	**L.F.**	**L.F.**	**L.F.**	**L.F.**

Exhaust Duct	Low Pressure Duct L'	Long Side"	Short Side"	Diam.	Liner "thick	Area SF	sum H+W	lb/ LF	Weight	Spiral Duct Info. Weight			Spiral Spiral 4"	6"	8"	10"	12"
Floor 1					Typ. No Insul. on Exhaust			0.23 lbs/SF									
Galvanized Duct	598	10	3.25		-	1,321	13	4	2,213								
Spiral Duct	468			4		-	-	2	1,048	1,048			468	-	-	-	-
Spiral Duct	676			6		-	-	4	2,623	2,623			-	676	-	-	-
Subtotal:						1,321			5,884	3,671	-	-	468	676	-	-	-
25.00% Fittings						330			1,471	918	-		117	169	-	-	-
TOTAL:						**1,651**			**7,355**	4,589	**-**		**585**	**845**	**-**	**-**	**-**
						S.F.			**Lbs.**	Lbs.	**S.F.**		**L.F.**	**L.F.**	**L.F.**	**L.F.**	**L.F.**

APPENDIX C - SUSTAINABILITY SCORESHEETS

Air Force Facilities Sustainability Requirements Scoresheet

version LEED® 2009 (Updated May 2015)

* required entry

General Information		INCOMPLETE	
	QJVF13-0026	Project ID (e.g. ABCD12345)	
		Real Property Unique ID (RPUID)	*
	Dorm Master Plan - Renovate Dorm 276	Building Name	
	Major Renovation and/or Addition	Project Type	
	Minot AFB	Installation	
	Minot	City	
	ND	State	
	Yes	CONUS	
	Air Force Materiel Command	MAJCOM	
SURVEY INCOMPLETE	Timothy Knickerbocker	PM Name	
		PA ($k)	*
	31,656	Building Size (SF)	
	2015	Program Year (FY####)	
	Design Complete	Project Phase	
	2014	Design Started (FY####)	
	7/15/2017	BOD (MM/DD/YY)	
	In Progress	Pursuing formal LEED® Certification	

09/09/2015	Date Project Registered (MM/DD/YY)
	Date Project Certified by GBCI (MM/DD/YY)
	LEED Points Awarded by GBCI (e.g. 42)
	LEED Energy and Water Points Awarded by GBCI
[Select]	LEED Certification Level Awarded by GBCI

	Registration	Certification
Fees ($)	900.00	

LEED® 2009	LEED® Rating System
50	LEED® Points Status
Silver	LEED® Certification Level Status
15	LEED® Energy and Water Points Status
100%	HPSB Compliant
10%	Energy Efficiency Achieved (% below ANSI/ASHRAE/IESNA Standard 90.1-2007)
2/27/2016	Date Scoresheet Completed or Revised
2013_V0	Scoresheet version

Color Coding: See Instructions Tab for more detail	
Drop-Down Box	Recommended (not required)
No Entry Required	Yes or N/A
Custom Entry	Maybe
LEED Prerequisite	No

* required entry

Federal Requirements for High Performance and Sustainable Buildings (HPSB) & UFC 1-200-02

HPSB I: Employ Integrated Design Principles (UFC 1-200-02 para 2-2)			
Total Points	2	Possible Points	2
Yes	HPSB I.1	**Integrated Design**	1
Yes	HPSB I.2	**Commissioning**	1
UFC 1-200-02 para 2-3. Promote Sustainable Location and Site Development			
Total Points	1	Possible Points (HPSB only)	1
Yes	UFC para 2-3.1	**Site selection**	1
N/A	UFC para 2-3.2	**Mitigation of Heat Island Effect**	1
Yes	UFC para 2-3.3	**Reduction of Light Pollution**	1
Yes	HPSB III.3-4	**Stormwater Management**	1

Air Force Facilities Sustainability Requirements Scoresheet

version LEED® 2009 (Updated May 2015)

* required entry

HPSB II: Optimize Energy Performance (UFC 1-200-02 para 2-4)				
Total Points	4		Possible Points	4
Yes	HPSB II.1	**Energy Efficiency**		1
		Yes	Reduce energy use 30% below ANSI/ASHRAE/IESNA Standard 90.1-2007 or if not - achieve maximum energy efficiency that is lifecycle cost effective	
		9.5%	Insert percentage below ANSI/ASHRAE/IESNA Standard 90.1-2007 in terms of energy use (e.g. 32)	
		81.76	Insert building energy intensity (kBtu/yr-sqft) calculated IAW 10 CFR 433	
Yes	HPSB II.2	**On-site Renewable Energy - Solar Hot Water Heater System**		1
		Yes	Installed solar hot water heater system or found installation not lifecycle cost effective	
		0.0	Insert generation capacity (MMBtu/yr)	
		0.0%	Insert percentage of demand	
Yes	HPSB II.3	**On-site Renewable Energy**		1
		Yes	Installed renewable energy elements or projects were not lifecycle cost effective	
		0	Renewable energy types (check below)	
			☐ Solar PV ☐ Geothermal ☐ Hydro ☐ Waste to Energy ☐ Solar CP ☐ GSHP ☐ Wind ☑ Renewables were not ☐ Solar Thermal Electric	
		0.0	Insert generation capacity (kW)	
		0.0%	Insert percentage of total building	
Yes	HPSB II.4	**Measurement and Verification**		1
		Yes	Water Metering: Select N/A if no service	
		Yes	Electric Metering: Select N/A if no service	
		Yes	Natural Gas Metering: Select N/A if no service	
		N/A	Steam Metering: Select N/A if no service	
HPSB III: Protect and Conserve Water (UFC 1-200-02 para 2-5)				
Total Points	3		Possible Points	3
Yes	HPSB III.1	**Indoor Water**		1
Yes	HPSB III.2	**Outdoor Water**		1
N/A	HPSB III.4	**Water used for heating and cooling**		1
		N/A	Water efficient measures were implemented with heating and cooling equipment when life cycle effective	
HPSB IV: Enhance Indoor Environmental Quality (UFC 1-200-02 para 2-6)				
Total Points	6		Possible Points	6
Yes	HPSB IV.1	**Thermal Comfort**		1
Yes	HPSB IV.2	**Ventilation**		1
Yes	HPSB IV.3	**Moisture Control**		1
N/A	HPSB IV.4	**Daylighting**		1
Yes	HPSB IV.5	**Low Emitting Materials**		1
Yes	HPSB IV.6	**Protect Indoor Air Quality during Construction**		1
Yes	HPSB IV.7	**Environmental Tobacco Smoke**		
HPSB V: Reduce Environmental Impact of Materials (UFC 1-200-02 para 2-7)				
Total Points	6		Possible Points	6
Yes	HPSB V.1	**Recycled Content**		1
Yes	HPSB V.2	**Biologically-based Products**		1
Yes	HPSB V.3	**Environmentally Preferable Products**		1
Yes	HPSB V.4	**Waste and Materials Management - Recycling**		1
Yes	HPSB V.5	**Waste and Materials Management - Divert 50% from Disposal**		1
		75.0%	Insert percentage diverted from landfill	
			Data element is not applicable	
Yes	HPSB V.6	**Ozone Depleting Substances**		1
HPSB Totals			Possible Points	**22**
22	**Federal Requirements - Yes or N/A**			
0	**Federal Requirements - Maybe**			
0	**Federal Requirements - No**			
100%	**Percentage of Federal Requirements Met**			

Air Force Facilities Sustainability Requirements Scoresheet

version LEED® 2009 (Updated May 2015) * required entry

LEED® 2009 Checklist

LEED® Credits and/or Prerequisites that meet HPSB/UFC Requirements
LEED® Credits and/or Prerequisites that align closely with HPSB/UFC Requirements
LEED® Credits that meet USAF Energy & Water Criteria (may depend on technologies & strategies)

Sustainable Sites

Achievable Points	13	Sustainable Sites	Possible Points 26
Yes	Prereq 1	**Construction Activity Pollution Prevention (HPSB GP3)**	Required
Yes	Credit 1	**Site Selection**	1
Yes	Credit 2	**Development Density & Community Connectivity**	5
No	Credit 3	**Brownfield Redevelopment**	1
No	Credit 4.1	**Alternative Transportation -** Public Transportation Access	6
No	Credit 4.2	**Alternative Transportation -** Bicycle Storage & Changing Rooms	1
Yes	Credit 4.3	**Alternative Transportation -** Low-Emitting & Fuel Efficient Vehicles	3
Yes	Credit 4.4	**Alternative Transportation -** Parking Capacity	2
No	Credit 5.1	**Site Development -** Protect or Restore Habitat	1
Yes	Credit 5.2	**Site Development -** Maximize Open Space	1
No	Credit 6.1	**Stormwater Design - Quantity Control (HPSB GP3)**	1
No	Credit 6.2	**Stormwater Design - Quality Control (HPSB GP3)**	1
No	Credit 7.1	**Heat Island Effect - Non-Roof (UFC)**	1
No	Credit 7.2	**Heat Island Effect - Roof (UFC)**	1
Yes	Credit 8	**Light Pollution Reduction**	1
		Option 1 — Select which LEED® Interior Lighting Option was used	

Water Efficiency

Achievable Points	8		Possible Points 10
Yes	Prereq 1	**Water Use Reduction - 20% Reduction (HPSB GP3)**	Required
4	Credit 1	**Water Efficient Landscaping (HPSB GP3)**	2 to 4
		2 — Reduce Potable Water Use by 50% (HPSB GP3)	2
		4 — No Potable Use or Irrigation (HPSB GP3)	2
No	Credit 2	**Innovative Wastewater Technologies**	2
4	Credit 3	**Water Use Reduction (HPSB GP3)**	2 to 4
		2 — 30% Reduction (HPSB GP3)	2
		3 — 35% Reduction (HPSB GP3)	1
		4 — 40% Reduction (HPSB GP3)	1

Energy & Atmosphere

Achievable Points	5		Possible Points 35
Yes	Prereq 1	**Fundamental Commissioning of the Building Energy Systems (HPSB GP1)**	Required
Yes	Prereq 2	**Minimum Energy Performance (HPSB GP2)**	Required
Yes	Prereq 3	**Fundamental Refrigerant Management (HPSB GP5)**	Required
5	Credit 1	**Optimize Energy Performance (HPSB GP2)**	1 to 19
		1 — 12% for New Buildings/8% for Existing Building Renovations	1
		2 — 14% for New Buildings/10% for Existing Building Renovations	1
		3 — 16% for New Buildings/12% for Existing Building Renovations	1
		4 — 18% for New Buildings/14% for Existing Building Renovations	1
		5 — 20% for New Buildings/16% for Existing Building Renovations	1
		6 — 22% for New Buildings/18% for Existing Building Renovations	1
		7 — 24% for New Buildings/20% for Existing Building Renovations	1
		8 — 26% for New Buildings/22% for Existing Building Renovations	1
		9 — 28% for New Buildings/24% for Existing Building Renovations	1
		10 — 30% for New Buildings/26% for Existing Building Renovations	1
		11 — 32% for New Buildings/28% for Existing Building Renovations	1
		12 — 34% for New Buildings/30% for Existing Building Renovations	1
		13 — 36% for New Buildings/32% for Existing Building Renovations	1
		14 — 38% for New Buildings/34% for Existing Building Renovations	1
		15 — 40% for New Buildings/36% for Existing Building Renovations	1
		16 — 42% for New Buildings/38% for Existing Building Renovations	1
		17 — 44% for New Buildings/40% for Existing Building Renovations	1
		18 — 46% for New Buildings/42% for Existing Building Renovations	1
		19 — 48%+ for New Buildings/44%+ for Existing Building Renovations	1
0	Credit 2	**On-Site Renewable Energy (HPSB GP2)**	1 to 7
		1 — On-site 1%	1
		2 — On-site 3%	1
		3 — On-site 5%	1
		4 — On-site 7%	1
		5 — On-site 9%	1
		6 — On-site 11%	1
		7 — On-site 13%	1
No	Credit 3	**Enhanced Commissioning (HPSB GP1)**	2
No	Credit 4	**Enhanced Refrigerant Management (HPSB GP5)**	2
Maybe	Credit 5	**Measurement & Verification (HPSB GP2)**	3
No	Credit 6	**Green Power**	2

Air Force Facilities Sustainability Requirements Scoresheet

version LEED® 2009 (Updated May 2015)

* required entry

Materials & Resources				
Achievable Points	7		Possible Points	14
Yes	Prereq 1	Storage & Collection of Recyclables (HPSB GP5)		Required
3	Credit 1.1	**Building Reuse -** Maintain Existing Walls Floors & Roof		1 to 3
		1	Maintain 55% of Existing Walls Floors & Roof	1
		2	Maintain 75% of Existing Walls Floors & Roof	1
		3	Maintain 95% of Existing Walls Floors & Roof	1
No	Credit 1.2	**Building Reuse -** Maintain 50% of Interior Non-Structural Elements		1
1	Credit 2	Construction Waste Management (HPSB GP5)		1 to 2
		1	50% Recycled or Salvaged	1
		2	75% Recycled or Salvaged	1
0	Credit 3	**Materials Reuse**		1 to 2
		1	5% of value of material reused content	1
		2	10% of value of material reused content	1
1	Credit 4	Recycled Content (HPSB GP5)		1 to 2
		1	10% of value of material recycled content	1
		2	20% of value of material reused content	1
1	Credit 5	**Regional Materials**		1 to 2
		1	10% Extracted, Processed & Manufactured	1
		2	20% Extracted, Processed & Manufactured	1
No	Credit 6	Rapidly Renewable Materials (HPSB GP5)		1
Yes	Credit 7	Certified Wood (HPSB GP5)		1
Indoor Environmental Quality				
Achievable Points	12		Possible Points	15
Yes	Prereq 1	Minimum IAQ Performance (HPSB GP4)		Required
Yes	Prereq 2	Environmental Tobacco Smoke (ETS) Control (HPSB GP4)		Required
Yes	Credit 1	**Outside Air Delivery Monitoring**		1
No	Credit 2	**Increased Ventilation**		1
Yes	Credit 3.1	Construction IAQ Management Plan, During Construction (HPSB GP4)		1
Yes	Credit 3.2	Construction IAQ Management Plan, Before Occupancy (HPSB GP4)		1
Yes	Credit 4.1	Low Emitting Materials, Adhesives & Sealants (HPSB GP4)		1
Yes	Credit 4.2	Low Emitting Materials, Paints & Coatings (HPSB GP4)		1
Yes	Credit 4.3	Low Emitting Materials, Flooring Systems (HPSB GP4)		1
Yes	Credit 4.4	Low Emitting Materials, Composite Wood & Agrifiber Products (HPSB GP4)		1
Yes	Credit 5	**Indoor Chemical & Pollutant Source Control**		1
Yes	Credit 6.1	Controllability of Systems, Lighting (HPSB GP4)		1
Yes	Credit 6.2	**Controllability of Systems,** Thermal Comfort		1
Yes	Credit 7.1	Thermal Comfort, Design (HPSB GP4)		1
Yes	Credit 7.2	**Thermal Comfort,** Verification		1
No	Credit 8.1	Daylight & Views - Daylight 75% of Spaces (HPSB GP4)		1
Maybe	Credit 8.2	**Daylight & Views** - Views for 90% of Spaces		1
Innovation & Design Process				
Achievable Points	2		Possible Points	6
Yes	Credit 1.1	**Innovation in Design 1.1**		1
			Select if ID 1.1 was for energy and/or water	
Maybe	Credit 1.2	**Innovation in Design 1.2**		1
			Select if ID 1.2 was for energy and/or water	
Maybe	Credit 1.3	**Innovation in Design 1.3**		1
			Select if ID 1.3 was for energy and/or water	
No	Credit 1.4	**Innovation in Design 1.4**		1
			Select if ID 1.4 was for energy and/or water	
No	Credit 1.5	**Innovation in Design 1.5**		1
			Select if ID 1.5 was for energy and/or water	
Yes	Credit 2	**LEED® Accredited Professional**		1
Regional Priority Credits				
Achievable Points	3		Possible Points	4
Yes	Credit 1.1	**Regional Priority 1.1**		1
			Select if RP 1.1 was for energy and/or water	
Yes	Credit 1.2	**Regional Priority 1.2**		1
			Select if RP 1.2 was for energy and/or water	
Yes	Credit 1.3	**Regional Priority 1.3**		1
			Select if RP 1.3 was for energy and/or water	
No	Credit 1.4	**Regional Priority 1.4**		1
			Select if RP 1.4 was for energy and/or water	
LEED Project Totals (pre-certification estimates)			Possible Points	110
50	Total LEED® Yes Points			
4	Total LEED® Maybe Points			
19	Total LEED® No Points			
15	Total LEED® Energy and Water Related Points			
Silver	**LEED® Certification Status**			
N/A	**LEED® Horizontal Benchmark Level**			
N/A	**LEED® Utility Benchmark Level**			
N/A	**LEED® Industrial Benchmark Level**			

LEED®: Certified: 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80-110

Federal Requirements for High Performance and Sustainable Buildings (HPSB) & UFC 1-200-02

Instructions: Provide a common or project specific justification for an element to be non-applicable, when completed, the Scoresheet tab will allow an N/A response.

Justification for Non-Applicable Answers		Common Justification	Project Specific Justification	Complete?
HPSB I: Employ Integrated Design Principles (UFC 1-200-02, 2-2)				
HPSB I.1	**Integrated Design**			Applicable
HPSB I.2	**Commissioning**			Applicable
UFC 1-200-02, 2-3. Promote Sustainable Location and Site Development				
UFC 2-3.1	**Site selection**			Applicable
UFC 2-3.2	**Mitigation of Heat Island Effect**	NA Facility function is not compatible	Existing facility - no scope of work for existing roof or hardscapes. Not life cycle cost effective.	Yes
UFC 2-3.3	**Reduction of Light Pollution**			Applicable
HPSB III.3-4	**Stormwater Management**	NA Facility function is not compatible	Existing facility - limited work to site	Applicable
HPSB II: Optimize Energy Performance (UFC 1-200-02, 2-4)				
HPSB II.1	**Energy Efficiency**		30% is not life-cycle cost effective. Refer to LCCA for mor einformation.	Applicable
HPSB II.2	**On-site Renewable Energy - Solar Hot Water Heater System**		Not life-cycle cost effective	Applicable
HPSB II.3	**On-site Renewable Energy**		Not life-cycle cost effective	Applicable
HPSB II.4	**Measurement and Verification**			
	Water Metering: Select N/A if no service			Applicable
	Electric Metering: Select N/A if no service			Applicable
	Natural Gas Metering: Select N/A if no service			Applicable
	Steam Metering: Select N/A if no service	NA Facility does not support this service or feature		Yes
HPSB III: Protect and Conserve Water (UFC 1-200-02, 2-5)				
HPSB III.1	**Indoor Water**			Applicable
HPSB III.2	**Outdoor Water**			Applicable
HPSB III.4	**Water used for heating and cooling**	NA Facility does not support this service or feature		Yes
HPSB IV: Enhance Indoor Environmental Quality (UFC 1-200-02, 2-6)				
HPSB IV.1	**Thermal Comfort**			Applicable
HPSB IV.2	**Ventilation**			Applicable
HPSB IV.3	**Moisture Control**			Applicable
HPSB IV.4	**Daylighting**	NA Facility function is not compatible	Existing facility with existing fenestration openings. Windows will be replaced, but opening sizes will not change due to constructability issues and life cycle cost. Existing openings do not comply with daylight factor requirements and would need to increase in size significantly to comply.	Yes
HPSB IV.5	**Low Emitting Materials**			Applicable
HPSB IV.6	**Protect Indoor Air Quality during Construction**			Applicable

HPSB V: Reduce Environmental Impact of Materials (UFC 1-200-02, 2-7)				
HPSB V.1	**Recycled Content**			Applicable
HPSB V.2	**Biologically based products**			Applicable
HPSB V.3	**Environmentally Preferable Products**			Applicable
HPSB V.4	**Waste and Materials Management - Recycling**			Applicable
HPSB V.5	**Waste and Materials Management - Divert 50% from Disposal**			Applicable
HPSB V.6	**Ozone Depleting Substances**			Applicable

LEED 2009 for New Construction and Major Renovations

Project Checklist

Minot AFB - Renovate Dorm 276

1/21/2016

Sustainable Sites — Possible Points: 26

Y	N	?	D/C			
13	13	0				
Y			C	Prereq 1	Construction Activity Pollution Prevention	Req'd
1			D	Credit 1	Site Selection	1
5			D	Credit 2	Development Density and Community Connectivity	5
	1		D	Credit 3	Brownfield Redevelopment	1
	6		D	Credit 4.1	Alternative Transportation—Public Transportation Access	6
	1		D	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
3			D	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			D	Credit 4.4	Alternative Transportation—Parking Capacity	2
	1		C	Credit 5.1	Site Development—Protect or Restore Habitat	1
1			D	Credit 5.2	Site Development—Maximize Open Space	1
	1		D	Credit 6.1	Stormwater Design—Quantity Control	1
	1		D	Credit 6.2	Stormwater Design—Quality Control	1
	1		C	Credit 7.1	Heat Island Effect—Non-roof	1
	1		D	Credit 7.2	Heat Island Effect—Roof	1
1			D	Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	N	?	D/C			
8	2	0				
Y			D	Prereq 1	Water Use Reduction—20% Reduction	
4			D	Credit 1	Water Efficient Landscaping	2 to 4
	2		D	Credit 2	Innovative Wastewater Technologies	2
4			D	Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	N	?	D/C			
5	27	3				
Y			C	Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			D	Prereq 2	Minimum Energy Performance	
Y			D	Prereq 3	Fundamental Refrigerant Management	
5	14	0	D	Credit 1	Optimize Energy Performance	1 to 19
	7		D	Credit 2	On-Site Renewable Energy	1 to 7
	2		C	Credit 3	Enhanced Commissioning	2
	2		D	Credit 4	Enhanced Refrigerant Management	2
		3	C	Credit 5	Measurement and Verification	3
	2		C	Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	N	?	D/C			
7	4	3				
Y			D	Prereq 1	Storage and Collection of Recyclables	
3			C	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
	1		C	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
1		1	C	Credit 2	Construction Waste Management	1 to 2
	2		C	Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	N	?	D/C			
1		1	C	Credit 4	Recycled Content	1 to 2
1		1	C	Credit 5	Regional Materials	1 to 2
	1		C	Credit 6	Rapidly Renewable Materials	1
1			C	Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	N	?	D/C			
12	2	1				
Y			D	Prereq 1	Minimum Indoor Air Quality Performance	**Req'd**
Y			D	Prereq 2	Environmental Tobacco Smoke (ETS) Control	**Req'd**
1			D	Credit 1	Outdoor Air Delivery Monitoring	1
	1		D	Credit 2	Increased Ventilation	1
1			C	Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			C	Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			C	Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			C	Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			C	Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			C	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			D	Credit 5	Indoor Chemical and Pollutant Source Control	1
1			D	Credit 6.1	Controllability of Systems—Lighting	1
1			D	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			D	Credit 7.1	Thermal Comfort—Design	1
1			D	Credit 7.2	Thermal Comfort—Verification	1
	1		D	Credit 8.1	Daylight and Views—Daylight	1
		1	D	Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	N	?	D/C			
2	2	2				
1			D	Credit 1.1	Innovation in Design: SSc5.2 - Maximize Open Space Exemplary Performance	1
		1	C	Credit 1.2	Innovation in Design: MRc7 - Certified Wood Exemplary Performance	1
		1	C	Credit 1.3	Innovation in Design: MRc2 - Construction Waste management Exemplary Pe	0
	1		C	Credit 1.4	Innovation in Design: Specific Title	1
	1		C	Credit 1.5	Innovation in Design: Specific Title	1
1			C	Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	N	?	D/C			
3	1	0				
1			C	Credit 1.1	Regional Priority:MRc2 - Construction waste management - 50%	1
1			D	Credit 1.2	Regional Priority: EQc7.1 - Thermal comfort -design	1
1			D	Credit 1.3	Regional Priority: EQc8.2 - Daylight and views - views	1
	1		D	Credit 1.4	Regional Priority: EAc2 - Onsite renewable energy - 1%	1

Total — Possible Points: 110

Y	N	?
50	51	9

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

APPENDIX D – DORMITORY SURVEY REPORT

Asbestos and Mold Surveys and Lead-Based Paint Screening

Renovate Dormitory
Building 276
Minot Air Force Base, North Dakota

December 17, 2015

Revised

Terracon Project No. M6157011

Prepared for:
Leidos Engineering LLC
Reston, Virginia

Prepared by:
Terracon Consultants, Inc.
Minot, North Dakota

December 17, 2015

Leidos Engineering, LLC
11951 Freedom Drive
Reston, Virginia 20190

Attn: Mr. Ronald Brumfield
P: 405-478-5353
E: Ronald.C.Brumfield@leidos.com

Re: Asbestos and Mold Surveys and Lead-Based Paint Screening - Revised
Building 276
Minot Air Force Base, North Dakota
Terracon Project No. M6157011

Dear Mr. Brumfield:

Terracon Consultants, Inc. (Terracon) is pleased to submit the attached report for the above referenced site to Leidos Engineering, LLC. The purpose of this report is to present the results of asbestos and mold surveys and lead-based paint screening conducted from July 28-30, 2015. The survey was conducted in general accordance with the Subcontract Agreement dated July 21, 2015. We understand this survey was requested due to planned renovation of the building. The report has been revised to include additional work conducted to confirm quantities.

Terracon appreciates the opportunity to provide this service to Leidos Engineering, LLC. If you have questions regarding this report, please contact the undersigned at 701-792-2615.

Sincerely,
Terracon Consultants, Inc.

Stephen T. Maliszeski
Field Geologist

Cindy A. Baldwin, CIH, FAIHA
Senior Industrial Hygienist

TABLE OF CONTENTS

ASBESTOS AND MOLD SURVEYS AND LEAD-BASED PAINT SCREENING – REVISED
Building 276
Minot Air Force Base

Terracon Project No. M6157011
December 17, 2015

EXECUTIVE SUMMARY

Terracon Consultants, Inc. (Terracon) conducted an asbestos survey, mold survey, and lead-based paint (LBP) screening of the Building 276 dormitory at the Minot Air Force Base, North Dakota. We understand the activities were requested to sample and identify suspect asbestos-containing materials (ACM) and provide information regarding their identity, location, condition, and approximate quantities, if present. The services also included identifying the presence and type of airborne mold spores and screening of surface coatings for LBP and mold spores. The services were conducted from July 27-30, 2015 by a team of North Dakota certified asbestos inspectors and a North Dakota certified lead-based paint inspector in general accordance with our proposal dated July 21, 2015 and the Leidos Engineering, LLC (Leidos) Subcontract Agreement dated July 21, 2015. The asbestos survey was conducted in accordance with the sampling protocols established in United States Environmental Protection Agency (USEPA) 40 Code of Federal Regulations Part 763-Asbestos, Subpart E 763-Asbestos-Containing Materials in Schools (40 CFR 763). Terracon collected approximately 96 bulk samples of suspect ACM from the building that were separated by the analytical laboratory into 137 individual layers for analysis.

The following ACMs were identified as a result of laboratory analysis:

Confirmed Asbestos-Containing Materials	
Air duct insulation	White mudded joints and fittings

The following materials are assumed ACM until they can be tested:

Assumed Asbestos-Containing Materials	
Metal fire doors	Wood doors
Roofing components	Vent insulation
2 inch water piping insulation	4 inch water piping insulation

Materials identified to contain more than 1% asbestos should be removed by a qualified and North Dakota-certified asbestos abatement firm.

As part of the proposed scope of work, air samples were collected using a Bio-Pump with Air-O-Cell cassettes to analyze for the presence and types of airborne mold. Several varieties of mold were found to exist in the air samples.

In conjunction with the asbestos and mold surveys, various surface coatings were screened for the presence of lead. Based on direct reading measurements conducted during the screening, LBP, as defined by the USEPA, was identified on the following interior portions of the dormitory:

- Brown handrails and supports in center stairwell with evidence of a green layer.
- White on lower wall of smooth concrete masonry units (CMU) in the storage locker room on first floor.
- White on concrete ceiling in laundry room.

Other coatings contained lead in concentrations below the USEPA definition. Anyone completing work scheduled to disturb any of the above noted areas should be notified of the presence of lead so that necessary precautions can be taken to protect personnel from potential exposures.

Please Note: Terracon understands the building on the property is not currently considered target housing as defined by the USEPA and the project is not receiving federal assistance or Department of Housing and Urban Development (HUD) financing.

ASBESTOS AND MOLD SURVEYS AND LEAD-BASED PAINT SCREENING – REVISED
Building 276
Minot Air Force Base

Terracon Project No. M6157011
December 17, 2015

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) conducted asbestos and mold surveys and lead-based paint (LBP) screening of the Building 276 dormitory at the Minot Air Force Base in North Dakota. The services were conducted from July 27-30, 2015 by a team of North Dakota certified asbestos inspectors in general accordance with Terracon Proposal No. PM6150090 and the Leidos Engineering, LLC (Leidos) Subcontract Agreement dated July 21, 2015. Accessible interior building components were surveyed and homogeneous areas of suspect asbestos-containing materials (ACM) were visually identified and documented. Additional samples were collected at a later date. Although reasonable effort was made to survey all suspect materials, some suspect materials were not sampled due to the occupied status of the building and limitations on disturbing building finishes. Suspect ACM samples were collected in general accordance with the sampling protocols outlined in United States Environmental Protection Agency (USEPA) regulations under 40 Code of Federal Regulations Part 763-Asbestos, Subpart E-Asbestos-Containing Materials in Schools (40 CFR 763). Samples were delivered to an accredited laboratory for analysis by polarized light microscopy (PLM).

We understand that the project services were requested to assess the building for asbestos, mold, and LBP. USEPA regulation 40 CFR 61, Subpart M, National Emission Standards for Hazardous Air Pollutants (NESHAP), prohibits the release of asbestos fibers to the atmosphere during renovation or demolition activities. The asbestos NESHAP requires that potentially regulated ACM must be identified, classified, and quantified prior to planned disturbances.

Although regulations requiring pre-renovation surveys for LBP have not been established, contractors should be informed of the presence of LBP in areas where renovation activities might result in potential worker exposure to lead. Therefore, screening for LBP is recommended so that necessary actions may be identified and initiated to comply with Occupational Safety and Health Administration (OSHA) and landfill disposal requirements.

1.1 Reliance

This report is for the exclusive use of Leidos for the project being discussed. Reliance on this report by other parties is prohibited without written authorization of Terracon and Leidos. Reliance on this report by Leidos and all authorized parties will be subject to the terms, conditions, and limitations stated in the proposal, this report, and the Subcontract Agreement dated July 21, 2015. The limitation of liability defined in the Subcontract Agreement is the aggregate limit of Terracon's liability to Leidos.

2.0 BUILDING DESCRIPTION

Building 276 lies on the Minot Air Force Base and was built in the 1960s. It is a three-story structure approximately 50 feet by 200 feet. It and is currently being used as a dormitory with approximately 80 dorm rooms. Each floor contains approximately 24 dorm rooms, with a shared bathroom between every two rooms as well as a lounge, one to two storage locker rooms, a common hallway, janitorial closets, a mechanical room containing air handling equipment and access to each of the three stairwells. In addition, the first floor contains one extra mechanical room accessed from the exterior of the building containing the heating and electrical equipment, a laundry room, kitchen, and entryway. The structure has a concrete lined piping chase which runs under the length of the first floor hallway containing five pipes which have insulation assumed to be asbestos containing, two labeled as potable water, two labeled as "M.T.W.S. 200," and one which is unlabeled. In addition, one metal pipe runs the length of the building, which may be inferred to be sanitary outflow. Each of these pipes elbows off toward each of the dorm restrooms through the concrete. The heating system is assumed to run along the outside perimeter of the building on each floor. The air handling system is within inaccessible areas and the presence of insulation materials could not be determined. Due to these areas not being accessible, any material encountered must be assumed as asbestos containing. The ceiling of the center stairwell contains a hatch allowing roof access to the original flat roof. A pitched shingle roof was added at a later date creating an attic crawl space and an additional hatch to the exterior roofing.

3.0 FIELD ACTIVITIES

3.1 Asbestos

The asbestos survey was conducted by Mr. Stephen Maliszeski and Ms. Terri Fields; North Dakota certified asbestos inspectors (certificate numbers 5680 and 5781, respectively). Copies of their asbestos inspector certificates are included in Appendix I. The survey was conducted in general accordance with the sample collection protocols established in USEPA 40 CFR 763.86, Sampling. A summary of the survey activities is provided in the following subsections.

3.1.1 Visual Assessment

Survey activities were initiated with visual assessments of accessible interior areas of the building to identify homogeneous areas of suspect ACM. A homogeneous area (HA) consists of building materials that appear similar throughout in terms of color and texture, with consideration given to the date of application.

3.1.2 Physical Assessment

A physical assessment of each HA of suspect ACM was conducted to assess the friability and condition of the materials. A friable material is defined by the USEPA as a material that can be crumbled, pulverized, or reduced to powder by hand pressure when dry. Friability was assessed by physically touching suspect materials.

3.1.3 Sample Collection

Based on results of the visual assessment, bulk samples of suspect ACM were collected in general accordance with USEPA sampling protocols. Samples of suspect materials were collected from randomly selected locations in each homogeneous area. Bulk samples were collected using wet methods as applicable to reduce the potential for fiber release. Samples were placed in sealable containers and labeled with unique sample numbers using an indelible marker.

The selection of sample locations and frequency of sampling were based on Terracon's observations and the assumption that like materials in the same area are homogeneous in content.

Terracon collected 96 bulk samples of suspect ACM from the building. The analytical laboratory separated some those samples into individual layers, resulting in analysis of 137 samples. A summary of suspect ACM samples collected during the survey is included in Appendix B.

Terracon had limited or no access in some areas due to safety and/or security considerations. The following general areas (not exclusive) could be concealing additional ACM. Several areas, such as material around ventilation systems and piping were unable to be sampled at this time as the building is still occupied; these areas will need to be evaluated further once the building is no longer occupied. Samples of suspect materials should be collected from the following areas before they are disturbed during renovation activities.

Table 1.0. Functional Areas with Limited Access with Assumed ACM

Inside heating, ventilating, and air handling equipment	Inside electrical panels, ducts, and switchgears
Inside door systems	Above hard ceilings
Utility piping chases under inaccessible flooring and within wall cavities	Roofing material

3.1.4 Sample Analysis

The bulk samples were submitted under chain of custody (COC) to International Asbestos Testing Laboratories (IATL) of Mt. Laurel, NJ for analysis by PLM with dispersion staining techniques per USEPA's *Method for the Determination of Asbestos in Bulk Building Materials* (600/R-93/116). The percentage of asbestos, if present, was determined by microscopic visual estimation. The laboratory reanalyzes samples with an initial reported asbestos concentration of less than or equal to (≤) 10% by point counting, as established by 40 CFR 763, Appendix E, Section 1.7.2.4. The point counting method allows for a more definitive analysis of asbestos content to establish if the material is asbestos-containing. IATL is accredited under the National Voluntary Laboratory Accreditation Program [(NVLAP) Accreditation No. 101165-00]. The findings are presented in Section 5.1 and the laboratory analytical report is included in Appendix D.

3.2 Mold

3.2.1 Physical Inspection

The physical survey was conducted to determine whether building materials were impacted by moisture intrusion or condensate formation, and to assess the interior for the possible presence of visible fungal growth. The assessment focused primarily on collecting observational data (i.e., information obtained by physical inspection of the building and interviews with the building management, owners, and occupants). The physical survey can help to formulate plans for more in-depth assessments.

The physical survey included:

- Examination of the interior physical structure and potential sources of moisture intrusion;
- Identification of discoloration or odors that could indicate moisture intrusion, water damage, and/or fungal growth; and
- Examination of the heating and cooling units.

Destructive sampling or testing to inspect interior wall cavity spaces or mechanical enclosures were not within the scope of work for this project. Terracon did not attempt to identify sources of moisture intrusion. A summary of general building information and results of the physical inspection are contained below.

3.2.2 Sample Collection and Analysis

High variability in airborne fungal spore concentrations can exist in different geographic locations, during different seasons, and weather patterns, and over the course of a given day. As a general rule, indoor air fungal spore concentrations in a heating, ventilating, and air-conditioning (HVAC)-supplied building are typically less than, but qualitatively similar to, fungal spore concentrations found in the outside environment. To help interpret the sampling results, we compared indoor air and outdoor air measurements.

Terracon collected 22 total non-viable (non-culturable) fungal spore trap samples using Air-O-Cell® sampling cassettes and a Zefon Bio-Pump® Plus, at a flow rate of 15 liters per minute for 10 minutes per sample. Air-O-Cell® sampling cassettes were collected at representative indoor and outdoor sample locations. After air sample collection, the sample cassettes were shipped under COC protocol to EMSL Analytical, Inc. (EMSL), in Cinnaminson, New Jersey. EMSL is accredited by the AIHA® Laboratory Accreditation Programs, LLC under the Environmental Microbiology Laboratory Accreditation Program (EMLAP #157245). The findings are presented in Section 5.2 and the laboratory analytical report is included in Appendix F.

3.3 Lead-Based Paint (LBP) Screening

LBP screening was conducted by Mr. Maliszeski on July 30, 2015. The screening services included visual observations of coated surfaces (i.e., paint, varnish, colored tiles) to identify potential LBP-coated components. Based on the visual observations, an x-ray fluorescence (XRF) analyzer was used to analyze and identify lead-containing materials on interior areas of the dormitory building. The purpose of the screening was to assess for the presence of LBP on building components that should be communicated to contractors involved in renovation so that they can take the necessary precautions to reduce potential exposures to personnel. A summary of the survey activities is provided below.

3.3.1 Sampling

An XRF analyzer was used to conduct direct reading measurements of lead content in interior surfaces. An XRF is a portable electronic device containing a small, sealed nuclear source. The device emits x-rays at various energy levels. The x-ray energy excites electrons in the outer orbits of lead atoms. The detector in the XRF unit reads this excitation and translates it into a semi-quantitative reading of lead present by surface area. XRF technology allows detection of lead in a painted surface, even several layers below the surface, without disturbing the painted surface. XRF is an industry standard for determining lead in painted surfaces. Using the XRF, Terracon conducted 137 measurements on painted surfaces in the spaces assessed to evaluate the presence of LBP. The XRF was calibrated prior to, during, and at the end of use.

Surfaces that were tested included, but were not limited to:

- Interior door components,
- Interior window components,
- Interior walls and wall components, and
- Ceilings.

The table below lists the materials that were identified as containing lead-based paint. A full list of the materials tested for lead content, including the associated results, is provided in Section 5.3 and field-testing results are presented in Appendix H.

Table 2.0. Confirmed Lead-Based Paint Containing Materials

First floor locker room, lower half	Laundry room ceiling	Handrail, center stairwell

4.0 REGULATORY OVERVIEW

4.1 Asbestos

In North Dakota, asbestos activities are regulated by the North Dakota Department of Health (NDDH). NDDH adopted the USEPA's asbestos NESHAP (40 CFR Part 61, Subpart M) by reference. Subpart M regulates asbestos fiber emissions and asbestos waste disposal practices. It also requires the identification and classification of existing building materials prior to demolition or renovation activity. Under NESHAP, asbestos-containing building materials are classified as friable, Category I nonfriable, or Category II nonfriable ACM. Friable materials are those that, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure. Category I nonfriable ACM includes packings, gaskets, resilient floor coverings, and asphalt roofing products containing more than 1% asbestos. Category II nonfriable ACM are any materials other than Category I materials that contain more than 1% asbestos.

Regulated ACM (RACM) must be removed before renovation or demolition activities that will disturb the materials. RACM includes:

- Friable ACM;
- Category I nonfriable ACM that has become friable or will be subjected to drilling, sanding, grinding, cutting, or abrading; and
- Category II nonfriable ACM that could be crumbled, pulverized, or reduced to powder during renovation or demolition activities.

The owner or operator must provide the NDDH with written notification of planned removal activities at least 10 working days prior to the commencement of asbestos abatement activities. Removal of RACM must be conducted by a North Dakota-permitted asbestos abatement contractor.

ACM must be assessed by North Dakota-certified inspectors. Asbestos abatement must be performed by North Dakota-certified asbestos abatement contractors. Management plans developed for the in-place management of asbestos-containing materials must be developed by a

North Dakota-certified management planner. When an abatement project design is prepared, it must be prepared by an NDDH-certified abatement project designer.

The Occupational Safety and Health Administration (OSHA) regulates employee exposure to asbestos in construction under 29 CFR 1926.1101. The OSHA standard requires that employee exposure to airborne asbestos fibers be maintained below the permissible exposure limits (PEL) of 0.1 asbestos fibers per cubic centimeter of air (0.1 f/cc) as an 8-hour time-weighted average and 1.0 f/cc as a 30-minute excursion. The OSHA standard classifies construction and maintenance activities that could disturb ACM and specifies work practices and precautions that employers must follow when engaging in each class of regulated work.

4.2 Mold

State or federal exposure limits have not been established for fungal aerosols. Regulatory standards or medically based threshold limit or dose-response relationships have not been determined for exposure to airborne or surface concentrations of mold spores. Terracon relies upon experience, professional judgment, current scientific literature, guidelines and recommendations made by professional organizations and experts, and statistical methods in interpreting mold sampling results.

4.3 LBP

Lead is regulated by the USEPA and OSHA. USEPA regulates lead use, removal, and disposal, and OSHA regulates worker exposure to lead. USEPA defines LBP as paint, varnish, stain or other applied coating that contains lead equal to or greater than 1.0 milligram per square centimeter (mg/cm^2), 5,000 milligrams per kilogram (mg/kg), or 0.5% by dry weight as determined by laboratory analysis. For the purpose of the OSHA lead standard, lead includes metallic lead, all inorganic lead compounds, and organic lead soaps. The OSHA standard does not define the amount of lead in paint that constitutes lead-based paint.

USEPA regulates disposal of hazardous materials. The USEPA has stated that components removed with intact LBP that is not delaminating from the substrate may be disposed as general demolition debris. If the LBP is stripped from components, or if it is delaminating from the substrate, the waste may be subject to hazardous waste rules [i.e., Toxicity Characteristics Leaching Procedure (TCLP)].

USEPA issued the Renovation, Repair, and Painting (RRP) rule (40 CFR Part 745) requiring the use of lead-safe practices and other actions aimed at preventing lead poisoning. Under the rule, beginning in April 2010, contractors performing renovation, repair, and painting projects that disturb LBP in homes, childcare facilities, and schools built before 1978 must be certified and must follow specific work practices to prevent lead contamination. The NDDH has adopted similar regulations.

The OSHA Lead Standard for Construction (29 CFR 1926.62) applies to all construction work where an employee may be occupationally exposed to lead. IAC 875–10 adopts 29 CFR 1926.62 by reference. All work related to construction, alteration or repair (including painting and decorating) is included. The lead-in-construction standard applies to any detectable concentration of lead in paint, as even small concentrations of lead can result in unacceptable employee exposures depending upon on the method of removal and other workplace conditions. Under this standard, construction includes, but is not limited to, the following:

- Demolition or salvage of structures where lead or materials containing lead are present.
- Removal or encapsulation of materials containing lead
- New construction, alteration, repair, or renovation of structures, substrates, or portions containing lead, or materials containing lead
- Installation of products containing lead
- Lead contamination/emergency clean-up
- Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed
- Maintenance operations associated with construction activities described above

Employers must assure that no employee will be exposed to lead at concentrations greater than the PEL of 50 micrograms per cubic meter ($\mu g/m^3$) averaged over an eight-hour period without adequate protection. The OSHA standard also establishes an action level of 30 $\mu g/m^3$, which if exceeded, triggers certain requirements, including periodic exposure monitoring and medical monitoring.

5.0 FINDINGS AND RECOMMENDATIONS

5.1 Asbestos Survey

The following ACMs were identified as a result of laboratory analysis:

Table 3.0. Confirmed ACMs

Asbestos Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
White duct wrapping on air handling equipment	Mechanical rooms on second and third floors	384 square feet	Good	Chrysotile	3.3

Asbestos Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
Off-white mudded joints and fittings	Around insulated piping under center stairwell, inside piping crawlspace, and mechanical rooms.	1,380 units	Good	Amosite	4.2
				Chrysotile	1.5

The following materials are assumed ACM until they can be tested:

Table 4.0. Assumed Asbestos-Containing Materials

Metal fire doors	Wood doors
Roofing components	Vent insulation
2 inch water piping insulation	4 inch water piping insulation

A summary of the classification, condition, and approximate quantity of identified ACM and a list of assumed ACM are presented Appendix A. A summary of the samples collected is presented in Appendix B. ACM location exhibits are included in Appendix C. The laboratory analytical report is included in Appendix D.

It should be reemphasized that, although reasonable efforts were made to physically survey and sample all suspect materials, some materials will need to be evaluated after the building is unoccupied. Additionally, suspect but unsampled materials could be located under existing building materials, in isolated areas, in pipe chases not accessed by Terracon during the survey, or in other concealed areas of the building. Therefore, if suspicious materials are encountered during renovation activities that do not appear to have been characterized as ACM or non-ACM, disturbance work should immediately stop, samples should be collected and analyzed prior to disturbing these materials or the materials can be assumed to contain asbestos and abated by a North Dakota licensed asbestos abatement firm.

5.2 Mold Survey

Table 5.0 contains an overview of findings from the physical survey. Significant findings are discussed in the section that follows.

Table 5.0. Physical Survey Findings

Inspection Parameter	Observation Comments
Year Constructed	1960
Type of Occupancy	Occupied dormitory
Major Renovations	None
Floors Above/Below Grade	3/0
Physical Examination (odors, housekeeping)	Evidence of mold was not noticed in the dormitories or common spaces. One area within the first floor storage locker room was observed to have historical moisture stains on the ceiling.
Type of Enclosure	Walls were a combination of gypsum wallboard and concrete masonry units (CMU). Ceilings were a combination of gypsum wallboard and concrete. Flooring appeared to be concrete throughout.
Types of Finishes ■ Walls ■ Ceilings ■ Floors	 ■ White paint throughout. Some areas had laminate wall panels over the gypsum wallboards. ■ White orange peel textured gypsum wallboard ceilings and flat paint on concrete. ■ Carpeting/concrete
Discoloration/Water Staining	Concrete ceiling in first floor storage locker room – historical.
HVAC Type	Centralized units with air ducts. One per floor.

The interior spaces of the building showed evidence of moisture in only the first floor storage locker room. Microbial growth was not observed.

5.2.1 Mold Analytical Results and Recommendations

Total indoor fungal spore concentrations ranged from 2,210 to 10,340 counts per cubic meter (count/m^3). The outdoor total fungal concentration was 8,970 count/m^3. The total mold spore concentration in one indoor sample location exceeded the outdoor concentration (indicated in bold) and one sample was overloaded and could not be read. Table 6.0 shows the results of the samples collected on July 29 and 30, 2015. The samples were collected at a rate of 15 liters per minute and for 10 minutes, totaling sample volumes of 150 liters of air.

Table 6.0. Mold Sample Results

Sample Date	Sample	Lab ID	Sample location	Total Fungal Spores (count/m^3)
7/29/15	AOC – 1	351505112-001	Dorm room 211	4,707
7/29/15	AOC – 2	351505112-002	2nd floor lounge	5,230
7/29/15	AOC – 3	351505112-003	2nd floor mechanical room	4,390
7/29/15	AOC – 4	351505112-004	Dorm room 226	3,247
7/29/15	**AOC – 5**	**351505112-005**	**2nd floor hall near room 223**	**10,340**
7/29/15	AOC – 6	351505112-006	2nd floor hall near room 204	5,287
7/29/15	AOC – 7	351505112-007	3rd floor lounge	5,370
7/29/15	AOC – 8	351505112-008	3rd floor mechanical room	5,330
7/30/15	AOC – 9	351505112-009	3rd floor hall near room 306	2,997
7/30/15	AOC – 10	351505112-010	Dorm room 309	Present[1]
7/30/15	AOC – 11	351505112-011	Dorm room 320	3,140
7/30/15	AOC – 12	351505112-012	3rd floor hall near room 323	3,217
7/30/15	AOC – 13	351505112-013	1st floor hall near room 119	3,530
7/30/15	AOC – 14	351505112-014	Dorm room 120	3,147
7/30/15	AOC – 15	351505112-015	1st floor lounge	3,457
7/30/15	AOC – 16	351505112-016	1st floor laundry room	3,600
7/30/15	AOC – 17	351505112-017	1st floor mechanical room	5,697
7/30/15	AOC – 18	351505112-018	Foyer	4,210
7/30/15	AOC – 19	351505112-019	Kitchen	5,760
7/30/15	AOC – 20	351505112-020	1st floor hall near room 106	5,967
7/30/15	AOC – 21	351505112-021	Dorm room 106	2,210
7/30/15	AOC - 22	351505112-022	Outdoor sample	8,970

The total mold spore counts were generally elevated, although only one exceeded the outdoor concentration. The types of mold spores indoors were similar to those found outdoors and elevated concentrations indoors may be due to outside air making its way into the building by way of doors and windows. Terracon recommends additional investigation to determine if these mold spore concentrations are typical for this building.

[1] The sample was overloaded and the laboratory was unable to quantify mold spores.

5.3 Limited Lead-Based Paint Screening

Based on direct reading measurements conducted during the XRF survey, LBP, as defined by the USEPA, was identified on interior portions of the dormitory. It should be noted that the XRF indicates an inconclusive range of 0.6 – 1.1 mg/cm^2 and therefore all results greater than 0.6 mg/cm^2 are considered lead-containing.

The painting history of any given location in an older building often will vary from point to point due to factors including variability in paints used, paint film thickness, variable retention of older paint layers before repainting, demolition/installation of walls during renovations, and unknown historic non-homogenous painting schemes. As such, a given color and building component combination that is currently apparent often will not provide consistent testing results for lead.

Terracon attempts to perform lead paint testing in sufficient quantity to establish trends in lead content based on distinguishable characteristics such as color or building component, subject to time and budget constraints. Based on testing results in Appendix H, in Terracon's opinion the following components are known to contain LBP:

Table 7.0. Confirmed Lead-Based Paint Containing Materials

Location	Color	Substrate	Area (square feet)
First floor locker room, lower half	White	Smooth CMU	360
Laundry room ceiling	White	Concrete	280
Handrail, center stairwell	Brown	Metal	16

The above list is not intended to be an inclusive list of all locations where LBP is present throughout the building. Anyone completing work scheduled to disturb any of the above noted areas/materials should be notified of the presence of LBP so that necessary precautions can be taken to protect personnel from potential exposures as per the OSHA lead standard.

5.3.1 LBP Recommendations

Lead-based paint was identified during this screening.

Terracon recommends that the contractor(s) involved in the renovation be notified of the presence of LBP and lead-containing paint (lead concentrations less than USEPA's criteria) on building components. OSHA's lead standard for construction (29 CFR 1926.62) applies regardless of the concentration and contractor(s) will need to provide appropriate personal protective equipment and conduct personal exposure monitoring, at a minimum. Terracon recommends the contractor review the specified work tasks and methods involved in the remodeling process and prepare a detailed LBP management plan. The LBP management plan should identify the work procedures and health and safety measures to be used in the LBP material removal/stabilization.

Please Note: Terracon understands the building on the property is not currently considered target housing as defined by the USEPA and the project is not receiving federal assistance or Department of Housing and Urban Development (HUD) financing. These types of programs and level of assistance can require implementation of some or all provisions of the USEPA and/or HUD regulations.

6.0 LIMITATIONS/GENERAL COMMENTS

The survey was conducted utilizing limited destructive sampling techniques. Therefore, efforts were made to determine if multiple layers of materials were present (e.g., flooring), but the efforts were limited to the extent of allowable access with hand tools without affecting security, fire and life safety; the presence of safety hazards (electrical, slips, trips, and/or fall hazards); or unacceptable aesthetic or functional damage to building surfaces and materials, as per the judgment of the inspector at the time of the survey. Therefore, suspect ACM may be present in concealed spaces, cavities, and plenums of the building. Additional inspection by a licensed asbestos inspector is required by USEPA prior to demolition or renovation that would impact such materials not identified in the survey.

The services were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same locale following an approved scope of work. The results, findings, and conclusions expressed in this report are based on conditions observed during our survey of the building. The information contained in this report is relevant to the date on which this survey was conducted and areas accessed, and should not be relied upon to represent conditions at a later date. This report has been prepared on behalf of and exclusively for use by Leidos for specific application to their project as discussed. This report is not a bidding document. Contractors or consultants reviewing this report must draw their own conclusions regarding further investigation or remediation deemed necessary. Terracon does not warrant the work of regulatory agencies, laboratories, or other third parties supplying information that may have been used in the preparation of this report. No warranty, express or implied is made.

APPENDIX A

Asbestos Survey

Minot Air Force Base, North Dakota

CONFIRMED ASBESTOS-CONTAINING MATERIALS BY HOMOGENEOUS AREA (HA)

Confirmed-Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
White duct wrapping on air handling equipment	Mechanical rooms on second and third floors	384 square feet	Good	Chrysotile	3.3
Off-white piping insulation, mudded joints and fittings	Around insulated piping under center stairwell, inside piping crawlspace, and mechanical rooms.	1,380 units	Good	Amosite	4.2
				Chrysotile	1.5

ASSUMED ASBESTOS-CONTAINING MATERIALS BY HA

Assumed Asbestos Containing Material	Location	Estimated Quantity	Condition
Metal fire doors	Stairwell entrance and building exits	17	Good
Wood room doors	Dorm rooms, restrooms, common rooms	166	Good
Roofing components	Pitched roof.	14,000 square feet[1]	Unknown
Vent insulation	Around air ducts above hallways with laterals to each room.	8,000 linear feet[1]	Unknown
2 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms. Two runs identified with laterals inside the piping crawlspace.	1,860 linear feet[1]	Damaged
4 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms, laundry and kitchen. Four runs identified with laterals inside the piping crawlspace.	3,660 linear feet[1]	Damaged

[1] Quantities will need to be evaluated further once building is unoccupied.

APPENDIX A

Asbestos Survey

Minot Air Force Base, North Dakota

CONFIRMED ASBESTOS-CONTAINING MATERIALS BY HOMOGENEOUS AREA (HA)

Confirmed-Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
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				Chrysotile	1.5

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Assumed Asbestos Containing Material	Location	Estimated Quantity	Condition
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Wood room doors	Dorm rooms, restrooms, common rooms	166	Good
Roofing components	Pitched roof.	14,000 square feet[1]	Unknown
Vent insulation	Around air ducts above hallways with laterals to each room.	8,000 linear feet[1]	Unknown
2 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms. Two runs identified with laterals inside the piping crawlspace.	1,860 linear feet[1]	Damaged
4 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms, laundry and kitchen. Four runs identified with laterals inside the piping crawlspace.	3,660 linear feet[1]	Damaged

[1] Quantities will need to be evaluated further once building is unoccupied.

APPENDIX B

ASBESTOS SURVEY SAMPLE LOCATION SUMMARY

HA MATERIAL LIST

HA No:	MATERIAL DESCRIPTION	HA No:	MATERIAL DESCRIPTION
F-1	9" x 9" floor tile and mastic	T-1	straight run pipe insulation
F-2	12" x 12" floor tile and mastic	T-2	mudded joints and fittings
F-3	vinyl sheet flooring	T-3	boiler insulation
F-4	mastic, only	T-4	flue insulation
F-5	carpet glue	T-5	storage tank insulation
F-6	wood vapor barrier	T-6	breeching insulation
F-7	Leveling Compound	T-7	boiler gaskets
F-8	2"x2" ceramic floor tile	T-8	duct insulation
F-9		T-9	boiler fire brick
		T-10	insulative mud
M-1	sheetrock and joint compound	T-11	fire stop
M-2	joint compound	T-12	vibration collar - brown
M-3	plaster	T-13	
M-4	cement asbestos panels	T-14	
M-5	2' x 4' lay-in ceiling panels	T-15	
M-6	2' x 2' lay-in ceiling panels		
M-7	12" x 12" ceiling tiles	R-1	built-up roof materials
M-8	12" x 12" ceiling tiles w/mastic	R-2	roof flashing
M-9	baseboard adhesive	R-3	roof shingles
M-10	window caulking	R-4	
M-11	building insulation	R-5	
M-12	flexible HVAC vibration collar		
M-13	Stage Light Cords	S-1	decorative/acoustical spray-on (knockdown)
M-14	Fire Door	S-2	decorative/acoustical troweled-on
M-15	Sink Coating	S-3	fire proofing spray-on
M-16	door caulking	S-4	fire proofing troweled-on
M-17	window glazing	S-5	
M-18	vinyl wall covering		
M-19	base ceramic tile 4"x6" beige		
M-20	4"x4" ceramic wall tile beige		
M-21	white tile grout		
M-22	random ceramic tile pattern - tan		
M-23	green tile grout		
M-24	bathroom tile mortar, orange		

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
F-5 - 1 - A	Entrance Room 211	5698685 9/29/30
F-5 - 1 - B	3rd Floor central stairwell entrance	5698686
F-5 - 1 - C	West end of hall, 1st floor	5698687
F-4 - 1 - A	1st floor foyer entrance	5698688
F-4 - 1 - B	1st floor Stairwell, west end	5698689
F-4 - 1 - C	1st floor stairwell, east end	5698690
F-2 - 1 - A	1st floor kitchen	5698691
F-2 - 1 - B	2nd floor stairwell - West end	5698692
F-2 - 1 - C	3rd floor utility closet - East end	5698693
M-9 - 1 - A	Room 211, near entrance	5698694
M-9 - 1 - B	1st floor hall, near Room 115	5698695
M-9 - 1 - C	3rd floor hall, near Room 323	5698696
M-9 - 2 - A	1st floor, east utility closet	5698697
M-9 - 2 - B	2nd floor, east utility closet	5698698
M-9 - 2 - C	2nd floor, west utility closet	5698699
S-1 - 3 - A	Room 211, east wall	5698700
S-1 - 3 - B	1st floor south wall, near Room 125	5698701
S-1 - 3 - C	1st floor north wall, near Room 106	5698702
S-1 - 3 - D	3rd floor, hall ceiling, near Room 302	5698703
S-1 - 3 - E	3rd floor locker, east wall	5698704
S-1 - 3 - F	2nd floor, hall ceiling, near Room 207	5698705

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: SJM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
S-1 - 3 - G	2nd floor, north wall, near Room 218	5698706 7/29/30
M-3 - 1 - A	2nd floor stairwell, east wall	5698707
M-3 - 1 - B	1st floor foyer, near NW corner	5698708
M-3 - 1 - C	1st floor ~~fo~~ building entrance, west wall	5698709
M-3 - 1 - D	land between 1st + 2nd floors, west wall	5698710
M-3 - 1 - E	3rd floor stairwell, near NW corner	5698711
M-18 - 1 - A	1st floor hall, west end	5698712
M-18 - 1 - B	2nd floor hall, east end	5698713
M-18 - 1 - C	Center stairwell	5698714
M-18 - 1 - D	3rd floor hall, west end	5698715
M-18 - 1 - E	Kitchen	5698716
M-6 - 1 - A	Room 129	5698717
M-6 - 1 - B	In Foyer, near stair	5698718
M-6 - 1 - C	In Foyer, near mail	5698719
S-1 - 2 - A	Room 129	5698720
S-1 - 2 - B	1st floor lounge, near south wall	5698721
S-1 - 2 - C	2nd floor lounge, near south wall	5698722
M22 - 1 - A	1st floor storage locker - East side	5698723
M22 - 1 - B	2nd floor Storage locker - West side	5698724
M22 - 1 - C	3rd floor Storage locker - East side	5698725
M23 - 1 - A	1st floor storage locker - East Side	5698726

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
M23 - 1 - B	2nd floor storage locker - West side	5698727 7/29/30
M23 - 1 - C	3rd floor storage locker - East side	5698728
F-4 - 3 - A	1st Floor Stair - West end	5698729
F-4 - 3 - B	2nd floor Stairs - Center	5698730
F-4 - 3 - C	3rd floor Stairs - East	5698731
F-4 - 2 - A	2nd floor mech room, SW corner	5698732
F-4 - 2 - B	3rd floor mech room, SE corner	5698733
F-4 - 2 - C	2nd floor mech room, NE corner	5698734
M-15 - 1 - A	kitchen sink	5698735
M-15 - 1 - B	kitchen sink	5698736
M-15 - 1 - C	kitchen sink	5698737
M-21 - 1 - A	Room 211, west shower wall	5698738
M-21 - 1 - B	Room 211, west shower wall	5698739
M-21 - 1 - C	Room 211, west shower wall	5698740
M-20 - 1 - A	Room 211, west shower wall	5698741
M-20 - 1 - B	Room 211, west shower wall	5698742
M-20 - 1 - C	Room 211, west shower wall	5698743
F-8 - 1 - A	Room 211, under sink	5698744
F-8 - 1 - B	Room 211, under sink	5698745
F-8 - 1 - C	Room 211, under sink	5698746
start M-19 - 1 - A	Room 211, under sink	5698747

Terracon PN: M6157011 **Asbestos Sample Location Log** Page 4 of 5

Client Name: Terracon
Building Name: ~~###~~ Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date:
M-19 - 1 - B	Room 211, under sink	5698748 7/29/30
M-19 - 1 - C	Room 211, under sink	5698749
M-24 - 1 - A	Room 211, under sink	5698750
M-24 - 1 - B	Room 211, under sink	5698751
M-24 - 1 - C	Room 211, under sink	5698752
M-1 - 1 - A	Room 211, east wall	5698753
M-1 - 1 - B	First floor lounge, north wall	5698754
M-1 - 1 - C	Kitchen, east wall	5698755
M-1 - 1 - D	2nd floor hall, west end outside room 202	5698756
M-1 - 1 - E	3rd floor lounge, Southwest corner	5698757
M-1 - 1 - F	3rd floor hall, east end outside room 329	5698758
M-1 - 1 - G	~~2nd floor hall, west end outside room~~ Room 106, south wall	5698759
T-12 - 1 - A	2nd floor Mechanical Room	5698760
T-12 - 1 - B	2nd floor Mechanical Room	5698761
T-12 - 1 - C	3rd floor Mechanical Room	5698762
T-8 - 1 - A	2nd floor Mechanical Room	5698763
T-8 - 1 - B	3rd floor Mechanical Room	5698764
T-8 - 1 - C	3rd Floor Mechanical Room	5698765
T1 - 1 - A	Stairwell - Center - between 1st & 2nd floors	5698766
T1 - 1 - B	Under 1st Floor stairs - center stairwell ~~1st Flo~~	5698767
T1 - 1 - C	1st Floor, exterior mechanical room	5698768

Terracon PN: M6157011 **Asbestos Sample Location Log** Page 5 of 5

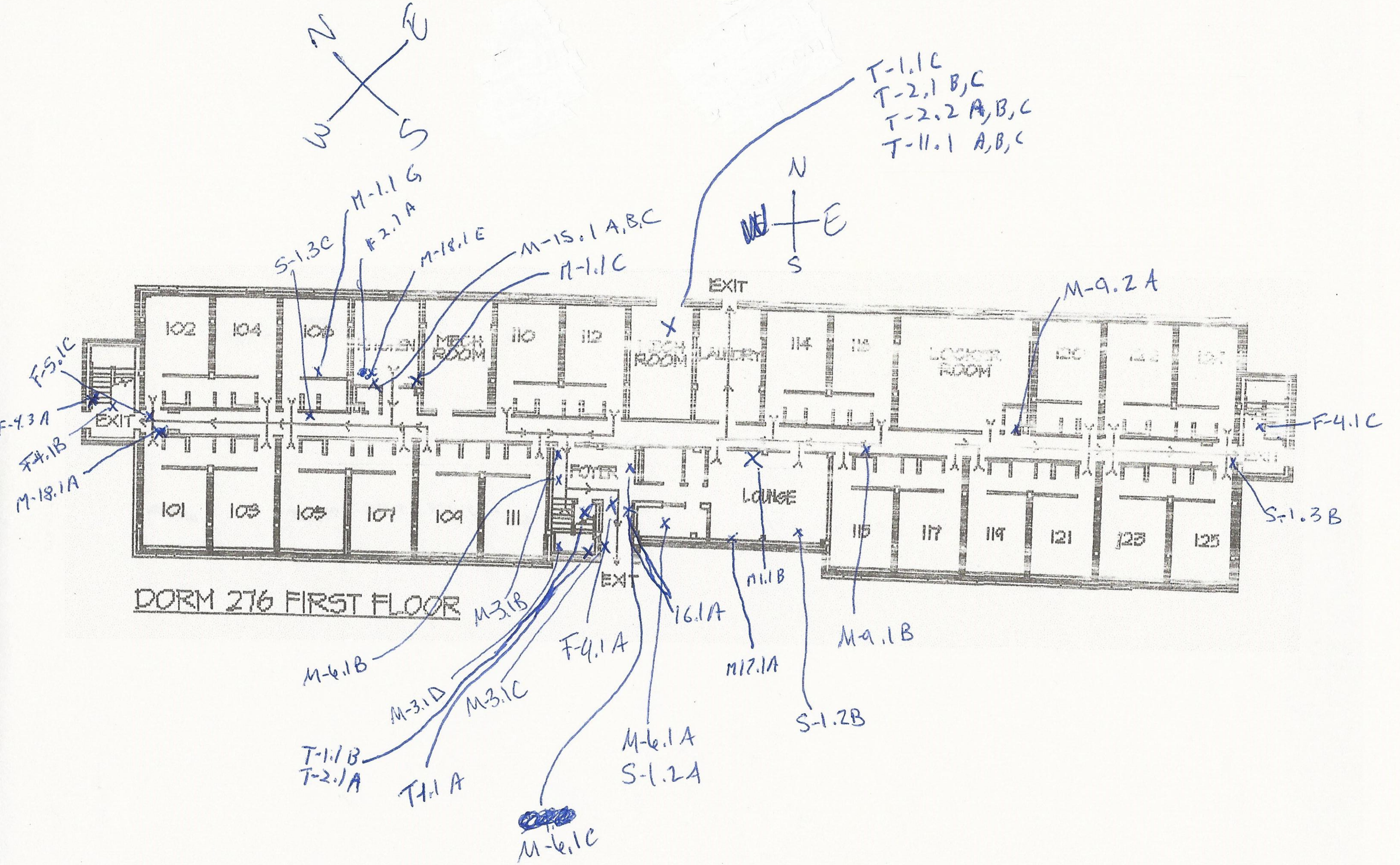
Client Name: Terracon
Building Name: Building 262 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
T-2 - 1 - A	Under 1st floor center stairwell	5698769 7/29/20
T-2 - 1 - B	1st floor exterior mechanical room	5698770
T-2 - 1 - C	1st floor exterior mechanical room	5698771
T-1 - 2 - A	1st floor exterior mechanical room	5698772
T-1 - 2 - B	1st floor exterior mechanical room	5698773
T-1 - 2 - C	1st floor exterior mechanical room	5698774
T-2 - 2 - A	1st floor exterior mechanical room	5698775
T-2 - 2 - B	1st floor exterior mechanical room	5698776
T-2 - 2 - C	1st floor exterior mechanical room	5698777
T-11 - 1 - A	1st floor exterior mechanical room	5698778
T-11 - 1 - B	1st floor exterior mechanical room	5698779
T-11 - 1 - C	1st floor exterior mechanical room	5698780
- -		
Additional Samples Labeled		
M-16 - 1 - A		5698781
- - B		5698782
- - C		5698783
M17 - 1 - A		5698784
- - B		5698785
- - C		5698786
- -		

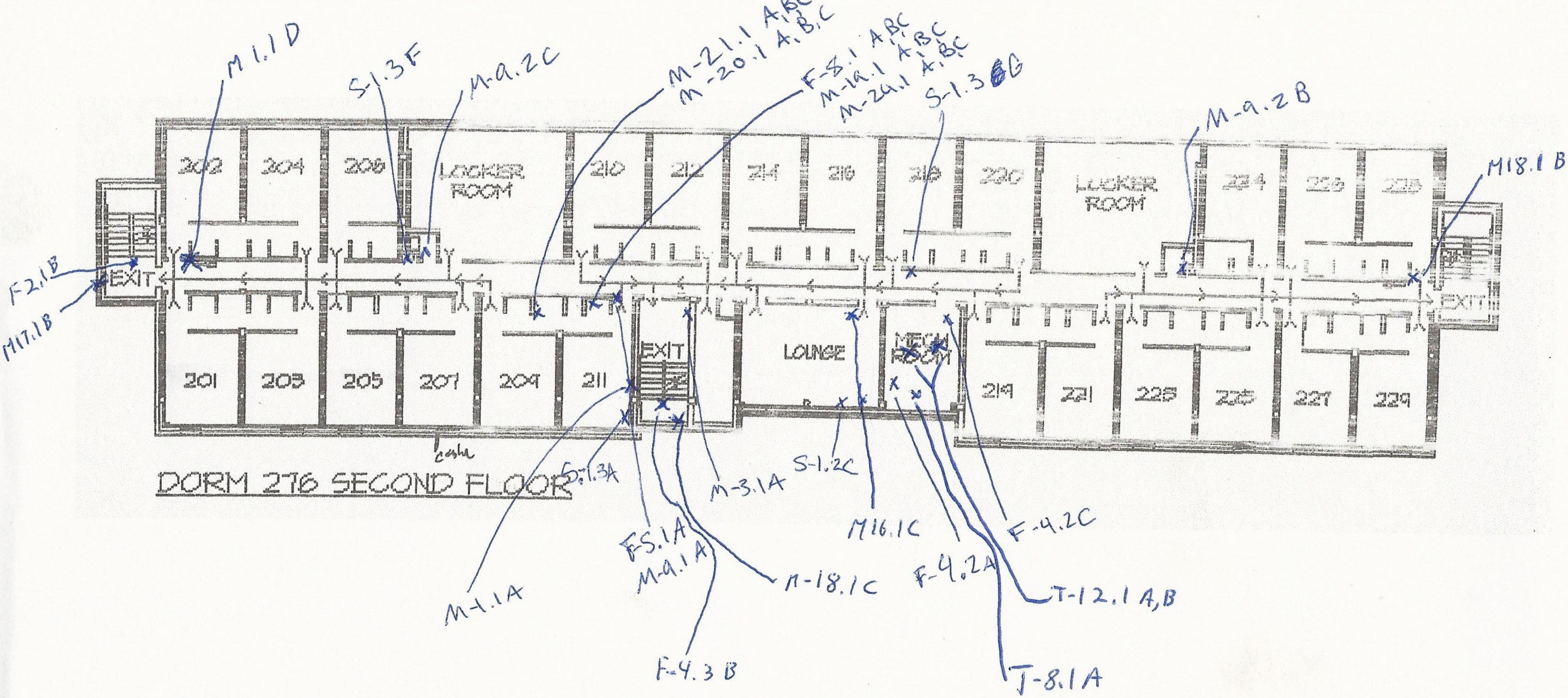
APPENDIX C

ASBESTOS SAMPLE LOCATION EXHIBITS

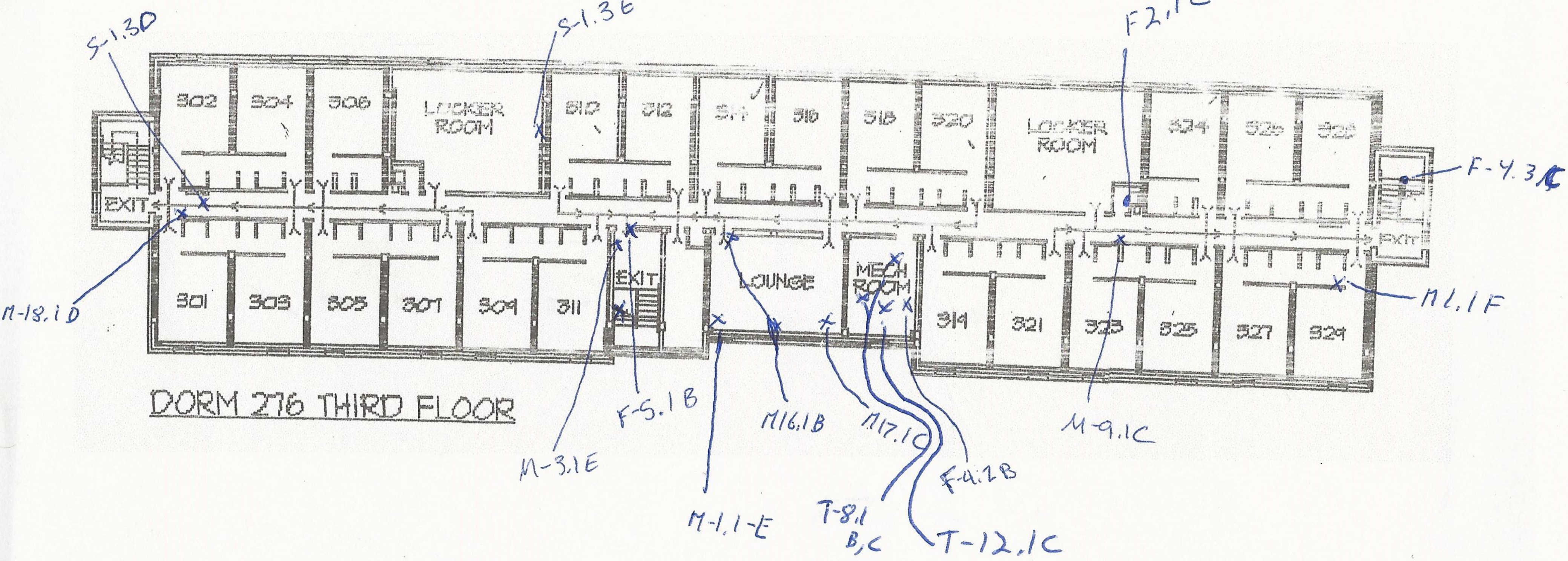
First Floor


N
E
W
S
T-1.1C
T-2.1 B,C
T-2.2 A,B,C
T-11.1 A,B,C
M-1.1G
F2.1A
S-1.3C
M-18.1E
M-15.1 A,B,C
M-1.1C
M-9.2A
EXIT
102
104
106
MECH ROOM
110
112
LAUNDRY
114
116
LOCKER ROOM
FOYER
LOUNGE
101
103
105
107
109
111
115
117
119
121
123
125
F-5.1C
F-4.3A
F4.1B
M-18.1A
F-4.1C
S-1.3B
DORM 276 FIRST FLOOR
M-3.1B
M-6.1B
M-3.1D
M-3.1C
F-4.1A
16.1A
M1.1B
M17.1A
M-9.1B
S-1.2B
T-1.1B
T-2.1A
T1.1A
M-6.1A
S-1.2A
M-6.1C

Second Floor



Third Floor



S-1.3D
S-1.3E
F2.1C
F-4.3.1C
302
304
306
LOCKER ROOM
310
312
314
316
318
320
LOCKER ROOM
324
326
328
EXIT
EXIT
EXIT
301
303
305
307
309
311
LOUNGE
MECH ROOM
314
321
323
325
327
329
M-18.1D
M1.1F
F-5.1B
M-3.1E
M-1.1-E
M16.1B
M17.1C
F-4.2B
T-8.1 B,C
T-12.1C
M-9.1C
DORM 276 THIRD FLOOR

APPENDIX D

ASBESTOS LABORATORY ANALYTICAL REPORT

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698685 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-A Entrance Room 211

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698686 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-B 3rd Floor Central Stairwell Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698687 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-C West End Of Hall,1st Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698688 **Description / Location:** Off-White Mastic
Client No.: F4-1-A 1st Floor Foyer Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello **Approved By:**

Date: 8/6/2015

Frank E. Ehrenfeld, III
Laboratory Director

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698689 **Description / Location:** Off-White Mastic
Client No.: F4-1-B 1st Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698690 **Description / Location:** Off-White Mastic
Client No.: F4-1-C 1st Floor Stairwell,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698691 **Description / Location:** Tan Floor Tile
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698691 **Description / Location:** Yellow Mastic **Layer No.: 2**
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698691 **Description / Location:** Grey Leveling Compound **Layer No.: 3**
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698692 **Description / Location:** Tan Floor Tile
Client No.: F2-1-B 2nd Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698692 **Description / Location:** Yellow/Black Mastic **Layer No.: 2**
Client No.: F2-1-B 2nd Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698693 **Description / Location:** Tan Floor Tile
Client No.: F2-1-C 3rd Floor Utility Closet,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698693 **Description / Location:** Yellow/Black Mastic **Layer No.: 2**
Client No.: F2-1-C 3rd Floor Utility Closet,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698694 **Description / Location:** Yellow Mastic
Client No.: M9-1-A Room 211, Near Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698695 **Description / Location:** Yellow Mastic
Client No.: M9-1-B 1st Floor Hall,Near Room 115

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698696 **Description / Location:** Yellow Mastic
Client No.: M9-1-C 3rd Floor Hall,Near Room 323

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698697 **Description / Location:** White/Black Paint
Client No.: M9-2-A 1st Floor,East Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698698 **Description / Location:** White/Black Paint
Client No.: M9-2-B 2nd Floor,East Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698699 **Description / Location:** White/Black Paint
Client No.: M9-2-C 2nd Floor,West Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698700 **Description / Location:** White Texture
Client No.: S1-3-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698701 **Description / Location:** White Texture
Client No.: S1-3-B 1st Floor South Wall,Near Room 125

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698702 **Description / Location:** White Texture
Client No.: S1-3-C 1st Floor North Wall,Near Room 106

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698703 **Description / Location:** White Texture
Client No.: S1-3-D 3rd Floor,Hall Ceiling,Near Room 302

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698704 **Description / Location:** White Texture
Client No.: S1-3-E 3rd Floor Locker,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698705 **Description / Location:** White Texture
Client No.: S1-3-F 2nd Floor,Hall Ceiling,Near Room 207

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

Date: 8/6/2015

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698706 **Description / Location:** White Texture
Client No.: S1-3-G 2nd Floor,North Wall,Near Room 218

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698707 **Description / Location:** White Texture
Client No.: M3-1-A 2nd Floor Stairwell,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698708 **Description / Location:** White Texture
Client No.: M3-1-B 1st Floor Foyer,Near NW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698709 **Description / Location:** White Texture
Client No.: M3-1-C 1st Floor Building Entrace,West Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698710 **Description / Location:** White Texture
Client No.: M3-1-D Land Between 1st&2nd Floors,West Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698711 **Description / Location:** White Texture
Client No.: M3-1-E 3rd Floor Stairwell,Near NW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698712 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-A 1st Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698712 **Description / Location:** Off-White Mastic **Layer No.:** 2
Client No.: M18-1-A 1st Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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CERTIFICATE OF ANALYSIS

Client: Terracon Consultants, Inc.
6701 4th Street SW
Minot ND 58701

Report Date: 8/6/2015
Report No.: 370048
Project: Minot AFB Dorm Survey
Project No.: M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698713
Client No.: M18-1-B
Description / Location: White Vinyl Wall Covering
2nd Floor Hall,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698713
Client No.: M18-1-B
Description / Location: Off-White Mastic
2nd Floor Hall,East End
Layer No.: 2

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698713
Client No.: M18-1-B
Description / Location: White Joint Compound
2nd Floor Hall,East End
Layer No.: 3

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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CERTIFICATE OF ANALYSIS

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698714 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698714 **Description / Location:** Off-White Mastic **Layer No.: 2**
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698714 **Description / Location:** White Joint Compound **Layer No.: 3**
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698715 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-D 3rd Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698715 **Description / Location:** Clear Mastic **Layer No.:** 2
Client No.: M18-1-D 3rd Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698716 **Description / Location:** Off - White Vinyl Wall Covering
Client No.: M18-1-E Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698716 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M18-1-E Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698717 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-A Room 129

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698718 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-B In Foyer,Near Stair

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698719 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-C In Foyer,Near Mail

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698720 **Description / Location:** Off-White Texture
Client No.: S1-2-A Room 129

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698721
Client No.: S1-2-B
Description / Location: Off-White Texture
1st Floor Lounge,Near South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Lab No.: 5698722
Client No.: S1-2-C
Description / Location: Off-White Texture
2nd Floor Lounge,Near South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Lab No.: 5698723
Client No.: M22-1-A
Description / Location: Tan Ceramic Tile
1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698723
Client No.: M22-1-A
Description / Location: Grey Mortar
1st Floor Storage Locker,East Side
Layer No.: 2

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698724 **Description / Location:** Tan Ceramic Tile
Client No.: M22-1-B 2nd Floor Storage Locker,West Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698725 **Description / Location:** Grey Grout
Client No.: M22-1-C 3rd Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698726 **Description / Location:** Tan Ceramic Tile
Client No.: M23-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698726 **Description / Location:** Grey Grout **Layer No.: 2**
Client No.: M23-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698727 **Description / Location:** Grey Grout
Client No.: M23-1-B 2nd Floor Storage Locker,West Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698728 **Description / Location:** Tan Ceramic Tile
Client No.: M23-1-C 3rd Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698729 **Description / Location:** Off-White/Grey Mastic/Leveling Comp
Client No.: F4-3-A 1st Floor Stair,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Date: 8/6/2015

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698730 **Description / Location:** Off-White Mastic
Client No.: F4-3-B 2nd Floor Stairs,Center

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698730 **Description / Location:** Brown Mastic **Layer No.: 2**
Client No.: F4-3-B 2nd Floor Stairs,Center

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698731 **Description / Location:** Off-White Mastic
Client No.: F4-3-C 3rd Floor Stairs,East

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698732 **Description / Location:** Black Mastic
Client No.: F4-2-A 2nd Floor Mech. Room,SW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698733 **Description / Location:** Black Mastic
Client No.: F4-2-B 3rd Floor Mech. Room,SE Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698734 **Description / Location:** Black Mastic
Client No.: F4-2-C 2nd Floor Mech. Room,NE Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698735 **Description / Location:** Black Insulation
Client No.: M15-1-A Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	1	Cellulose	99

Lab No.: 5698736 **Description / Location:** Black Insulation
Client No.: M15-1-B Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	2	Cellulose	98

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698737 **Description / Location:** Black Insulation
Client No.: M15-1-C Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	2	Cellulose	98

Lab No.: 5698738 **Description / Location:** White Grout
Client No.: M21-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698739 **Description / Location:** White Grout
Client No.: M21-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698740 **Description / Location:** White Grout
Client No.: M21-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698741 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698741 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M20-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698742 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698742 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M20-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698743 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698743 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M20-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698744 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698745 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698746 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698747 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698747 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M19-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698748 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698748 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M19-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698749 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698749 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M19-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698750 **Description / Location:** Tan Mastic
Client No.: M24-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698751 **Description / Location:** Tan Mastic
Client No.: M24-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698752 **Description / Location:** Tan Mastic
Client No.: M24-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698753 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698753 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698754 **Description / Location:** Grey/Tan Sheetrock
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	40	Cellulose	60

Lab No.: 5698754 **Description / Location:** White/Tan Sheetrock **Layer No.: 2**
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75
		Trace	Fibrous Glass	

Lab No.: 5698754 **Description / Location:** White Joint Compound **Layer No.: 3**
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698755 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-C Kitchen,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698755 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M1-1-C Kitchen,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698756 **Description / Location:** White/Tan Sheetrock
Client No.: M1-1-D 2nd Floor Hall,West End Outside Rm 202

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75

Lab No.: 5698756 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M1-1-D 2nd Floor Hall,West End Outside Rm 202

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698757 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-E 3rd Floor Lounge,South West Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698757 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-E 3rd Floor Lounge,South West Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698758 **Description / Location:** White/Tan Sheetrock
Client No.: M1-1-F 3rd Floor Hall,Est End Outside Rm 329

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698758 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-F 3rd Floor Hall,Est End Outside Rm 329

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

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	Minot	ND 58701	**Project:**	Minot AFB Dorm Survey
			Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698759 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-G Room 106,South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75
		Trace	Fibrous Glass	

Lab No.: 5698759 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-G Room 106,South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698760 **Description / Location:** Black/White Fibrous Material
Client No.: T12-1-A 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	50	Fibrous Glass	50

Lab No.: 5698761 **Description / Location:** Black/White Fibrous Material
Client No.: T12-1-B 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	60	Fibrous Glass	40

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698762 **Description / Location:** Black/White Fibrous Material
Client No.: T12-1-C 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	60	Fibrous Glass	40

Lab No.: 5698763 **Description / Location:** Yellow Insulation
Client No.: T8-1-A 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698764 **Description / Location:** Yellow Insulation
Client No.: T8-1-B 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698764 **Description / Location:** White/Silver Wrap **Layer No.: 2**
Client No.: T8-1-B 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
PC 3.3	Chrysotile	40	Cellulose	PC 51.7
		5	Fibrous Glass	

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698765 **Description / Location:** Yellow Insulation
Client No.: T8-1-C 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698766 **Description / Location:** Yellow Insulation
Client No.: T1-1-A Stairwell Center Between 1st & 2nd Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698766 **Description / Location:** White/Silver Wrap **Layer No.: 2**
Client No.: T1-1-A Stairwell Center Between 1st & 2nd Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	50	Cellulose	45
		5	Fibrous Glass	

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698767 **Description / Location:** Tan Insulation
Client No.: T1-1-B Under 1st Floor Stairs,Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698767 **Description / Location:** Tan/Off-White Wrap **Layer No.: 2**
Client No.: T1-1-B Under 1st Floor Stairs,Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	80	Cellulose	20

Lab No.: 5698768 **Description / Location:** Tan Insulation
Client No.: T1-1-C 1st Floor,Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698768 **Description / Location:** Tan/Off-White Wrap **Layer No.: 2**
Client No.: T1-1-C 1st Floor,Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	75	Cellulose	25

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Analysis Performed By: B. Hargrove

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698769 **Description / Location:** Off-White Insulation
Client No.: T2-1-A Under 1st Floor Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
PC 4.2	Amosite	35	Fibrous Glass	PC 54.3
PC 1.5	Chrysotile	5	Cellulose	

Lab No.: 5698770 **Description / Location:** Sample Not Analzyed
Client No.: T2-1-B

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
	Sample Not Analyzed		Sample Not Analyzed	

Lab No.: 5698771 **Description / Location:** Sample Not Analzyed
Client No.: T2-1-C

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
	Sample Not Analyzed		Sample Not Analyzed	

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: B. Hargrove

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698772 **Description / Location:** Tan Insulation
Client No.: T1-2-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698772 **Description / Location:** Grey/Silver Wrap **Layer No.: 2**
Client No.: T1-2-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	45	Cellulose	45
		10	Fibrous Glass	

Lab No.: 5698773 **Description / Location:** Tan Insulation
Client No.: T1-2-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698773 **Description / Location:** Grey/Tan Wrap **Layer No.: 2**
Client No.: T1-2-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	75	Cellulose	25

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698774 **Description / Location:** Tan Insulation
Client No.: T1-2-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	95	Fibrous Glass	5

Lab No.: 5698774 **Description / Location:** Off-White/Grey Wrap **Layer No.: 2**
Client No.: T1-2-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	85	Cellulose	15

Lab No.: 5698775 **Description / Location:** White/Grey Wrap
Client No.: T2-2A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698776 **Description / Location:** White/Brown Wrap
Client No.: T2-2B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698777 **Description / Location:** Off-White Wrap
Client No.: T2-2C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698778 **Description / Location:** Red Caulk
Client No.: T11-1-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	10	Synthetic	90

Lab No.: 5698779 **Description / Location:** Red Caulk
Client No.: T11-1-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	10	Synthetic	90

Lab No.: 5698780 **Description / Location:** Red Caulk
Client No.: T11-1-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698781 **Description / Location:** White Caulk
Client No.: M16-1-A

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698782 **Description / Location:** White Caulk
Client No.: M16-1-B

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698783 **Description / Location:** Off-White Caulk
Client No.: M16-1-C

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698784 **Description / Location:** Off-White Caulk
Client No.: M17-1-A

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: B. Hargrove

Date: 8/6/2015

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Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698785 **Description / Location:** Off-White Caulk
Client No.: M17-1-B

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698786 **Description / Location:** Off-White Caulk
Client No.: M17-1-C

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

iATL
INTERNATIONAL
ASBESTOS TESTING LABORATORIES

9000 Commerce Parkway, Suite B • Mount Laurel, NJ 08054
Phone: 877-428-4285/856-231-9449 • Fax: 856-231-9818

Chain of Custody

–Bulk Asbestos –

Contact Information

Client Company:	Terracon Consultants, Inc	**Project Number:**	M6157011
Office Address:	6701 4th Street SW	**Project Name:**	Minot AFB Dorm Survey
City, State, Zip:	Minot, ND 58701	**Primary Contact:**	Steve Maliszeski
Fax Number:	701-772-2633	**Office Phone:**	701-792-2615
Email Address:	steve.maliszeski@terracon.com	**Cell Phone:**	440-665-4840

PLM Instructions:

- [x] PLM: Bulk Asbestos Building Materials EPA 600 R-93/116, 1993
- [ ] PLM: Bulk Asbestos Building Materials EPA 600 M-4/82-020, 1982
- [ ] PLM: Bulk Asbestos Building Materials NIOSH 9002, 1985
- [ ] PLM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.1, 2002
- [ ] PLM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.6, 2010
- [ ] TEM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.4, 2009

E-MAILED
Prelim 8/6/15 NG

- [x] PLM: Point Counting
  - [ ] PC: via ELAP 198.1
  - [ ] PC: 400 Points
  - [ ] PC: 800 Points *
  - [ ] PC: 1600 Points *
- [x] PLM: Instructions for Multi-Layered Samples
  - [x] Analyze and Report All Separable Layers per EPA 600
  - [x] Report Composite for Drywall Systems per NESHAP
  - [ ] Report All Layers and Composite Where Applicable
  - [ ] Only Analyze and Report Specifically Noted Layer
- [x] PLM: Analyze Until Positive (Positive Stop)
  - [x] AUP: by Homogenous Area as Noted
  - [ ] AUP: by Material Type as Noted
- [ ] PLM: NOB via 198.6
  - [ ] PLM: Friable via EPA 600 2.3
  - [ ] If <1% by PLM, to TEM via 198.4 *
  - [ ] If <1% by PLM, Hold for Instructions
- [ ] PLM: Non-Building Material** (Dust, Wipe, Tape)
  - [ ] Soil or Vermiculite Analysis*
  - [ ] CARB 435

E-MAILED
8-7-15 DL

Special Instructions: Analyze per Terracon standard, please submit with .pdf and database file for use with Terracon ARMS system. Please call with questions. Point count <10% per Terracon standard.

** Additional charge and turnaround may be required* *** Alternative Method (ex: EPA 600/R-04/004) may be recommended by Laboratory*

Turnaround Time

Preliminary Results Requested Date: ____________ (Specific date / time)

- [ ] Verbal
- [x] Email
- [ ] Fax

96

- [ ] 10 Day
- [ ] 5 Day
- [x] 3 Day
- [ ] 2 Day
- [ ] 1 Day*
- [ ] 12 Hour**
- [ ] 6 Hour**
- [ ] RUSH**

* End of next business day unless otherwise specified. ** Matrix Dependent. *****Please notify the lab before shipping*****

Chain of Custody

Relinquished (Name/Organization):	Steve Maliszeski/Terracon	Date:	7/30/15	Time:	1700
Received (Name / iATL):		Date:		Time:	
Sample Login (Name / iATL):		Date:	8/3/15	Time:	
Analysis(Name(s) / iATL):	BM	Date:	8-6-15	Time:	
QA/QC Review (Name / iATL):	PBC 8/7/15	Date:		Time:	
Archived / Released: ______ QA/QC InterLAB Use:		Date:		Time:	

RECEIVED
AUG - 3 2015
iATL - By

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
F-5 - 1 - A	Entrance Room 211	5698685 9/29/30
F-5 - 1 - B	3rd Floor central stairwell entrance	5698686
F-5 - 1 - C	west end of hall, 1st floor	5698687
F-4 - 1 - A	1st floor foyer entrance	5698688
F-4 - 1 - B	1st floor Stairwell, west end	5698689
F-4 - 1 - C	1st floor stairwell, east end	5698690
F-2 - 1 - A	1st floor kitchen	5698691
F-2 - 1 - B	2nd floor stairwell - West end	5698692
F-2 - 1 - C	3rd floor utility closet - East end	5698693
M-9 - 1 - A	Room 211, near entrance	5698694
M-9 - 1 - B	1st floor hall, near Room 115	5698695
M-9 - 1 - C	3rd floor hall, near Room 323	5698696
M-9 - 2 - A	1st floor, east utility closet	5698697
M-9 - 2 - B	2nd floor, east utility closet	5698698
M-9 - 2 - C	2nd floor, west utility closet	5698699
S-1 - 3 - A	Room 211, east wall	5698700
S-1 - 3 - B	1st floor south wall, near Room 125	5698701
S-1 - 3 - C	1st floor north wall, near Room 106	5698702
S-1 - 3 - D	3rd floor, hall ceiling, near Room 302	5698703
S-1 - 3 - E	3rd floor locker, east wall	5698704
S-1 - 3 - F	2nd floor, hall ceiling, near Room 207	5698705

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
S-1 - 3 - B	2nd floor, north wall, near Room 218	5698706 7/29/30
M-3 - 1 - A	2nd floor stairwell, east wall	5698707
M-3 - 1 - B	1st floor foyer, near NW corner	5698708
M-3 - 1 - C	1st floor ~~fe~~ building entrance, west wall	5698709
M-3 - 1 - D	land between 1st + 2nd floors, west wall	5698710
M-3 - 1 - E	3rd floor stairwell, near NW corner	5698711
M-18 - 1 - A	1st floor hall, west end	5698712
M-18 - 1 - B	2nd floor hall, east end	5698713
M-18 - 1 - C	Center stairwell	5698714
M-18 - 1 - D	3rd floor hall, west end	5698715
M-18 - 1 - E	Kitchen	5698716
M-6 - 1 - A	Room 129	5698717
M-6 - 1 - B	In Foyer, near stair	5698718
M-6 - 1 - C	In Foyer, near mail	5698719
S-1 - 2 - A	Room 129	5698720
S-1 - 2 - B	1st floor lounge, near south wall	5698721
S-1 - 2 - C	2nd floor lounge, near south wall	5698722
M22 - 1 - A	1st floor storage locker - East side	5698723
M22 - 1 - B	2nd floor Storage locker - West side	5698724
M22 - 1 - C	3rd floor Storage locker - East side	5698725
M23 - 1 - A	1st floor storage locker - East Side	5698726

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
M23 - 1 - B	2nd floor storage locker - West side	5698727 7/29/30
M23 - 1 - C	3rd Floor Storage locker - East side	5698728
F-4 - 3 - A	1st Floor Stair - West end	5698729
F-4 - 3 - B	2nd floor Stairs - Center	5698730
F-4 - 3 - C	3rd floor Stairs - East	5698731
F-4 - 2 - A	2nd floor mech room, SW corner	5698732
F-4 - 2 - B	3rd floor mech room, SE corner	5698733
F-4 - 2 - C	2nd floor mech room, NE corner	5698734
M-15 - 1 - A	kitchen sink	5698735
M-15 - 1 - B	kitchen sink	5698736
M-15 - 1 - C	kitchen sink	5698737
M-21 - 1 - A	Room 211, west shower wall	5698738
M-21 - 1 - B	Room 211, west shower wall	5698739
M-21 - 1 - C	Room 211, west shower wall	5698740
M-20 - 1 - A	Room 211, west shower wall	5698741
M-20 - 1 - B	Room 211, west shower wall	5698742
M-20 - 1 - C	Room 211, west shower wall	5698743
F-8 - 1 - A	Room 211, under sink	5698744
F-8 - 1 - B	Room 211, under sink	5698745
F-8 - 1 - C	Room 211, under sink	5698746
start M-19 - 1 - A	Room 211, under sink	5698747

Terracon PN: M6157011 **Asbestos Sample Location Log** Page 4 of 5

Client Name: Terracon
Building Name: ~~[illegible]~~ Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
M-19 - 1 - B	Room 211, under sink	5698748 7/29/30
M-19 - 1 - C	Room 211, under sink	5698749
M-24 - 1 - A	Room 211, under sink	5698750
M-24 - 1 - B	Room 211, under sink	5698751
M-24 - 1 - C	Room 211, under sink	5698752
M-1 - 1 - A	Room 211, east wall	5698753
M-1 - 1 - B	First floor lounge, north wall	5698754
M-1 - 1 - C	Kitchen, east wall	5698755
M-1 - 1 - D	2nd floor hall, west end outside room ~~[illegible]~~ 202	5698756
M-1 - 1 - E	3rd floor lounge, Southwest corner	5698757
M-1 - 1 - F	3rd floor hall, east end outside room 329	5698758
M-1 - 1 - G	~~2nd floor hall, west end outside room~~ Room 106, south wall	5698759
T-12 - 1 - A	2nd floor Mechanical Room	5698760
T-12 - 1 - B	2nd floor Mechanical Room	5698761
T-12 - 1 - C	3rd floor Mechanical Room	5698762
T-8 - 1 - A	2nd floor Mechanical Room	5698763
T-8 - 1 - B	3rd floor Mechanical Room	5698764
T-8 - 1 - C	3rd Floor Mechanical Room	5698765
T1 - 1 - A	Stairwell - Center - between 1st & 2nd floors	5698766
T1 - 1 - B	Under 1st Floor stairs - center stairwell ~~1st flo~~	5698767
T1 - 1 - C	1st Floor, exterior mechanical room	5698768

Terracon PN: M615701l **Asbestos Sample Location Log** Page 5 of 5

Client Name: Terracon
Building Name: Building 262 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
T-2 - 1 - A	Under 1st floor center stairwell	5698769 7/29/30
T-2 - 1 - B	1st floor exterior mechanical room	5698770
T-2 - 1 - C	1st floor exterior mechanical room	5698771
T-1 - 2 - A	1st floor exterior mechanical room	5698772
T-1 - 2 - B	1st floor exterior mechanical room	5698773
T-1 - 2 - C	1st floor exterior mechanical room	5698774
T-2 - 2 - A	1st floor exterior mechanical room	5698775
T-2 - 2 - B	1st floor exterior mechanical room	5698776
T-2 - 2 - C	1st floor exterior mechanical room	5698777
T-11 - 1 - A	1st floor exterior mechanical room	5698778
T-11 - 1 - B	1st floor exterior mechanical room	5698779
T-11 - 1 - C	1st floor exterior mechanical room	5698780
- -		
Additional Samples Labeled		
M-16 - 1 - A		5698781
- - B		5698782
- - C		5698783
M17 - 1 - A		5698784
- - B		5698785
- - C		5698786
- -		

APPENDIX E

MOLD SURVEY SAMPLE LOCATION EXHIBITS

~~Note~~ Notes

* No observable mold
- No obvious signs of water intrusion
- Peeling paint observed in several utility closets & lockers
- No observable odor, except for exterior mech room
- DID NOT CHECK EVERY DORM ROOM, as some were occupied.

Note: All thermo switches in dorm rooms contain mercury.

Dorm 276 1st Floor

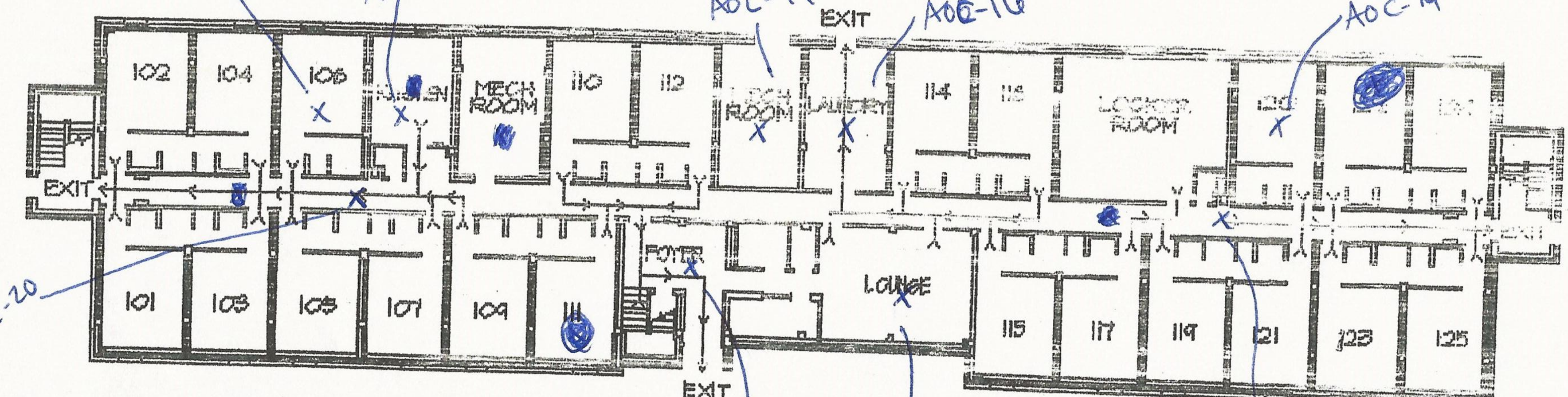
Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.
2. If there is a fire in your room and you cannot safely extinguish it:
   - Evacuate the area, close all doors as you leave, and take your room key.
   - Activate the fire alarm in the corridor.
3. If there is a fire outside your room:
   - Feel the door.
   - If it's hot, do not open it.
   - Seal the bottom of the door with wet towels to keep the smoke out. Call for further assistance.
   - If the door is not hot, and no danger appears through the peep hole, open cautiously, crawling behind the door.
   - Be prepared to close your door fast, if necessary.
4. If you are able to exit your room safely, walk to the nearest stairwell (crawl if smoke is present in the hallway).

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 FIRST FLOOR

AOC-22 (outdoor sample)

~~* one unoccupied room from each wing~~

Dorm 276 2nd Floor

S
E W
N

Outdoor sample

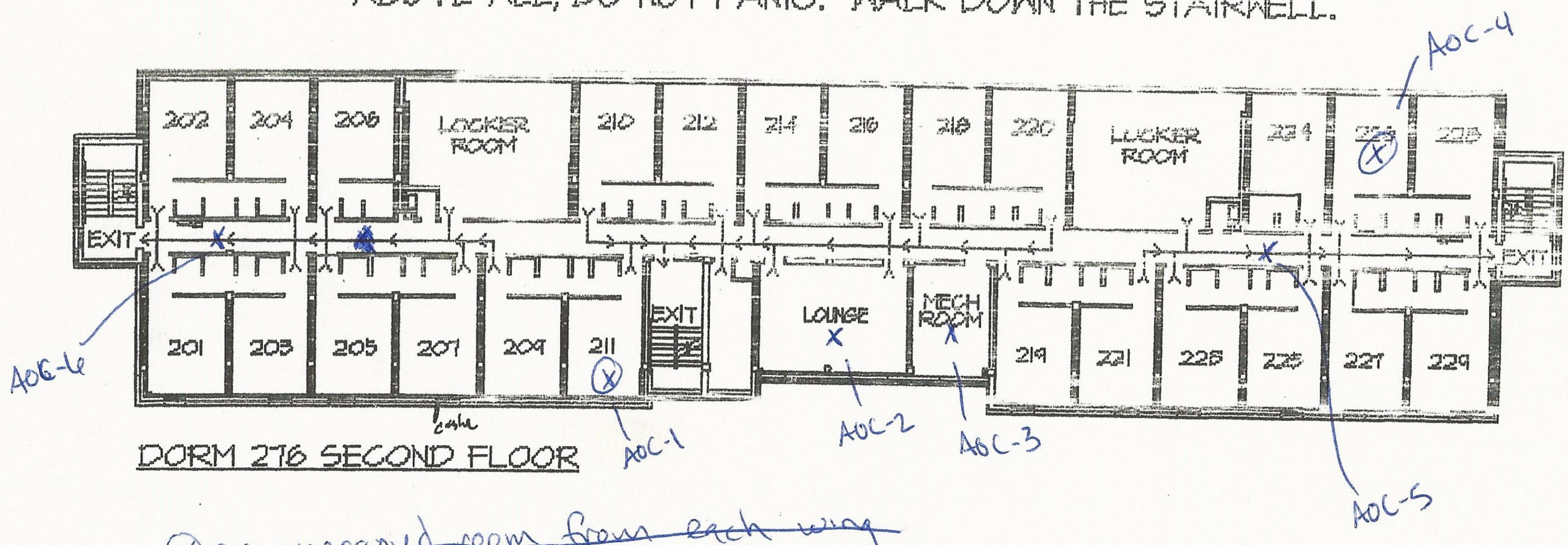
Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.
2. If there is a fire in your room and you cannot safely extinguish it:
   - Evacuate the area, close all doors as you leave, and [illegible]
   - Activate the fire alarm in the corridor.
3. If there is a fire outside your room:
   - Feel the door.
   - If it is hot, do not open it.
   - Seal the bottom of the door with wet towels to keep the smoke out. [illegible] for further assistance.
   - If the door is not hot, and no danger appears through the peep hole, open [illegible] standing behind the door.
   - Be prepared to close your door fast, if necessary.
4. If you are able to exit your room safely, walk to the nearest stairwell [illegible] smoke is present in the hallway.

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 SECOND FLOOR

~~(x) one unoccupied room from each wing~~

Dorm 276 3rd Floor

Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

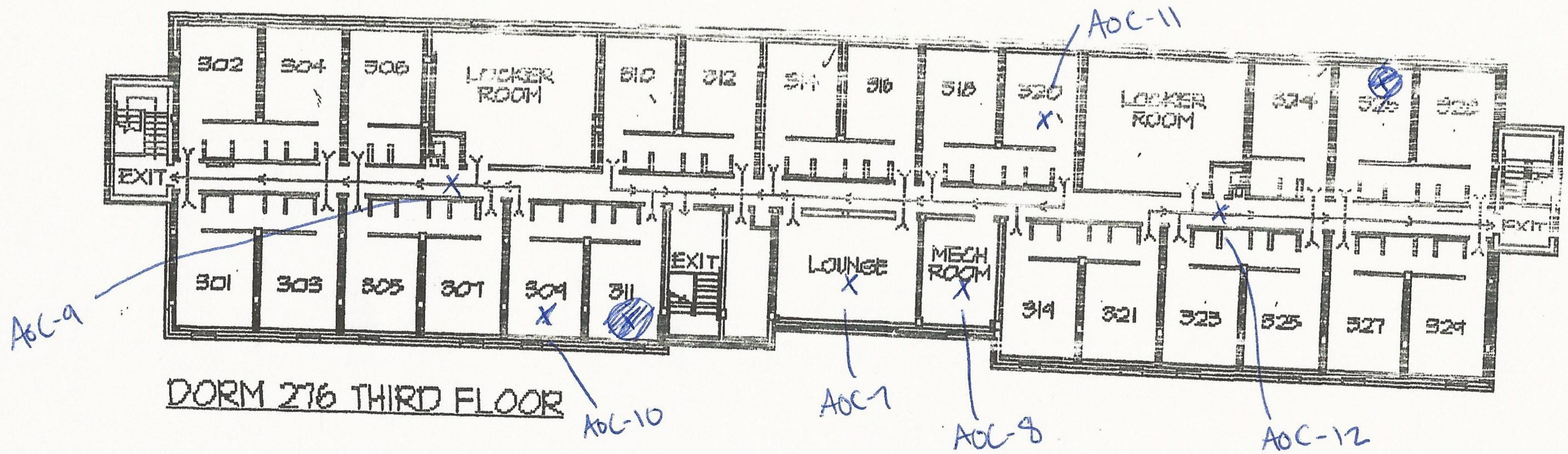
1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.

2. If there is a fire in your room and you cannot safely extinguish it:
   -Evacuate the area, close all doors as you exit, and take your room key.
   -Activate the fire alarm in the corridor.

3. If there is a fire outside your room:
   -Feel the door.
   -If it is hot, do not open it.
   -Seal the bottom of the door with wet towels to keep the smoke out. Wait for further assistance.
   -If the door is not hot, and no danger appears through the peep hole, open cautiously standing behind the door.
   -Be prepared to close your door fast, if necessary.

4. If you are able to exit your room safely walk to the nearest stairwell (crawl, if smoke is present in the hallway).

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 THIRD FLOOR

X ~~one unoccupied room from each wing~~

APPENDIX F

MOLD LABORATORY ANALYTICAL REPORT

OrderID: 351505112

EMSL ANALYTICAL, INC.
LABORATORY•PRODUCTS•TRAINING

Microbiology Chain of Custody

EMSL Order Number *(Lab Use Only)*:

5112

EMSL ANALYTICAL INC.
14375 23RD AVE NORTH
MINNEAPOLIS, MN 55447
763-449-4922

Company : Terracon	**EMSL-Bill to:** ☐ Same ☒ Different **If Bill to is Different please note in Comments****
Street: 6701 4th Street SW	*Third Party Billing requires written authorization from third party*
City: Minot / **State/Province: ND**	**Zip/Postal Code: 58701** / **Country: USA**
Report To (Name): Steve Maliszeski	**Fax #: 701-772-2633**
Telephone #: 701-792-2615	**E-mail Address: steve.maliszeski@terracon.com**

Project Name/ Number: Minot AFB Dorm Renovation

Please Provide Results: ☐ Fax ☒ E-mail | **PO# M6157011** | **State Samples Taken: ND**

Turnaround Time (TAT) Options* - Please Check

☐ 3 Hours | ☐ 6 Hours | ☐ 24 Hours | ☐ 48 Hours | ☒ 3 Days | ☐ 4 Days | ☐ 5 Days | ☐ 10 Days | ☐ 2 Weeks

**Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide. TATs are subject to methodology requirements*

Non Culturable Air Samples (Spore Traps)

- **M001** Air-O-Cell
- **M049** BioSIS
- **M030** Micro 5
- **M173** Allegro M2
- **M003** Burkard
- **M174** MoldSnap
- **M004** Allergenco
- **M043** Cyclex
- **M176** Relle Smart
- **M032** Allergenco-D
- **M002** Cyclex-d
- **M130** Via-Cell
- **M172** Versa Trap

Other Microbiology Test Codes

- **M041** Fungal Direct Examination
- **M005** Viable Fungi ID and Count
- **M006** Viable Fungi ID and Count (Speciation)
- **M007** Culturable Fungi
- **M008** Culturable Fungi (Speciation)
- **M009** Gram Stain Culturable Bacteria
- **M010** Bacterial Count and ID – 3 Most Prominent
- **M011** Bacterial Count and ID – 5 Most Prominent
- **M013** Sewage Contamination in Buildings
- **M014** Endotoxin Analysis
- **M015** Heterotrophic Plate Count
- **M180** Real Time Q-PCR-ERMI 36 Panel
- **M018** Total Coliform (Membrane Filtration)
- **M020** Fecal *Streptococcus* (Membrane Filtration)
- **M210-215** *Legionella* Detection
- **M026** Recreational Water Screen
- **M027** Mycotoxin Analysis
- **M029** *Enterococci*
- **M019** Fecal Coliform
- **M133** MRSA Analysis
- **M028** *Cryptococcus neoformans* Detection
- **M120** *Histoplasma capsulatum* Detection
- **M033-39** Allergen Testing
- **M044** Group Allergen (Cat, Dog, Cockroach, Dustmites)
- **Other** See Analytical Price Guide

Preservation Method (Water):

Name of Sampler: Steve Maliszeski | **Signature of Sampler:** [signature]

Sample #	Sample Location	Sample Type	Test Code	Volume/Area	Date/Time Collected
	See Attached Forms				

Client Sample # (s): - | **Total # of Samples:** 22

Relinquished (Client): Steve Maliszeski [signature] **Date: 7/30/15** **Time: 1700**

Received (Client): Mclaypool FE **Date:** 8/13/15 **Time:** 9:05

Comments: Invoice: A.P., 1555 N. 42nd Street Unit B, Grand Forks, ND 58203 780 7/66 3853

5112

5

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-1	Room 211	Air M001 150 L	4:15 pm	79.5° / 38.6%	July 29 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-2	2nd Floor Lounge		4:27 pm	77.7° / 34.1%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-3	2nd Floor mech. room		4:39 pm	77.9° / 38.5%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-4	Room 226		4:52 pm	78.4° / 41.5%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-5	2nd Floor, west hall, near room 223		5:03 pm	77.9° / 38.6%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 1 of 5

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND. 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-6	2nd Floor, east hall near Room 204	Air, M001, 150 L	5:15 pm	78° / 40.2%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-7	3rd Floor Lounge		5:28 p.m.	71.2° / 48%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-8	3rd Floor Mech Rm		5:41 p.m.	74.6° / 43.2%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-9	3rd Floor, east hall near room 306		8:36 a.m.	75.5° / 45.7%	July 30, 2015	150	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-10	Room 309		8:49 a.m.	78.6° / 41.2%	July 30, 2015	150	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 2 of 5

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-11	Room 320	Air, M001, 150 L	9:03 a.m.	76.6° / 43.4%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-12	3rd Floor, west hall, near room 323		9:15 a.m.	77.0° / 41.1%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-13	1st Floor, west hall, near room 119		9:30 a.m.	76.4° / 46.5%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-14	Room 120		9:42 a.m.	76.6° / 46.9%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-15	1st Floor Lounge		9:54 a.m.	78.2° / 44.8%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by:
		Steve Maliszeski [signature]	5 of 22 total	Total samples
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 3 of 5

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-16	1st Floor Laundry	Air, M001, 150 L	10:06 a.m.	77.1° / 47.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-17	1st Floor, Exterior Mech Room		10:18 a.m.	81.5° / 42.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-18	Foyer		10:30 a.m.	75.9° / 50%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-19	Kitchen		10:42 a.m.	74.3° / 49.7%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-20	First Floor, East hall, near room 106		10:54 a.m.	75.9° / 49.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 4 of 5

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220 FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-21	Room 106	Air, MOD1, 150 L	11:06 a.m.	76.2° / 47.8%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-22	Outdoor Sample		11:18 a.m.	76.1° / 45.5%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski	2 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 5 of 5

EMSL Analytical, Inc.
14375 23rd Avenue North Minneapolis, Mn 55447
Phone/Fax: (763) 449-4922 / (763) 449-4924
http://www.EMSL.com / minneapolislab@emsl.com

Order ID: 351505112
Customer ID: TCND42
Customer PO:
Project ID:

Attn: Steve Maliszeski
Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone: (701) 792-2615
Fax:
Collected: 07/29/2015
Received: 08/03/2015
Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0001			351505112-0002			351505112-0003		
Client Sample ID:	AOC-1			AOC-2			AOC-3		
Volume (L):	150			150			150		
Sample Location:	Room 211			2nd Floor Lounge			2nd Floor Mech. Room		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	9	200	4.2	1	20	0.4	11	230	5.2
Ascospores	27	570	12.1	42	890	17	25	530	12.1
Aspergillus/Penicillium	5	100	2.1	-	-	-	-	-	-
Basidiospores	35	740	15.7	95	2000	38.2	40	840	19.1
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	135	2850	60.5	107	2260	43.2	112	2360	53.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	-	-	-	2	40	0.9
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	3	60	1.3	2	40	0.8	1	20	0.5
Myxomycetes++	7	100	2.1	-	-	-	11	230	5.2
Pithomyces	1	20	0.4	-	-	-	-	-	-
Rust	-	-	-	-	-	-	5	100	2.3
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	1	20	0.4	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	3	60	1.3	-	-	-	1	20	0.5
Nigrospora	1*	7*	0.1	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	1	20	0.5
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**226**	**4707**	**100**	**248**	**5230**	**100**	**209**	**4390**	**100**
Hyphal Fragment	21	440	-	8	200	-	21	440	-
Insect Fragment	1*	7*	-	-	-	-	1*	7*	-
Pollen	1	20	-	-	-	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	4	-	-	1	-	-	2	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

For Information on the fungi listed in this report please visit the Resources section at www.emsl.com

EMSL Analytical, Inc.

14375 23rd Avenue North Minneapolis, Mn 55447
Phone/Fax: (763) 449-4922 / (763) 449-4924
http://www.EMSL.com / minneapolislab@emsl.com

Order ID:	351505112
Customer ID:	TCND42
Customer PO:	
Project ID:	

Attn: Steve Maliszeski
Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone:	(701) 792-2615
Fax:	
Collected:	07/29/2015
Received:	08/03/2015
Analyzed:	08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0004**			**351505112-0005**			**351505112-0006**		
Client Sample ID:	**AOC-4**			**AOC-5**			**AOC-6**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**Room 226**			**2nd Floor West Hall, Near Room 223**			**2nd Floor, East Hall, Near Room 204**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	5	100	3.1	8	200	1.9	13	270	5.1
Ascospores	32	680	20.9	36	760	7.4	28	590	11.2
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	54	1100	33.9	189	3990	38.6	54	1100	20.8
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	1*	7*	0.1
Cladosporium	57	1200	37	247	5210	50.4	140	2950	55.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.6	-	-	-	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	2	40	1.2	4	80	0.8	7	100	1.9
Myxomycetes++	4	80	2.5	7	100	1	11	230	4.4
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	-	-	-	-	-	-	2	40	0.8
Nigrospora	1*	7*	0.2	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	1	20	0.6	-	-	-	-	-	-
Total Fungi	**157**	**3247**	**100**	**491**	**10340**	**100**	**256**	**5287**	**100**
Hyphal Fragment	4	80	-	24	510	-	15	320	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	1	20	-	-	-	-	1	20	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	2	-	-	2	-	-	4	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

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Initial report from: 08/05/2015 16:22:36

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Minot, ND 58701

Phone: (701) 792-2615
Fax:
Collected: 07/29/2015
Received: 08/03/2015
Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0007**			**351505112-0008**			**351505112-0009**		
Client Sample ID:	**AOC-7**			**AOC-8**			**AOC-9**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**3rd Floor Lounge**			**3rd Floor Mech. Rm**			**3rd Floor, East Hall Near Room 306**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	2	40	0.7	10	210	3.9	5	100	3.3
Ascospores	25	530	9.9	12	250	4.7	31	650	21.7
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	92	1900	35.4	39	820	15.4	16	340	11.3
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	131	2760	51.4	180	3800	71.3	83	1800	60.1
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	1	20	0.4	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	4	80	1.5	-	-	-	-	-	-
Myxomycetes++	2	40	0.7	11	230	4.3	6	100	3.3
Pithomyces	-	-	-	-	-	-	1*	7*	0.2
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	1	20	0.4	-	-	-	-	-	-
Cercospora	-	-	-	-	-	-	-	-	-
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**257**	**5370**	**100**	**253**	**5330**	**100**	**142**	**2997**	**100**
Hyphal Fragment	5	100	-	15	320	-	12	250	-
Insect Fragment	-	-	-	2	40	-	1	20	-
Pollen	3*	20*	-	1	20	-	1	20	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	3	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	4	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

For Information on the fungi listed in this report please visit the Resources section at www.emsl.com

EMSL Analytical, Inc.

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Order ID: 351505112
Customer ID: TCND42
Customer PO:
Project ID:

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Phone: (701) 792-2615
Fax:
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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0010**			**351505112-0011**			**351505112-0012**		
Client Sample ID:	**AOC-10**			**AOC-11**			**AOC-12**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**Room 309**			**Room 320**			**3rd Floor, West Hall, Near Room 323**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	Present	Present	-	2	40	1.3	23	490	15.2
Ascospores	Present	Present	-	76	1600	51	32	680	21.1
Aspergillus/Penicillium	-	-	-	-	-	-	2	40	1.2
Basidiospores	-	-	-	40	840	26.8	22	460	14.3
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	Present	Present	-	23	490	15.6	57	1200	37.3
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	Present	Present	-	1	20	0.6	1	20	0.6
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	-	-	-	1	20	0.6
Myxomycetes++	Present	Present	-	6	100	3.2	13	270	8.4
Pithomyces	-	-	-	-	-	-	2*	10*	0.3
Rust	Present	Present	-	2*	10*	0.3	1*	7*	0.2
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	1	20	0.6	-	-	-
Cercospora	-	-	-	1	20	0.6	-	-	-
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	1	20	0.6
Total Fungi	**-**	**-**	**-**	**152**	**3140**	**100**	**155**	**3217**	**100**
Hyphal Fragment	Present	Present	-	2	40	-	15	320	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	-	-	-	-	-	-	3	60	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	5	-	-	1	-	-	2	-

Sample Comments: 351505112-0010 Overloaded

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0013**			**351505112-0014**			**351505112-0015**		
Client Sample ID:	**AOC-13**			**AOC-14**			**AOC-15**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**1st Floor, West Hall, Near Room 119**			**Room 120**			**1st Floor Lounge**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	9	200	5.7	3	60	1.9	2*	10*	0.3
Ascospores	79	1700	48.2	51	1100	35	91	1900	55
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	29	610	17.3	22	460	14.6	41	870	25.2
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	39	820	23.2	65	1400	44.5	25	530	15.3
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.6	-	-	-	1*	7*	0.2
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	-	-	-	1	20	0.6
Myxomycetes++	5	100	2.8	4	80	2.5	5	100	2.9
Pithomyces	1	20	0.6	1*	7*	0.2	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	1	20	0.6	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	2	40	1.1	2	40	1.3	1	20	0.6
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**166**	**3530**	**100**	**148**	**3147**	**100**	**167**	**3457**	**100**
Hyphal Fragment	9	200	-	8	200	-	2	40	-
Insect Fragment	-	-	-	-	-	-	1	20	-
Pollen	1	20	-	1	20	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	1	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0016			351505112-0017			351505112-0018		
Client Sample ID:	AOC-16			AOC-17			AOC-18		
Volume (L):	150			150			150		
Sample Location:	1st Floor Laundry			1st Floor, Exterior Mech Room			Foyer		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	-	-	-	23	490	8.6	1	20	0.5
Ascospores	66	1400	38.9	35	740	13	70	1500	35.6
Aspergillus/Penicillium	-	-	-	2	40	0.7	2	40	1
Basidiospores	80	1700	47.2	36	760	13.3	93	2000	47.5
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	21	440	12.2	160	3380	59.3	29	610	14.5
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	5	100	1.8	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	1	20	0.6	1	20	0.4	1	20	0.5
Myxomycetes++	1	20	0.6	7	100	1.8	1	20	0.5
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	1	20	0.4	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	1	20	0.6	2	40	0.7	-	-	-
Nigrospora	-	-	-	1*	7*	0.1	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**170**	**3600**	**100**	**273**	**5697**	**100**	**197**	**4210**	**100**
Hyphal Fragment	2	40	-	21	440	-	2	40	-
Insect Fragment	-	-	-	4	80	-	-	-	-
Pollen	1*	7*	-	4	80	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	-	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	1	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0019			351505112-0020			351505112-0021		
Client Sample ID:	AOC-19			AOC-20			AOC-21		
Volume (L):	150			150			150		
Sample Location:	Kitchen			First Floor, East Hall, Near Room 106			Room 106		
Spore Types	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total
Alternaria	1	20	0.3	4	80	1.3	4	80	3.6
Ascospores	76	1600	27.8	73	1500	25.1	17	360	16.3
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	143	3020	52.4	113	2380	39.9	29	610	27.6
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	49	1000	17.4	89	1900	31.8	54	1100	49.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.3	1	20	0.3	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	2	40	0.7	-	-	-
Myxomycetes++	3	60	1	2	40	0.7	3	60	2.7
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	1	20	0.3	-	-	-	-	-	-
Nigrospora	-	-	-	1*	7*	0.1	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	1	20	0.3	-	-	-	-	-	-
Total Fungi	**275**	**5760**	**100**	**285**	**5967**	**100**	**107**	**2210**	**100**
Hyphal Fragment	2	40	-	11	230	-	8	200	-
Insect Fragment	-	-	-	-	-	-	1	20	-
Pollen	1	20	-	5	100	-	3*	20*	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	2	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Analyzed:	08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0022**								
Client Sample ID:	**AOC-22**								
Volume (L):	**150**								
Sample Location:	**Outdoor Sample**								
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	-	-	-	-	-	-
Alternaria	2	40	0.4	-	-	-	-	-	-
Ascospores	94	2000	22.3	-	-	-	-	-	-
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	228	4810	53.6	-	-	-	-	-	-
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	95	2000	22.3	-	-	-	-	-	-
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.2	-	-	-	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	2	40	0.4	-	-	-	-	-	-
Myxomycetes++	-	-	-	-	-	-	-	-	-
Pithomyces	1	20	0.2	-	-	-	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-						
Cercospora	1	20	0.2	-	-	-	-	-	-
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	1	20	0.2	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**425**	**8970**	**100**	-	-	-	-	-	-
Hyphal Fragment	11	230	-	-	-	-	-	-	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	3	60	-	-	-	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	-	-	-	-	-
Analyt. Sensitivity 300x	-	7*	-	-	-	-	-	-	-
Skin Fragments (1-4)	-	-	-	-	-	-	-	-	-
Fibrous Particulate (1-4)	-	1	-	-	-	-	-	-	-
Background (1-5)	-	1	-	-	-	-	-	-	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

For Information on the fungi listed in this report please visit the Resources section at www.emsl.com

APPENDIX G

IDENTIFIED LEAD-BASED LBP LOCATIONS
Minot Air Force Base, North Dakota

Confirmed Lead-Based Paint Containing Materials			
Location	**Color**	**Substrate**	**Area (square feet)**
First floor locker room, lower half	White	Smooth CMU	360
Laundry room ceiling	White	Concrete	280
Handrail, center stairwell	Brown	Metal	16

APPENDIX H

LBP TESTING DATA SHEETS

Building 276 - First Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Dorm Room	111	North	White	Drywall	Orange Peel	Negative	
Dorm Room	111	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	111		White	Metal		Negative	Radiator
Dorm Room	111		White	Wood		Negative	Window
Dorm Room	111		Brown	Metal		Negative	Restroom door
Dorm Room	117	West	White	Drywall	Orange Peel	Negative	
Dorm Room	117	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	117		White	Metal		Negative	West wing
Dorm Room	117		White	Wood		Negative	Window
Dorm Room	117		Brown	Metal		Negative	Restroom door
Hallway - West	117	North	White	Laminate		Negative	
Hallway - West	117	North	White	Drywall	Orange Peel	Negative	
Hallway - West	117	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	117	North	Brown	Metal		Negative	
Hallway - East	103	North	White	Laminate	Orange Peel	Negative	East wing
Hallway - East	103	North	White	Drywall	Orange Peel	Negative	
Hallway - East	103	North	Brown	Metal		Negative	Door frame
Hallway - East		Ceiling	White	Drywall	Orange Peel	Negative	
Utility Closet		South	White	CMU		Negative	East wing
Utility Closet		Ceiling	White	concrete	Orange Peel	Negative	
Utility Closet		South	White	CMU		Negative	West wing
Utility Closet		Ceiling	White	concrete		Negative	
Locker Room		West	White	CMU		Positive	Lower section of wall
Locker Room		West	White	CMU		Negative	Upper wall rough texture cmu
Locker Room		Ceiling	White	concrete		Negative	
Locker Room		North	White	Drywall	Orange Peel	Negative	West wing
Locker Room			White	Metal		Negative	West wing
Locker Room			Brown	Wood		Negative	Window

Building 276 - First Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Lounge		South	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Concrete	Popcorn	Negative	
Lounge			White	Metal		Negative	Radiator
Lounge		North	White	Wood		Negative	Window
Storage		Ceiling	White	concrete	Popcorn	Negative	
Storage			White	Wood		Negative	North room next to lounge
Lounge		West	White	Drywall	Orange Peel	Negative	Restroom
Lounge		Ceiling	White	Drywall		Negative	Restroom
Mechanical			Blue	Metal		Negative	Exterior entry mechanical
Mechanical			Brown	Metal		Negative	Exterior entry mechanical room
Kitchen		East	White	Laminate		Negative	
Kitchen		West	White	Drywall	Orange Peel	Negative	
Kitchen		Ceiling	White	Drywall	Orange Peel	Negative	
Kitchen			White	Wood		Negative	window
Kitchen			White	Metal		Negative	Radiator
Laundry		East	White	CMU		Negative	
Laundry		East	White	Drywall		Negative	
Laundry		Ceiling	White	concrete		Positive	
Laundry			Brown	Metal		Negative	Door
Foyer		East	White	CMU		Negative	
Foyer		North	White	Drywall	Orange Peel	Negative	
Foyer		West	White	Drywall	Orange Peel	Negative	
Foyer		Ceiling	White	Drywall		Negative	
Foyer		Ceiling	White	concrete		Negative	
Storage - Foyer		West	Blue	Drywall		Negative	Storage closet
Entry		West	White	Drywall	Orange Peel	Negative	

Building 276 -Second Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Stair - West		East	White	CMU		Negative	
Stair - West			White	Metal		Negative	Stair supports
Stair - West			Black	Metal		Negative	Handrail
Stair - West			Brown	Metal		Negative	Door
Stair - West			Brown	Wood		Negative	Window
Stair - East		North	White	CMU		Negative	
Stair - East			White	Metal		Negative	Stair supports
Stair - East			Brown	Metal		Negative	Door
Stair - East			Brown	Wood		Negative	Window
Dorm Room	205	West	White	Drywall	Orange Peel	Negative	
Dorm Room	205	Ceiling	White	Drywall	Orange Peel	Negative	East wing
Dorm Room	205		White	Metal		Negative	Radiator
Dorm Room	205		White	Wood		Negative	Window
Dorm Room	205		Brown	Metal		Negative	Restroom door
Dorm Room	325	West	White	Drywall	Orange Peel	Negative	East wing
Dorm Room	223	North	White	Drywall	Orange Peel	Negative	
Dorm Room	223	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	223	North	White	Wood	Orange Peel	Negative	
Dorm Room	223	North	White	Wood		Negative	Window
Dorm Room	223	North	White	Metal		Negative	Radiator
Dorm Room	223		Brown	Metal		Negative	Restroom door
Hallway - West	219	North	White	Drywall	Orange Peel	Negative	
Hallway - West	219	North	White	Laminate		Negative	
Hallway - West	219	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	219	North	Brown	Metal		Negative	Doorframe
Hallway - East	207	North	White	Drywall	Orange Peel	Negative	
Hallway - East	207	North	White	Laminate		Negative	
Hallway - East		Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - East	207	North	Brown	Metal		Negative	Doorframe

Building 276 -Second Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Utility Closet		South	White	CMU		Negative	Visible green paint
Utility Closet		Ceiling	White	concrete		Negative	
Utility Closet		West	White	CMU		Negative	West wing
Utility Closet		Ceiling	White	concrete		Negative	
Locker Room		East	White	CMU		Negative	East wing
Locker Room		East	White	CMU	Orange Peel	Negative	East wing
Locker Room			White	Metal		Negative	Radiator
Locker Room			Brown	Wood		Negative	Window
Locker Room		Ceiling	White	concrete		Negative	
Lounge		East	White	Drywall	Orange Peel	Negative	Western
Lounge			White	Metal	Orange Peel	Negative	Radiator
Lounge			White	Wood		Negative	Window
Lounge		Ceiling	White	Drywall		Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Dorm Room	309	North	White	Drywall	Orange Peel	Negative	
Dorm Room	309	North	White	Drywall	Orange Peel	Negative	
Dorm Room	309	Ceiling	White	Wood		Negative	Vent
Dorm Room	309	North	Brown	Wood		Negative	Window
Dorm Room	309		Brown	Metal		Negative	Rest Room
Dorm Room	309	North	Brown	Wood		Negative	Window
Dorm Room	320	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	320	South	Brown	Wood		Negative	Window
Dorm Room	320	South	White	Metal		Negative	Radiator
Dorm Room	320		Brown	Metal		Negative	Rest Room Door
Dorm Room	320	West	White	Drywall	Orange Peel	Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Hallway - West	325	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	325	North	Brown	Metal		Negative	Doorframe
Hallway - West			White	Piping insulation		Negative	Vent insulation
Hallway - East	325	South	White	Drywall	Orange Peel	Negative	
Hallway - East	325	South	White	Drywall	Orange Peel	Negative	
Hallway - East	305	North	White	Drywall	Orange Peel	Negative	
Hallway - East	305	North	White	Drywall	Orange Peel	Negative	
Hallway - East	305	South	White	Laminate		Negative	
Utility Closet		South	White	Drywall		Negative	East Ceiling
Utility Closet		South	Brown	Metal		Negative	Hallway - East Door Frame
Utility Closet		South	White	CMU		Negative	Hallway - East
Utility Closet		South	White	CMU		Negative	Hallway - East
Utility Closet		South	White	CMU		Negative	Hallway - West
Utility Closet		Ceiling	White	Drywall		Negative	West Hallway
Locker Room		West	White	CMU		Negative	West hallway
Locker Room				Metal		Negative	Silver on cages
Locker Room			White	Metal		Negative	Radiator
Locker Room		South	White	CMU		Negative	East wing
Locker Room		South	Brown	Wood		Negative	Window
Locker Room		West	White	Drywall	Orange Peel	Negative	East wing
Locker Room		Ceiling	White	concrete		Negative	
Locker Room			White	Metal		Negative	Radiator
Locker Room		Ceiling	White	concrete		Negative	East Wing
Lounge			White	Metal	Orange Peel	Negative	Radiator
Lounge		South	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Drywall		Negative	
Lounge		North	White	Wood		Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Mechanical		West	White	CMU		Negative	
Mechanical			White	Piping insulation		Negative	Yellow on straight pipe insulation
Mechanical		Ceiling	White	concrete		Negative	
Mechanical				Metal		Negative	Gray paint on door frame
stair - Center		East	White	concrete	Orange Peel	Negative	
stair - Center		Ceiling	White	concrete		Negative	
stair - Center			Brown	Metal		Negative	Emergency ladder
stair - Center			Brown	Metal		Negative	Railing
stair - Center			Brown	Metal		Positive	Green paint visable
stair - Center			Brown	Metal		Negative	Door
Stair - East	311	Ceiling	White	Drywall	Orange Peel	Negative	

APPENDIX I

LICENSES AND CERTIFICATIONS

NORTH DAKOTA
DEPARTMENT *of* HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov

July 22, 2015

Terracon Consultants, Inc.
2281 S. Plaza Drive, Unit 16
Rapid City, SD 57702

Ladies and Gentlemen:

Enclosed you will find an asbestos certification card issued by the North Dakota Department of Health for Terri Fields.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of one year from the date of completion of the last training course. Individuals who intend to continue performing asbestos work must be recertified prior to that time. To be recertified, an individual must have attended an EPA approved refresher course in the specific discipline for which they are applying for recertification within the previous 12-month period.

If you have any questions concerning the certification or certification process, please feel free to contact me at (701)328-5188.

Sincerely,

Sandi Washek
For Justin L. Otto
Environmental Scientist
Asbestos Control Program

JLO:csc
Enc:

North Dakota Department of Health
Certificate
of No. 5781
Asbestos Abatement

This is to certify that Terri Lynn Fields has met the requirements of Chapter 33-15-13 of the North Dakota Air Pollution Control Rules for certification in the following asbestos abatement discipline(s):

- Supervisor
- Worker
- x Inspector Exp: 3/6/2016
- Management Planner
- Project Designer
- Project Monitor

Sandi Washek
Asbestos Control Program

March 13, 2015

Terracon Consultants, Inc.
6701 – 4th St SW
Minot, ND 58701

Ladies and Gentlemen:

Enclosed you will find an asbestos certification card issued by the North Dakota Department of Health for Stephen Maliszeski.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of one year from the date of completion of the last training course. Individuals who intend to continue performing asbestos work must be recertified prior to that time. To be recertified, an individual must have attended an EPA approved refresher course in the specific discipline for which they are applying for recertification within the previous 12-month period.

If you have any questions concerning the certification or certification process, please feel free to contact me at (701)328-5188.

Sincerely,

Justin L. Otto
Environmental Scientist
Asbestos Control Program

JLO:csc
Enc:

North Dakota Department of Health
Certificate
of **No. 5680**
Asbestos Abatement

This is to certify that Steve T. Maliszeski has met the requirements of Chapter 33-15-13 of the North Dakota Air Pollution Control Rules for certification in the following asbestos abatement discipline(s):

Supervisor
Worker
x Inspector
Management Planner
Project Designer
Project Monitor

Exp: 3/28/2016

Asbestos Control Program

February 17, 2015

Terracon
6701 Fourth St SW
Minot, ND 58701

Ladies and Gentlemen:

Enclosed you will find a lead-based paint certification card issued by the North Dakota Department of Health for Stephen Maliszeski.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of three years from the date of completion of the last training course. Individuals who intend to continue performing lead-based paint work must be recertified prior to that time. To be recertified, an individual must have attended an EPA or State approved refresher course in the specific discipline for which they are applying for recertification within the previous three year period.

If you have any questions concerning the certification, please feel free to contact me at 701-328-5188.

Sincerely,

Sandi Washek
Environmental Scientist
Lead-Based Paint Program

SW:csc
Enc:

North Dakota Department of Health
Certificate
of
Lead-Based Paint Abatement

GREAT SEAL STATE OF NORTH DAKOTA

No. 315

This is to certify that Stephen T. Maliszeski has met the requirements of Chapter 33-15-24 of the North Dakota Air Pollution Control Rules for certification in the following lead-based paint abatement discipline(s):

Supervisor
Worker
Inspector
x Risk Assessor
Project Designer

Exp: 1/23/2018

LBP Control Program

Project Manual for the Environmental Remediation of

Renovate Dormitory – Building 276

Minot Air Force Base

Minot, North Dakota

December 18, 2015

Terracon Project No. M6157011

Prepared for:

Leidos Engineering, LLC.
11951 Freedom Drive
Reston, Virginia 20190

Prepared by:

Terracon Consultants, Inc.
Minot, North Dakota

This Project Manual was prepared by Mike Willey of Terracon Consultants, Inc., 13400 15th Avenue North, Minneapolis, Minnesota. I am an accredited Asbestos and Lead Project Designer in the State of North Dakota, Certificate Number 322.

Signed: ______________________________ Date: December 18, 2015

Mike J. Willey
Asbestos and Lead Project Designer NDDH No. 2435 and 322

North Dakota Department of Health
Certificate
of
No. 2435
Asbestos Abatement

This is to certify that Mike James Willey has met the requirements of Chapter 33-15-13 of the North Dakota Air Pollution Control Rules for certification in the following asbestos abatement discipline(s):

- X Supervisor Exp: 5/20/2016
- Worker
- X Inspector Exp: 10/12/2016
- Management Planner
- X Project Designer Exp: 11/3/2016
- Project Monitor

Asbestos Control Program

North Dakota Department of Health
Certificate
of
Lead-Based Paint Abatement

No. 322

This is to certify that Mike J. Willey has met the requirements of Chapter 33-15-24 of the North Dakota Air Pollution Control Rules for certification in the following lead-based paint abatement discipline(s):

- Supervisor
- Worker
- Inspector
- X Risk Assessor Exp: 6/9/2018
- X Project Designer Exp: 10/20/2018

LBP Control Program

END OF SECTION 00 01 05

00 01 10 TABLE OF CONTENTS

DIVISION 0 – BIDDING AND CONTRACT REQUIREMENTS

DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 2 – SITE WORK

APPENDICES

Appendix B – Inspection Reports:

"*Asbestos and Mold Surveys and Lead-Based Paint Screening, Renovate Dormitory Building 276 Minot Air Force Base, North Dakota*," prepared for Leidos Engineering, LLC., by Terracon Consultants, Inc. under project number M6157011, dated December 17, 2015.

DIVISION 0

BIDDING AND CONTRACT REQUIREMENTS

1.0 DEFINITIONS

Bidding documents includes the Bid Form and Contracting Forms and Supplements. The Bidding requirements include the Instructions to Bidders and other sample bidding and contract forms.

2.0 PROJECT DESCRIPTION

Terracon Consultants, Inc. (Terracon) was retained by Leidos Engineering, LLC. (Leidos) to prepare a Project Manual for the Dormitory Building 276 (the Building) located at the Air Force Base in Minot, North Dakota (the Property). Figure #1 in Appendix A is a Property location map. Figure #2 in Appendix A is a Property aerial lay-out plan showing the location of the Building on the Property.

The Building on the Property will be substantially renovated.

The Building is described as follows:

- **Dormitory Building 276** – The dormitory is a three-story structure approximately 30,000 square feet constructed in 1960. The building contains approximately 80 dorm rooms including mechanical, lounge, locker and laundry rooms, three staircases, a crawlspace and attic. The building has an exterior brick façade on a concrete masonry unit structure, aluminum clad windows with an original flat roof recently covered with a pitched shingled roofing system. Interior finishes include carpeting with various mastics floor tile, ceiling tile, ceramic tile, sheetrock walls and ceiling systems with various texturing, and four inch interior masonry walls.

The Project Manual is based on the findings in the Inspection Reports in **Appendix B** and referenced in **Section 00 31 26**, which collectively are referred to as the Survey Reports in the Project Manual. The Survey Reports were the basis for the development of the scope of work and means of material quantification for the Building on the Property.

As a part of this contract the Abatement Contractor shall be responsible for the complete removal and proper disposal and management of:

- The removal and proper disposal of <u>all</u> Friable, Category I and II Non-Friable Asbestos-Containing Materials (**ACM**) as identified in the Project Manual and Inspection Reports.

- Abatement and/or Interim Controls of identified lead hazards, as identified in the Project Manual.

Collectively the project work is referred to as the “Work” in the Project Manual.

3.0 BIDDING PROCEDURE

3.1 Bids will be received at the Terracon office 6701 4th Street Southwest Minot, ND 58701 until **2:00 p.m. TBD** at which time they will be privately opened.

3.2 Refer to Section 01 11 00 Summary of Work.

3.3 Refer to Section 00 41 46 Bid Form for summary of work being bid at this time.

3.4 Bids must be submitted on the appropriate Bid Form included in Section 00 41 46. Fax your Bid Forms to the attention of Mike Willey at (763) 489-3101 or e-mail to mike.willey@terracon.com.

Copies of the Bid Forms shall **also** be mailed to Leidos Engineering, LLC. 11951 Freedom Drive Reston, Virginia 20190 attention Mr. Ronald Brumfield and emailed to ronald.c.brumfield@leidos.com

3.5 Do not call for bidding results until at least 10 days after the bid due date. Prior to that time you may be contacted for clarifications or additional information.

3.6 **All bids shall be in effect for a minimum of 6 months.**

4.0 EXAMINATION AND PROCUREMENT OF DOCUMENTS

4.1 The bidder is responsible to obtain all documents related to their scope of work. No adjustments will be made to bids, or subcontract amounts, due to bidder obtaining partial sets of documents.

4.2 Contact Terracon for Addenda information.

5.0 EXAMINATION OF DOCUMENTS, SITE, AND LOCAL CONDITIONS

By submitting a bid, the bidder represents that they have examined and understand the Bid Documents, that they have familiarized themselves with the site and local conditions under which the Work is to be performed, that they have considered federal, state, and local laws and regulations that may affect cost, progress, performance, or furnishing of the Work, and that their bid is made in compliance therewith.

6.0 INTERPRETATIONS DURING BIDDING

During the Bidding Period the following Terracon employee may be contacted to answer questions pertaining to the Scope of Work.

Mike Willey, Senior Project Manager, (763) 489-3126

7.0 PRE-BID CONFERENCE

A mandatory pre-bid conference will be held at the Property **TBD at 1 pm**.

8.0 MODIFICATION OR WITHDRAWAL OF BIDS

Bids may not be withdrawn during the 6 month period immediately following the date of receipt of bids.

9.0 CONSIDERATION OF BIDS AND AWARD OF SUBCONTRACT

9.1 Leidos reserves the right to waive irregularities and to reject any or all bids at their discretion.

9.2 Leidos reserves the right to reject bids based upon past performance on Leidos projects.

9.3 Upon request, Bidder shall submit evidence, such as financial data, previous experience, present commitments, and other such data as may be requested to demonstrate qualifications of Bidder and/or their subcontractor to perform the Work.

9.4 Bidder shall submit technical data, drawings or diagrams, names of manufacturers, suppliers, or subcontractors, and other such data necessary for the evaluation of bidder's proposal.

9.5 Subcontracts will be awarded to those bidders whose proposals are deemed by Leidos to be most advantageous, based on an evaluation of bidder qualifications, bid price, proposed systems, materials, and equipment, schedule, and other factors relevant to the performance of the Work.

9.6 Subcontract Agreements will be written to reference all requirements of the Bid Documents. By submitting a bid, the Bidder represents that the bid is based upon the materials, equipment, and systems required by the Bid Documents. While the proposal is the basis for evaluation of bids, it will not limit Bidder's responsibility to satisfy all requirements of the Bid Documents.

9.7 Leidos reserves the right to reject bids if the bidder is unable to qualify as a registered subcontractor in accordance with Leidos registration requirements.

END OF SECTION 00 21 13

The following documents are provided for the information of the Abatement Contractor.

The Abatement Contractor is responsible for verification of estimated quantities contained in the Inspection Reports. Estimated quantities of ACM are for informational purposes only. The Abatement Contractor shall satisfy their interests regarding efforts required to remove and dispose of the actual quantities requiring abatement/disposal for those materials identified, assumed or concealed.

Inspection Reports:

"*Asbestos and Mold Surveys and Lead-Based Paint Screening, Renovate Dormitory Building 276 Minot Air Force Base, North Dakota*," prepared for Leidos Engineering, LLC., by Terracon Consultants, Inc. under project number M6157011, dated December 17, 2015.

END OF SECTION 00 31 26

Terracon

BID FORM

BID FORM SUBMITTED BY ____
Legal name of person, firm or corporation

To whom it may concern:

1. The undersigned, having carefully examined the Bidding Documents prepared by Terracon Consultants, Inc. (Terracon) for the Work in conjunction with the:

   Project Title: **Project Manual for the Environmental Remediation of**

   Site: **Renovate Dormitory – Building 276**
   Minot Air Force Base
   Minot, ND

   and having examined the site and being familiar with the local conditions affecting the cost of the Work, hereby proposes to furnish all labor, material, equipment, tools, transportation, disposal and services necessary to complete the Work in accordance with said Contract Documents for the following sums:

Bid Item	Asbestos Abatement	# of Units	Units	Cost/Unit	Total Cost
	Crawlspace, Level One-Three				
1	Off-White Piping Insulation, Mudded Joints and Fittings	1,380	Each	$	$
2	White Duct Wrapping on Air Handling Equipment	384	Sqft	$	$
3	Fire Doors	183	Each	$	$
	Roofing				
4	Roofing Penetrations	12	Each	$	$
	Selective Demolition				
5	Selective demolition required to Access ACM throughout the Building	1	Lump sum	--	$

Bid Item	Lead-Based Paint	# of Units	Units	Cost/Unit	Total Cost
	Level One – East Locker Room				
6	Paint Stabilization and Encapsulation	360	Sqft	$	$
	Level One – Laundry Room				
7	Paint Stabilization and Encapsulation	280	Sqft	$	$
	Level One – Three - Central Staircase				
8	Component Removal of the Guard Railing and Hand Railing Systems.	1	Lump sum	$	$

TOTAL BASE BID (ITEMS 1-8)	$

TOTAL BASE BID

____

____Dollars ($______________)

ALTERNATE COSTS - LEAD-BASED PAINT ABATEMENT					
Bid Item	**Lead-Based Paint**	**# of Units**	**Units**	**Cost/Unit**	**Total Cost**
Alt #1	Level One – East Locker Room – Chemical Removal of all LBP associated with the walls.	360	Sqft	$	$
Alt #2	Level One – Laundry Room – Chemical Removal of all LBP associated with the ceiling.	280	Sqft	$	$
Alt #3	Level Three - Component Removal of the Attic Ladder and Hatch.	1	Lump sum	$	$

ALTERNATE COSTS - ASBESTOS ABATEMENT					
Bid Item	**Asbestos Abatement**	**# of Units**	**Units**	**Cost/Unit**	**Total Cost**
Alt #4	Vent Insulation – Around air ducts above hallways with laterals to each room including demolition.	8,000	Sqft	$	$
Alt #5	2 and 4 Inch Water Piping Insulation – within the crawlspace and laterals into restrooms and associated pipe chases through levels 1-3, including demolition to assess the materials.	5,520	Lnft	$	$

TOTAL ALTERNATE COSTS (ITEMS Alt 1-Alt 5)	$

SCHEDULE			
Items	**# of 8/Hour Shifts**	**# of Workers/Shift**	**Total Hours**
Base Bid Items 1-8			
Alternate Bid Items 1-3			

SCHEDULE			
Items	**# of 8/Hour Shifts**	**# of Workers/Shift**	**Total Hours**
Alternate Bid Item 4			
Alternate Bid Item 5			

UNIT COSTS			
Materials	**# of Units**	**Units**	**Cost/Unit**
Thermal System Insulation on Air Handling Equipment	1	Sqft	$
Vent Ducting	1	Lnft	$
Thermal System Insulation on 2-4 Inch Piping (includes fittings on ACM piping)	1	Lnft	$
Thermal System Insulation on Fittings on non-ACM piping	1	Each	$
Surfacing Materials on Plaster, Sheetrock and other similar surfaces	1	Sqft	$
Sheet Flooring and adhesive	1	Sqft	$
Fire Door	1	Each	$
Floor Tile and Mastic	1	Sqft	$
Ceramic Flooring (tile, grout and bedding)	1	Sqft	$
Mirror Adhesive	1	Sqft	$
Caulking	1	Lnft	$
Flange Gaskets	1	Each	$
Stair Tread Adhesive	1	Sqft	$
Baseboard Adhesive	1	Sqft	$
Chemical Removal of LBP	1	Sqft	$
Roofing	1	Sqft	$
Supervisor	1	Hour	$
Worker	1	Hour	$

1. As part of their Bid, Bidder shall complete unit price costs for the units provided to determine the costs associated with each floor at the project site. These line item costs will be the schedule of values for payment under this contract. Unit prices shall determine the value of extra work or changes in the Work, as applicable. They shall be considered complete and shall include all material and

equipment, labor, installation costs, disposal, overhead and profit. Unit prices shall be used uniformly for additions or deductions.

2. The undersigned agrees, if awarded the Contract, to substantially complete the Work of the Contract, subject to the time provisions of the Contracting Forms and Supplements.

3. The undersigned agrees, if awarded the Contract, to execute and deliver to the Owner, within fifteen (15) calendar days after receipt of written notification of said award, an Agreement, in the form specified.

4. The undersigned agrees that this Bid may not be withdrawn for a period of six (6) months immediately following the date of receipt of bids.

5. In submitting this Bid, it is understood that the Owner reserves the right to reject any or all bids, to accept any alternate(s) in any order or combination, and to waive any informality or minor irregularity in any bid received, and/or to rebid for new bids where rejection, waiving or rebidding is deemed by the Owner to be in its best interest.

6. In submitting this Bid, the Bidder understands and agrees that if awarded the Contract, the contractor and all subcontractors shall pay all laborers and mechanics employed in connection with the contract not less than the wages, as specifically noted in the Contract Document.

7. By submitting this proposal, the Bidder certifies that his/her firm is not prohibited from doing business with either the Federal or State of North Dakota Governments as a result of debarment or suspension proceedings.

8. Addenda No(s). ______, ______, ______, ______, ______, have been received and incorporated in this bid.

The undersigned operates as a:

______________________ Sole Owner ______________________ Partnership

______________________ Corporation, Incorporated in the State of ______________________

Other (Specify) ____

LEGAL NAME OF PERSON, FIRM OR CORPORATION

Name ____

Address ____

____

Telephone (______)_______-________________ Fax (______)_________-__________________

Email Address ____

By ______________________________________ Title _________________________________

By ______________________________________ Title _________________________________

1.0 CONTRACT FORMS

1.1 References to the following Contract Forms are included:

A101–2007, Standard Form of Agreement between Owner and Contractor where the basis of payment is a Stipulated Sum

A201–2007, General Conditions of the Contract for Construction

1.2 Bidder agrees that the Work shall be done and performed in a good and workmanlike manner, which all materials and labor shall be in strict conformity in every respect with the Contract Documents and shall be subject to inspection and approval of Leidos Engineering, LLC. or their authorized representative.

2.0 MISCELLANEOUS PROVISIONS

2.1 “REQUIRED RECORDS: The Contractor shall maintain books, records, documents and other evidence pertaining to all costs and expenses incurred and revenues received under this Contract in sufficient detail to reflect all costs, direct and indirect, or labor, materials, equipment, supplies, services and other costs and expenses of whatever nature, for which payment is claimed under this Contract.”

2.2 “RECORD RETENTION REQUIREMENTS: The Contractor shall maintain records for a period of five (5) years per contract beyond the dates upon which the final payments are made and all other pending matters are closed. Records shall be retained beyond the prescribed period if any litigation or audit is begun or if a claim is instituted. In these instances, the records shall be retained until the litigation, audit or claim has been finally resolved or until the end of the regular period, whichever is later.”

END OF SECTION 00 50 00

Terracon

DIVISION 1

GENERAL REQUIREMENTS

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the Contract Forms and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 PROJECT/WORK IDENTIFICATION

1.1 General: Project name is Environmental Remediation of the Renovate Dormitory Building 276 (the Building) located at the Minot Air Force Base in Minot, North Dakota (the Property) as described in this Project Manual prepared by Owner's Representative, Terracon Consultants, Inc. (Terracon).

1.2 Abbreviated Written Summary: Briefly and without force and effect upon the Contract Documents, the Work of the Contract can be summarized as follows:

1.2.1 Attendance at the pre-construction meeting.

1.2.2 Work area preparation including containment areas, abatement, disposal, decontamination facilities, disposal routes, and security.

1.2.3 The Base Bid Work includes:

1.2.3.1 **Base Bid Item 1**: The complete removal and disposal of the following identified asbestos containing materials (ACMs) within the Utility Tunnel, Level 1, 2 and 3:

- White Mudded Joints and Fittings – estimated 1,380 each

  The White Mudded Joint and Fittings shall be removed in accordance with **Sections 02 82 13, 02 82 14, 02 82 17 and/or 02-82-20**. Additionally, all debris within the utility tunnel shall also be considered friable ACM and removed utilizing High Efficiency Particulate Air (HEPA) vacuums and then properly disposed. Refer to **Exhibit 3: PD100 Foundation - Demolition Plan**, for area location information. Piping passing through sidewalls are to be abated flush with the wall and then permanently sealed air and water tight then labeled. An additional mobilization shall be included in the base bid to account for returning to the site to safely access ACM which was initially inaccessible. All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.3.3 **Base Bid Items 2**: The complete removal and disposal of the following identified asbestos containing materials (**ACMs**) within Level One, Two and Three:

- White Duct Wrapping on Air Handling Equipment – estimated 384 sqft

  The Air Handling Insulation shall be removed in accordance with

Sections 02 82 13, 02 82 14 and/or 02 82 20. Exceptions include; the existing Boiler Room ducting is to remain intact while the insulation is fully removed in accordance with **Sections 02 82 13 and 02 82 14**. Additionally, the Contractor will be responsible for all selective demolition as required to access ACM within wall/ceiling systems (sheetrock and/or masonry). All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.3.4 **Base Bid Items 3**: The complete removal and disposal of the following identified asbestos containing materials (**ACMs**) within Level One, Two and Three:

- Fire Doors – estimated 183 each

The Fire Doors shall be removed in accordance with **Sections 02 82 13 and 02 82 20**. Additionally, the Contractor will be responsible for all selective demolition as required to access ACM within wall/ceiling systems (sheetrock and/or masonry). All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.3.5 **Base Bid Items 4**: The complete removal and disposal of the following identified asbestos containing materials (**ACMs**) within the Attic and Roof:

- Roofing Penetrations – estimated 12 each

The Roofing Penetration shall be removed in accordance with **Sections 02 82 13 and 02 82 18 and/or 20 82 19**. The Contractor will be responsible for removal of assumed roofing materials to facilitate the installation of new exhaust vent penetrations within the attic and roof penetration. All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.3.6 **Base Bid Items 5**: The Contractor is responsible for all Selective Demolition to access previously inaccessible spaces impacted by the renovation project, for discovery and/or removal of ACM that will be required including all costs associated with selective demolition, which shall be included in the base bid work. Refer to **Exhibits 4-6** in **Appendix A** for floor demolition plans. Where demolition is required the Contractor shall fully remove the wall/ceiling system to the extent necessary to abate the ACM and void of collapse or falling hazards. The Abatement Contractor shall place clean demolition debris (free of asbestos) within localized areas/rooms which do not restrict egress or exiting the building.

1.2.3.7 **Base Bid Items 6**: The complete stabilization and encapsulation of the following identified Lead-Based Paint (**LBP**) coating within Level One – East Locker Room:

- LBP coasting on Walls – estimated 360 sqft

The Contractor shall conduct paint film stabilization and encapsulation with an approved manufacturer specific lead coating conducting in accordance with **Sections 02 82 01, Section 02 82 16 Part 1.2 and Section 02 82 20 Part 1.2**.

1.2.3.8 **Base Bid Items 7**: The complete stabilization and encapsulation of the following identified Lead-Based Paint (**LBP**) coating within Level One – Laundry Room:

- LBP coasting on ceiling – estimated 280 sqft

  The contractor shall conduct paint film stabilization and encapsulation with an approved manufacturer specific lead coating conducting in accordance with **Sections 02 82 01, Section 02 82 16 Part 1.2 and Section 02 82 20 Part 1.2**.

1.2.3.9 **Base Bid Items 8**: The complete component removal of the following identified Lead-Based Paint (**LBP**) coating items within Level One, Two and Three – Central Staircase:

- LBP coating on Guard Railing and Hand Railing Systems – estimated 16 sqft

  The contractor shall conduct component removal in accordance with **Sections 02 82 01 and Section 02 82 20 Part 1.1**.

1.2.4 The Alternate Work includes:

1.2.4.1 **Alternate Item 1**: The complete removal of Lead-Based Paint (**LBP**) coats within Level One – East Locker Room:

- LBP coating on Walls – estimated 360 sqft

  The Contractor shall conduct paint film removal utilizing chemical stripper in accordance with **Sections 02 82 01 and Section 02 82 20 Part 1.4**.

1.2.4.2 **Alternate Item 2**: The complete removal of all Lead-Based Paint (**LBP**) coats within Level One – Laundry Room:

- LBP coating on Ceilings – estimated 280 sqft

  The Contractor shall conduct paint film removal utilizing chemical stripper in accordance with **Sections 02 82 01 and Section 02 82 20 Part 1.4**.

1.2.4.3 **Alternate Item 3**: **Base Bid Items 9**: The complete component removal of the following identified Lead-Based Paint (**LBP**) coated items within Level Three – Central Staircase:

- LBP coating on ladder and hatch – estimated 16 sqft

  The contractor shall conduct component removal in accordance with **Sections 02 82 01 and Section 02 82 20 Part 1.1**.

1.2.4.4 **Alternate Item 4**: The complete removal and disposal of the following assumed asbestos containing materials (ACMs) within the Utility Tunnel, Level 1, 2 and 3:

- Vent Insulation – estimated 8,000 sqft

  The Vent Insulation shall be removed in accordance with **Sections 02 82 13, 02 82 14, 02 82 17 and/or 02-82-20**. Additionally, all debris within the areas housing the vents shall also be considered friable ACM and removed utilizing High Efficiency Particulate Air (HEPA) vacuums and then properly disposed. These vents are assumed to be insulated and located primarily within existing ceiling systems in the main hallways with lateral ducts entering each room. All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.4.5 **Alternate Item 5**: The complete removal and disposal of the following identified asbestos containing materials (ACMs) within the Utility Tunnel, Level 1, 2 and 3:

- 2 and 4 Inch Water Piping Insulation – estimated 5,520 lnft

  The 2 and 4 Inch Water Piping Insulation shall be removed in accordance with **Sections 02 82 13, 02 82 14, 02 82 17 and/or 02-82-20**. The 2 and 4 Inch Water Piping Insulation has been assumed to be present within the crawlspace with lateral line entering restrooms and associated pipe chases through levels 1-3. This work includes selective demolition to assess the ACM. Additionally, all debris within the utility tunnel shall also be considered friable ACM and removed utilizing High Efficiency Particulate Air (HEPA) vacuums and then properly disposed. Refer to **Exhibit 3: PD100 Foundation - Demolition Plan**, for area location information. Piping passing through sidewalls are to be abated flush with the wall and then permanently sealed air and water tight then labeled. An additional mobilization shall be included in the base bid to account for returning to the site to safely access ACM which was initially inaccessible. All ACM waste shall be disposed of in accordance with **Section 02 82 33**.

1.2.5 Provide all labor, material, equipment, employee training and compliance with all Regulations, permits, notifications, licenses, and agreements necessary to perform the abatement work as described in this Project Manual.

1.2.6 Pack, label, transport, and dispose of all contaminated material in accordance with the project Manual.

1.2.7 Provide appropriate respiratory protection equipment, clothing, and personal protection training to all visitors authorized by the Owner or Consultant

1.2.9 The Contractor shall achieve clearance in accordance with **Sections 01 45 29 and/or 01 45 30.**

1.2.8 Final clean-up and removal of all remaining temporary barriers, equipment, and supplies.

1.3 Upon Notice to Proceed, Contractor will immediately file all applicable notices of intent to perform asbestos abatement work with all appropriate regulatory agencies.

1.4 Contractor may begin preparation of work areas as soon as he sees fit after necessary waiting period set forth by notification requirements.

1.5 Upon completion of the abatement process, owners representative personnel will perform a visual inspection of the removal area. Successful completion of this inspection will result in release of the area for lock-down encapsulation. At no time shall the Contractor begin encapsulation procedures without written authorization from owner's representative.

1.5.1 Upon completion of the final inspection process, PCM final air clearance testing will be performed by the owner's representative in the work area.

1.6 It shall be the Contractor's responsibility to verify quantities and anticipated quantities of inaccessible materials during the pre-bid period.

1.7 Normal working hours will be Monday through Friday from 7:00 a.m. to 5:00 p.m. Any variance from this schedule must be approved by the Owner.

1.8 All materials found to be contaminated with asbestos shall be disposed of in a manner which will ensure materials remain adequately wet and container integrity is maintained.

2.0 ANTICIPATED SCHEDULE

Mandatory Bid Walkthrough	TBD at 1 pm
Receive Bids	TBD at 2 pm
Begin Site Work	TBD
Final Completion	The Abatement Contractor will be provided a maximum of twenty (20) working days for completion of the Work.

3.0 POTENTIAL ASBESTOS HAZARD

3.1 The disturbance or dislocation of asbestos may cause asbestos fibers to be released into the building's atmosphere, thereby creating a potential health hazard to workers and building occupants. Apprise all workers, supervisory personnel, subcontractors and consultants who will be at the job site of the seriousness of the hazard and of proper work procedures which must be followed.

3.2 Where in the performance of the work, workers, supervisory personnel, subcontractors, or consultants may encounter, disturb, or otherwise function in the immediate vicinity of any identified asbestos-containing materials, take appropriate continuous measures as necessary to protect all building occupants from the potential hazard of exposure to airborne asbestos. Such measures shall include the procedures and methods described herein, and compliance with regulations of applicable federal, state and local agencies.

4.0 POTENTIAL LEAD HAZARD

4.1 The disturbance or dislocation of coated surfaces may cause lead particulate to be released into the building, thereby creating a potential health hazard to workers and building occupants. Apprise all workers, supervisory personnel, subcontractors and consultants who will be at the job site of the seriousness of the hazard and of proper work procedures which must be followed.

4.2 Where in the performance of the work, workers, supervisory personnel, subcontractors, or consultants may encounter, disturb, or otherwise function in the immediate vicinity of any identified coated surfaces, take appropriate continuous measures as necessary to protect all building occupants from the potential hazard of exposure to lead. Such measures shall include the procedures and methods described herein, and compliance with regulations of applicable federal, state and local agencies.

5.0 STOP WORK

5.1 If the Owner, the Owner's Representative, or the Project Manager presents a written stop work order, immediately and automatically stop all work. Do not recommence work until authorized in writing by Owner's Representative or Project Manager.

6.0 CONTRACTOR USE OF PREMISES

6.1 <u>General</u>: The Contractor shall limit his use of the premises to the work indicated, so as to allow for Owner occupancy.

6.2 <u>Use of the Site</u>: Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed.

6.2.1 Keep existing driveways and entrances serving the premises clear and available to the Owner and his employees at all times. Do not use these areas for parking or storage of materials.

6.2.2 Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials. If additional storage is necessary obtain and pay for such storage off site.

6.2.3 Lock automotive type vehicles, such as passenger cars and trucks and other mechanized or motorized construction equipment, when parked and unattended, so as to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place or accessible to unauthorized persons.

6.3 Contractor's Use of the Existing Building: Maintain existing building in a safe and weather tight condition throughout the construction period. Take all precautions necessary to protect the building and its occupants during the construction period.

6.3.1 Smoking or open fires will not be permitted within the building enclosure or on the premises.

6.4 The Abatement Contractor is responsible for coordinating with Owner regarding selective demolition activities or abatement activities which may impact items of historic preservation and/or salvage prior to conducting the Work.

7.0 OWNER OCCUPANCY

7.1 The Owner will occupy the site and the existing building during the period of Abatement. Therefore, cooperate fully with the Owner or his representatives during operations to minimize conflicts and to facilitate Owner usage. Perform the work so as not to interfere with the Owner's operations.

END OF SECTION 01 11 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the Contract Forms and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 APPLICATIONS FOR PAYMENT

1.1 Contractors making applications for payment shall submit completed and notarized AIA G702 and G703 forms, entitled "Application and Certificate for Payment" and "Continuation Sheet" respectively, to the Owner Representative for review. The schedule of values on the continuation sheet shall be outline as per the Bid Form.

1.2 Refer to Contract Forms and Supplements for additional payment procedures.

2.0 UNIT PRICES

2.1 The unit prices listed on the Bid Form shall determine the value of extra work or changes in the work, as applicable. They shall be considered complete and shall include all material and equipment, labor, installation costs, overhead, disposal and profit. Unit prices shall be used uniformly for additions or deductions.

2.2 The Contractor, upon discovery of hidden or otherwise unknown asbestos-containing building materials, which have not been anticipated in the summary of work, shall, in coordination with the owner's on-site representative, determine the quantities involved, prior to any abatement of said materials. Both parties shall sign a form acknowledging and agreeing upon the quantity found.

2.3 The Owner's Representative shall investigate to determine if knowledge of such materials could reasonably have been obtained by pre-bid site inspection by the Contractor, or if such information was provided in project documents.

2.4 If the Owner's Representative determines the work in question to be extra work, upon completion of that work the Contractor may include the work in application for payment. The agreed upon quantities shall be applied to the unit prices listed in the Contract.

END OF SECTION 01 20 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the Contract Forms and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 CHANGE ORDERS

1.1 The Contractors shall submit change order requests in written form to the Owner's Representative. The request shall detail changes in scope, contract sum, and contract time.

1.2 The Owner's Representative and Owner shall review the request. If approved, the Owner's Representative shall issue a completed change order (AIA Form G701) for execution by the Owner, Contractor and Owner's Representative.

1.3 To obtain quantities of materials for extra work, the on-site monitoring technician (owner's representative) and the contractor's job foreman shall jointly measure and quantify the materials. This shall be documented by filling out the "Acknowledgement of Quantities" form, generated by Owner's Representative.

2.0 FIELD ORDERS

2.1 The Owner's Representative's on-site representative shall have authority to order minor changes in the Work not involving adjustments in the contract sum or extension of the contract time and not inconsistent with the intent of the Contract Documents.

3.0 DIRECTIVES

3.1 In the absence of total agreement on the terms of a change order, a construction change directive (AIA Form G714) shall be issued.

END OF SECTION 01 26 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

1.1 This Section specifies administrative and supervisory requirements necessary for Project coordination.

2.0 GENERAL SUPERINTENDENT

2.1 Provide a full-time General Superintendent who is experienced in administration and supervision of asbestos abatement projects including work practices, protective measures for building and personnel, disposal procedures, etc. This person is the contractor`s representative responsible for compliance with all applicable federal, state and local regulations, particularly those relating to asbestos-containing materials.

2.2 Certification: The General Superintendent must hold a current North Dakota Asbestos Abatement Site Supervisor Certificate. A copy of this certificate shall be on file with Terracon prior to the initiation of the project.

3.0 PROGRESS MEETINGS

3.1 General: In addition to specific coordination, Owner's Representative will hold general progress meetings as required. These meetings will be scheduled, when possible. Require each entity then involved in planning, coordination or performance of work to be properly represented at each meeting.

3.2 Pre-Construction Meeting: After award of Contract, at a time designated by the Owner or the Environmental Consultant, the Contractor, and the mechanical and electrical subcontractors shall attend a Pre-Construction Meeting. Procedures to be followed, critical work sequencing, submittals, coordination efforts, contract payments and similar matters will be reviewed.

3.3 Progress Meetings: During construction, periodic site meetings will be held with the Contractor, Owner, and Environmental Consultant. These meetings will be held weekly (unless job conditions do not warrant) and may be held more frequently if job progress and needs indicate. Contractor shall have one or more responsible representatives in attendance. Contractor shall record the “minutes of the meeting, shall distribute the minutes as appropriate and shall include such minutes within the Project records.

4.0 DAILY LOG

4.1 Daily Log: The Contractor shall maintain within the Decontamination Unit a daily log documenting the dates and time of but not limited to, the following items:

- Meetings; purpose, attendees, brief discussion
- Visitations; authorized and unauthorized
- Personnel, by name, entering and leaving the work area
- Special or unusual events, i.e. barrier breaching, equipment failures, accidents
- Air monitoring tests and test results (Contractors)
- Documentation of Contractor's completion of the following:
    - Inspection of work area preparation prior to start of removal and daily thereafter
    - Removal of any sheet plastic barriers
    - Contractor's inspections prior to spray back, lock back, encapsulation, enclosure or any other operation that will conceal the condition of asbestos-containing materials or the substrate from which such materials have been removed
    - Removal of waste materials from work area, and the amount of waste removed
    - Decontamination of equipment (list items)
    - Contractor's final inspection/final air test analysis

4.2 Provide one copy of this log to the Consultant on a weekly basis.

5.0 SPECIAL REPORTS

5.1 General: Except as otherwise indicated, submit special reports directly to the Project Administrator within one day of occurrence requiring special report, with copy to Owner's Representative and others affected by occurrence.

5.2 Reporting Unusual Events: When an event of unusual and significant nature occurs at site (examples: failure of pressure differential system, rupture of temporary enclosures), prepare and submit a special report listing chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. When such events are known or predictable in advance, advise the Project Administrator and the Owner's Representative in advance at earliest possible date.

5.3 Reporting Accidents: Prepare and submit reports of significant accidents, at site and anywhere else work is in progress. Record and document data and actions; comply with industry standards. For this purpose, a significant accident is defined to include events where personal injury is sustained, property loss of substance is sustained, or where the event posed a significant threat of loss or personal injury.

5.4 Report Discovered Conditions: When an unusual condition of the building is discovered during the work (e.g. leaks, termites, corrosion) prepare and submit a special report indication condition discovered.

6.0 CONTINGENCY PLAN

6.1 Contingency plan: Prepare a contingency plan for emergencies including fire, accident, power failure, pressure differential system failure, supplied air system failure, or any other event that may require modification or abridgement of decontamination or work area isolation procedures. Include in plan specific procedures for decontamination or work area isolation. Note that nothing in this specification should impede safe exiting or providing of adequate medical attention in the event of an emergency.

6.2 Post: In clean room of personnel decontamination unit, post telephone numbers and locations of emergency services including but not limited to the following hospital, police department, fire department, and poison control center.

7.0 NOTIFICATIONS

7.1 Notify other entities at the job site of the nature of the asbestos abatement activities, location of asbestos-containing materials, requirements relative to asbestos set forth in these specifications and applicable regulations.

7.2 Notifications of Emergency: Any individual at the job site may notify emergency service agencies if necessary without effect on this Contract or the Contract Sum.

7.3 Notify the local Police and Fire Departments which have jurisdiction. A copy of this notification shall be submitted to Terracon prior to the initiation of the site work.

8.0 SAFETY DIRECTOR

Provide safety supervision throughout the Work.

END OF SECTION 01 31 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

This Section specifies administrative and procedural requirements for submittal required for performance of the work, including:

Contractor's construction schedule
Submittal schedule
Product Data
Submittal Checklist
Regulatory Permit
State Licenses

2.0 SUBMITTAL PROCEDURES

2.1 Coordination: Coordinate preparation and processing of submittal with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittal and related activities that require sequential activity.

Coordinate transmittal of different types of submittal for related elements of the work so processing will not be delayed by the need to review submittal concurrently for coordination.

The Owner's Representative reserves the right to withhold project authorization if pre-construction submittal has not been received three working days in advance of the initiation of the project.

2.2 Processing: Allow sufficient review time so that the project will not be delayed as a result of the time required to process submittal, including time for resubmittal.

Allow three working days for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittal. The Owner's Representative will promptly advise the Contractor when a submittal being processed must be delayed for coordination.

If an intermediate submittal is necessary, process the same as the initial submittal.

Allow three working days for reprocessing each submittal.

No extension of Contract Time will be authorized because of failure to transmit submittal to the Owner's Representative sufficiently in advance of the work to

permit processing.

2.3 Submittal Preparation: Indicate the Section and Sub-Section(s) for which the submittal applies and indicate the name of the submittal and date.

2.4 Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Owner's Representative using a transmittal form. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

3.0 CONTRACTOR'S CONSTRUCTION SCHEDULE

3.1 Schedule: Provide proposed detailed schedule including work dates, work shift time, number of employees, dates of start and completion including dates of preparation work, removals and final inspection dates.

3.1.1 The construction schedule shall be provided with the pre-construction submittal.

3.1.2 Indicate clearance monitoring of each work area in advance of the dates established for completion. Allow time for testing and other Owner's Representative's procedures necessary for clearance monitoring and subsequent completion.

3.2 Phasing: Provide notations on the schedule to show how the sequence of the work is affected by requirements for phased completion and partial occupancy by the Owner prior to completion.

3.3 Work Stages: Indicate important stages of construction for each major portion of the work. Include indication of start and finish times for the following:

Preparation of the Work Area
Asbestos removal
Clearance testing
Completion

3.4 Area Separations: Identify each work area or major construction area for each major portion of the work. Indicate where each element in an area must be sequenced or integrated with other activities.

3.5 Distribution: Following response to the initial submittal, print and distribute copies to the Owner's Representative, Project Administrator, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Site Supervisor's temporary field office.

When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in construction activities.

3.6 Schedule Updating: Revise the schedule on a weekly basis as needed. Distribution of the revised schedule shall be made as indicated in 3.5 (above).

4.0 PRODUCT DATA

4.1 Safety Data Sheets: Process safety and data sheets as "product data."

4.1.1 Material Safety Data Sheets shall be provided for any chemical agents which are to be used in conjunction with this project. These include, but are not limited to the following:

Encapsulants
Adhesives
Solvents
Stripping Agents
Spray Poly

4.1.2 Safety Data Sheets shall be submitted as part of the pre-construction submittal.

5.0 RENTAL EQUIPMENT

5.1 For any rental equipment to be used in conjunction with the project, the Contractor shall submit a letter from the respective rental company stating that the rental company understands that the equipment will be used in conjunction with an asbestos removal project.

6.0 PRE-PROJECT SUBMITTALS

Pre-project submittals shall be submitted to the Consultant within one (1) week of Notice to Proceed. Site work may not proceed until pre-project submittals are in place.

6.1 Asbestos Contractor License.

6.2 Site Supervisor name, Asbestos Site Supervisor Certificate, and contact information (telephone numbers, etc.)

6.3 Asbestos Worker Certificates.

6.4 Regulatory Notification.

7.0 POST-PROJECT SUBMITTALS

Final payment will not be recommended by the Consultant until all Post-project submittals are received.

7.1. Daily entry logs documenting the names of all persons entering or leaving any containment areas where an asbestos contaminated or potentially contaminated atmosphere exists.

7.2 Results of all asbestos exposure monitoring data collected by Contractor.

7.3 Contractor's daily logs summarizing and documenting daily abatement activities, calibration of the manometer, unusual events and amount of waste material removed from the work site.

7.4 Pressure monitoring data.

7.5 Waste transport and disposal certificates (manifests) after load-out and transportation of the waste to the Landfill. Provide copy of manifest to the Consultant prior to shipment of materials from site. Submit the completed copy from the Landfill within 24 hours of receiving each manifest.

7.6 Records of emergency evacuations, emergency cleanup, and any injuries or other accidents after each occurrence. (Submit within 24-hours of the event.)

7.7 Amended regulatory notification(s). Submit within 24-hours of submitting to the appropriate agencies.

7.8 A log of all equipment repairs, filter changes, etc. on a weekly basis or as they occur.

END OF SECTION 01 33 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specification. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.

Requirements include adherence to work practices and procedures set forth in applicable codes, regulations and standards.

Requirements include obtaining permits, licenses, inspections, releases and similar documentation, as well as payments, statements and similar requirements associated with codes, regulations, and standards.

2.0 CODES AND REGULATIONS

2.1 General Applicability of Codes, Regulations, and Standards: Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.

2.2 Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, State, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable Federal, State, and local regulations. The Contractor shall hold the Owner and Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of himself, his employees, or his subcontractors.

2.3 Federal Requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

2.3.1 OSHA: U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:

Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules Title 29, Part 1910, Section 1001 and Part 1926, Section 1101 of the Code of Federal Regulations

Respiratory Protection

Title 29, Part 1910, Section 134 of the Code of Federal Regulations

Construction Industry

Title 29, Part 1926, of the Code of Federal Regulations

Access to Employee Exposure and Medical Records

Title 29, Part 1910, of the Code of Federal Regulations

Hazard Communication

Title 29, Part 1910, Section 1200 of the Code of Federal Regulations

Specifications for Accident Prevention Signs and Tags

Title 29, Part 1910, Section 145 of the Code of Federal Regulations

2.3.2 DOT: U. S. Department of Transportation, including but not limited to:

Hazardous Substances

Title 29, Part 171 and 172 of the Code of Federal Regulations

2.3.3 EPA: U. S. Environmental Protection Agency (EPA), including but not limited to:

Asbestos Abatement Projects Title 40 Part 763, Subpart E of the Code of Federal Regulations

National Emission Standard for Hazardous Air Pollutants (NESHAP), for Asbestos Title 40, Part 61, Subpart A, and Subpart M (Revised Subpart B) of the Code of Federal Regulations

2.3.4 State Requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

North Dakota Division of Air Quality, North Dakota Department of Health Administrative Code Chapter 33-15-13

2.3.5 Local Requirements: Abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials

3.0 STANDARDS

3.1 General Applicability of Standards: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

3.2 Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all standards and patents pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor shall hold the Owner and Owner's Representative harmless for failure to comply with any applicable standard on the part of himself, his employees, or his subcontractors.

3.2 Standards which apply to asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

American National Standards Institute (ANSI)
25 West 43rd Street, 4th floor
New York, New York 10036
(212-642-4900

- Occupational and Educational Personal Eye and Face Protection Devices
  - Publication Z871-2015
- Respiratory Protection – Respirator Use – Physical Qualifications for Personnel
  - Publication Z886-2006
- Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters
  - Publication Z887-2010
- Respirator Fit Testing Methods
  - Publication Z8810-2010
- Personal Protection – Protective Headwear for Industrial Workers
  - Publication Z891-2014
- Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-2012
- Practices for Respiratory Protection Publication Z88.2-80

ASTM International
100 Bar Harbor Drive
PO Box C700
West Conshohocken. PA
(877)909-2786

- Standard Practice for Visual Inspection of Asbestos Abatement Projects E 1368
- Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear F 2413

4.0 EPA GUIDANCE DOCUMENTS

4.1 EPA Guidance Documents discuss asbestos abatement work or hauling and disposal of asbestos waste materials listed below for the Contractor's information only. These documents do not describe the work and are not a part of the work of this contract. EPA maintains an information number (800) 334-8571, publications can be ordered from (800) 424-9065 (554-1404 in Washington, DC):

Asbestos-Containing Materials in School Buildings - A Guidance Document. Part 1 & 2. (Orange Books), EPA C00090 (out of print)

Guidance for Controlling Asbestos-Containing Materials in Buildings (Purple Book), EPA 560/5-85-024

Friable Asbestos-Containing Materials in Schools: Identification and Notification Rule (40 CFR Part 763)

Evaluation of the EPA Asbestos-in-Schools Identification and Notification Rule, EPA 560/5-84-005.

Asbestos in Buildings: National Survey of Asbestos-Containing Friable Materials, EPA 560/5-84-006.

Asbestos in Buildings: Guidance for Service and Maintenance Personnel, EPA 560/5-85-018.

Asbestos Waste Management Guidance. EPA 530-SW-85-007.

Asbestos Fact Book. EPA Office of Public Affairs.

Asbestos in Buildings. Simplified Sampling Scheme for Friable Surfacing Materials.

Commercial Laboratories with Polarized Light Microscopy Capabilities for bulk asbestos identification.

A Guide to Respiratory Protection for the Asbestos Abatement Industry. EPA-560-OPTS-86-001

5.0 NOTICES

5.1 Send written notification as required by the North Dakota Department of Health Asbestos Control Program prior to beginning any work on asbestos-containing materials and submit a copy of these notifications as part of the preconstruction submittal.

5.2 A copy of the original North Dakota Department of Public Health permit shall be submitted to the Owner's Representative. The original, as required by the State, shall be posted at the site.

6.0 LICENSES

7.1 Licenses: Maintain current licenses as required by the State of North Dakota for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

7.2 A copy of the Contractor's license, the Site Supervisor's license, and each worker's license, shall be submitted to the Owner's Representative prior to the initiation of on-site activity.

7.0 POSTING AND FILING OF REGULATIONS

8.1 Posting and Filing of Regulations: Post all notices required by applicable federal, state and local regulations. Maintain two (2) copies of applicable federal, state and local regulations and standard. Maintain one copy of each at job site. Keep on file in Contractor's office one copy of each.

END OF SECTION 01 41 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specification. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.

Requirements include adherence to work practices and procedures set forth in applicable codes, regulations and standards. Requirements include obtaining permits, licenses, inspections, releases and similar documentation, as well as payments, statements and similar requirements associated with codes, regulations, and standards.

2.0 CODES AND REGULATIONS

2.1 General Applicability of Codes and Regulations, and Standards: Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.

2.2 Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, State, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable Federal, State, and local regulations. The Contractor shall hold the Owner and Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of himself, his employees, or his subcontractors.

2.3 Federal Requirements which govern lead work or hauling and disposal of lead waste materials include but are not limited to the following:

2.3.1 OSHA: U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:

Occupational Exposure to Lead; Title 29, Part 1910, Section 1025 and Part 1926, Section 62 of the Code of Federal Regulations

Respiratory Protection
Title 29, Part 1910, Section 134 of the Code of Federal Regulations

Construction Industry
Title 29, Part 1926, of the Code of Federal Regulations

Access to Employee Exposure and Medical Records
Title 29, Part 1910, Section 2 of the Code of Federal Regulations

Hazard Communication
Title 29, Part 1910, Section 1200 of the Code of Federal Regulations

Specifications for Accident Prevention Signs and Tags
Title 29, Part 1910, Section 145 of the Code of Federal Regulations

2.3.2 DOT: U. S. Department of Transportation, including but not limited to:

Hazardous Substances
Title 29, Part 171 and 172 of the Code of Federal Regulations

2.3.3 EPA: U. S. Environmental Protection Agency (EPA), including but not limited to:

Toxic Substances Control Act (TSCA)
Residential Lead-Based Paint Hazard Reduction Act of 1992 (Title X)
Clean Air Act (CAA)
Clean Water Act (CWA)
Safe Drinking Water Act (SDWA)
Resource Conservation and Recovery Act (RCRA)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

2.3.4 State Requirements which govern lead abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

North Dakota Department of Health Lead-Based Paint Rules
Chapter 33-15-24

2.3.5 Local Requirements: Abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials.

3.0 STANDARDS

3.1 General Applicability of Standards: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

3.2 Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all standards and patents pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor shall hold the Owner and Owner's Representative harmless for failure to comply with any applicable standard on the part of himself, his employees, or his subcontractors.

4.0 EPA GUIDANCE DOCUMENTS

4.1 EPA Guidance Documents: The Uniform Act, passed by Congress in 1970, is a federal law that establishes minimum standards for federally funded programs and projects that require the acquisition of real property (real estate) or displace persons from their homes, businesses, or farms. The Uniform Act's protections and assistance apply to the acquisition, rehabilitation, or demolition of real property for federal or federally funded projects.

Housing and Urban Development (HUD) Handbook 1378 provides HUD policy and guidance on implementing the Uniform Act and 49 CFR Part 24 for HUD funded programs and projects.

5.0 NOTICES

5.1 Send written notification as required by the North Dakota Department of Health, prior to beginning any residential or target housing removal and submit a copy of these notifications as part of the preconstruction submittal.

5.1.1 State notification includes the advance notification.

7.0 LICENSES

7.1 Licenses: Maintain current licenses as required by the State of North Dakota for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

7.2 A copy of the Contractor's license, the Site Supervisor's license, and each worker's license, shall be submitted to the Owner's Representative prior to the initiation of on-site activity.

8.0 POSTING AND FILING OF REGULATIONS

8.1 Posting and Filing of Regulations: Post all notices requires by applicable federal, state and local regulations. Maintain two (2) copies of applicable federal, state and local regulations and standard. Maintain one copy of each at job site. Keep on file in Contractor's office one copy of each.

END OF SECTION 01 41 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

1.1 General Explanation: A substantial amount of specification language constitutes definitions for terms found in other contract documents, including the drawings. (Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated thereon.) Certain terms used in Contract Documents are defined in this article.

2.0 DEFINITIONS

Aerosol: A system consisting of particles, solid or liquid, suspended in air.

Abatement: The removal, encapsulation, enclosure, or repair of asbestos-containing materials.

Aggressive Air Sampling: A sampling technique in which the Testing Laboratory collecting the air sample creates air movement by blowers or fans before/during the sampling period to stir up settled dust or particulate matter. Intended to simulate worst-case scenario for fiber release in the area contained.

Air Cell: Insulation normally used on pipes and duct work that is comprised of corrugated cardboard which is frequently composed of asbestos combined with cellulose or refractory binders.

Air Monitoring: The collection of a known volume of air through a filter media for assessing airborne fiber concentrations at strategic locations in and around abatement work. Also known as air sampling or air testing

Alternative Indoor Air Standard: Determined by collection of preliminary air samples by phase contrast microscopy, as defined in the North Dakota Department of Health Asbestos Abatement Rules

Amended Water: Water to which a surfactant has been added to decrease the surface tension to 35 or less dynes.

Architect: See Consultant.

Asbestos: The asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite. For purposes of determining respiratory and worker protection both the asbestiform and non-asbestiform varieties of the above minerals and any of these materials that have been chemically treated and/or altered shall be considered as asbestos.

Asbestos-Containing Material (ACM): Any material containing more than 1% by weight of asbestos of any type or mixture of types.

Asbestos-Containing Building Material (ACBM): Surfacing ACM, thermal system insulation ACM, or miscellaneous ACM that is found in or on interior structural members or other parts of a building.

Asbestos-Containing Waste Material: Any material which is or is suspected of being or any material contaminated with an asbestos-containing material which is to be removed from a work area for disposal.

Asbestos debris: Pieces of ACBM that can be identified by color, texture, or composition, or dust, if the dust is determined by an accredited inspector to be ACM.

Asbestos Filtration Device (AFD) : Device using high efficiency particulate air (HEPA) filtration systems to filter air, usually operating to reduce containment area air pressure relative to outside.

Authorized Visitor: The Owner, the Owner's Representative, testing lab personnel, the Architect/Engineer, emergency personnel or a representative of any federal, state and local regulatory or other agency having authority over the project.

Barrier: Any surface that seals the work area to inhibit the movement of fibers.

Breathing Zone: A hemisphere forward of the shoulders with a radius of approximately 6 to 9 inches.

Ceiling Concentration: The concentration of an airborne substance that shall not be exceeded.

Certified Industrial Hygienist (C.I.H.): An industrial hygienist certified in Comprehensive Practice by the American Board of Industrial Hygiene.

Clean *(verb)* : Remove contamination from a surface using wet-wipe methods or HEPA-filtered vacuuming.

Clearance Air Monitoring: Employing aggressive air sampling techniques in a previously contaminated area to verify that airborne fiber levels are at or below an established clearance level. Also known as clearance sampling or clearance testing.

Consultant: Serves the role of Architect for purposes of the Contract Documents. Also is the Testing Laboratory representative contracted by the Owner to perform on-site air monitoring.

Containment area: A system for safely abating asbestos-containing materials without contaminating adjacent areas.

Contractor: The individual or business, licensed by the state as an Asbestos Abatement Contractor, with which the Building Owner contracts to perform asbestos abatement.

Critical Barrier: Primary seal or barrier on all containment area openings into adjacent areas including: doors, vents, corridors, etc.

Demolition: The removal of any building component, system, finish or assembly of a facility together with any related handling operations.

Disposal Bag: A properly labeled 6 mil thick leak-tight plastic bag used for transporting asbestos waste from work and to disposal site.

Encapsulant: A material that surrounds or embeds asbestos fibers in an adhesive matrix, to prevent release of fibers.

> Bridging encapsulant: an encapsulant that forms a discrete layer on the surface of an in situ asbestos matrix.
>
> Penetrating encapsulant: an encapsulant that is absorbed by the in situ asbestos matrix without leaving a discrete surface layer.
>
> Removal encapsulant: a penetrating lock down encapsulant specifically designed to minimize fiber release after removal of asbestos-containing materials.

Encapsulation: Treatment of asbestos-containing materials with an encapsulant.

Enclosure: The construction of an air-tight, impermeable, permanent barrier around asbestos-containing material to control the release of asbestos fibers into the air.

Environmental Consultant: See Consultant.

Fiber: Refers specifically to fibers having an aspect ratio of 3:1 or greater, and longer than 5 microns in length (NIOSH 7400 Method).

Filter: A media component used in respirators to remove solid or liquid particles from the inspired air.

Friable Asbestos Material: Asbestos-containing material that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.

General Superintendent: This is the Contractor's Representative at the work site. This person will generally be the Competent Person required by OSHA in 29 CFR 1926.

Glovebag: A sack (typically constructed of 6 mil transparent polyethylene or polyvinylchloride plastic) with inward projecting long sleeve gloves, which are designed to enclose an object from which an asbestos-containing material is to be removed, and contain airborne asbestos fibers released during the process.

HEPA Filter: A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97% of asbestos fibers greater than 0.3 microns in diameter.

HEPA Filter Vacuum Collection Equipment (or vacuum cleaner): High efficiency particulate air filtered vacuum collection equipment with a filter system capable of collecting and retaining asbestos fibers. Filters should be of 99.97% efficiency for retaining fibers of 0.3 microns or larger.

High-efficiency particulate air filter: (HEPA) refers to a filtering system capable of trapping and retaining 99.97 percent of all monodispersed particles 0.3 microns (um) in diameter or larger.

HVAC: Heating, ventilating, and air conditioning systems.

Manometer: A monitor used for the detection of pressure differentials between the containment area and outside adjacent areas.

Negative Pressure Respirator: A respirator in which the air pressure inside the respirator inlet covering is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.

Negative Pressure Ventilation System: A pressure differential and ventilation system.

OSHA: Occupational Safety and Health Administration.

Owner's Representative: Terracon will serve as the Owner's Representative for this project. The Owner's Representative/Consultant will represent the Owner during construction and until final payment is due. The Owner's Representative will advise and consult with the Owner. The Owner's instructions to the Contractor will be forwarded through the Owner's Representative.

PAPR: Powered Air Purifying Respirator.

PCM: Phase Contrast Microscopy.

Personal Monitoring: Sampling of the airborne asbestos fiber concentrations within the breathing zone of an employee.

Phase Contrast Microscopy: Method of optical microscopy used to count fibers for determination of airborne fiber concentrations.

Powered Air-Purifying Respirator (PAPR): Full-face respirator with battery powered fan unit capable of delivering four to six cubic feet of air per minute (CFM) to the face piece.

Preliminary Air Sampling: The method used to determine background airborne fiber concentrations inside and outside of the building prior to any asbestos abatement work.

Pressure Differential and Ventilation System: A local exhaust system, utilizing HEPA filtration capable of maintaining a pressure differential with the inside of the Work Area at a lower pressure than any adjacent area, and which cleans recirculated air or generates a constant air flow from adjacent areas into the Work Area.

Project Manager: The project manager as assigned by and from Hennepin County

Property Services.

Protection Factor: The ratio of the ambient concentration of an airborne substance to the concentration of the substance inside the respirator at the breathing zone of the wearer. The protection factor is a measure of the degree of protection provided by a respirator to the wearer.

Removal: The stripping of any asbestos-containing materials from surfaces or components of a facility.

Renovation: Altering in any way, one or more facility non-structural components, excluding demolition.

Repair: Returning damaged ACBM to an undamaged condition or to an intact state so as to prevent fiber release.

Respirator: A device designed to protect the wearer from the inhalation of harmful atmospheres.

Surfactant: A chemical wetting agent added to water to improve penetration, thus reducing the quantity of water required for a given operation or area.

TEM: Transmission Electron Microscopy.

Testing Laboratories: An independent entity engaged to perform specific inspections or tests, either at the project site or elsewhere, and to report on, and, if required, to interpret, results of those inspections or tests. Often, but not always, the same entity as the Owner's Representative/Consultant.

Time Weighted Average (TWA): The average concentration of a contaminant in air during a specific time period.

Transmission Electron Microscopy (TEM): A method of analyzing asbestos air samples for fiber concentration.

Visible Emissions: Any emissions containing particulate asbestos material that are visually detectable without the aid of instruments. This does not include condensed uncombined water vapor.

Wet Cleaning: The process of eliminating asbestos contamination from building surfaces and objects by using cloths, mops, or other cleaning utensils which have been dampened with amended water or diluted removal encapsulant.

Work Area: The area where asbestos-related work or removal operations are performed which is defined and/or isolated to prevent the spread of asbestos dust, fibers or debris, and entry by unauthorized personnel. Work area is a Regulated Area as defined by 29 CFR 1926. A Work Are" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.

3.0 INDUSTRY STANDARDS

3.1 Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the Project Site for reference.

3.2 Referenced industry standards take precedence over standards that are not referenced but recognized in the construction industry as applicable.

3.3 Unreferenced industry standards are not directly applicable to the work, except as a general requirement of whether the work complies with recognized construction industry standards.

3.4 Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Owner's Representative for a decision before proceeding.

3.5 Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Owner's Representative for decision before proceeding.

3.6 Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entities' construction activity. Copies of applicable standards are not bound with the Contract Documents.

Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

Although copies of standards needed for enforcement of requirements may be part of required submittal, the Owner's Representative reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

3.7 Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change, and are believed to be, but are not assured to be, accurate and up-to-date as of date of Contract Documents:

AIHA American Industrial Hygiene Association
3141 Fairview Park Drive, Suite 777
Falls Church, VA 22042

(703) 849-8888

AIA American Institute of Architects
1735 New York Ave. NW
Washington, DC 20006
202/626-7474

ANSI American National Standards Institute
25 West 43rd Street, 4th floor
New York, NY 10036
212-642-4900

ASHRAE American Society for Heating, Refrigerating, and Air Conditioning Engineers
1791 Tullie Circle NE
Atlanta, GA 30329
404/636-8400

ASME American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
800-843-2763

ASPE American Society of Plumbing Engineers
6400 Shafer Ct., Suite 350
Rosemont, IL 60018-4914
847-296-0002

ASTM International
100 Bar Harbor Drive
PO Box C700
West Conshohocken, PA 19428
877-909-2786

AWCI Association of the Wall and Ceiling Industries-International
513 W Broad St,
Falls Church, VA 22046
(703) 538-1600

CFR Code of Federal Regulations
Available from Government Printing Office
Washington, DC 20402 (usually first published in Federal Register)
202/783-3238

CGA Compressed Gas Association
14501 George Carter Way
Suite 103
Chantilly, VA 20151
703-788-2700

NIST National Institute of Standards and Technology
100 Bureau Drive, Stop 1070
Gaithersburg, MD 20899-1070
(301) 975-6478

DOT Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590
202/426-4000

EPA Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
(202) 272-0167

FS Federal Specification (General Services Admin.)
Obtain from your Regional GSA Office, or purchase from GSA Specifications Unit (WFSIS)
7th and D Streets, S.W.
Washington, DC 20406
202/472-2205 or 2140

GA Gypsum Association
1603 Orrington Ave.
Evanston, IL 60201
312/491-1744

GSA General Services Administration
F St. and 18th St., NW
Washington, DC 20405
202/655-4000

IEEE Institute of Electrical and Electronic Engineers
345 E. 47th Street
New York, NY 10017
212/705-7900

MIL Military Standardization Documents
(U.S. Dept. of Defense)
Naval Publications and Forms Center
5801 Tabor Ave.
Philadelphia, PA 19120

NEC National Electrical Code (by NFPA)

NFPA National Fire Protection Association
Batterymarch Park
Quincy, MA 02269
617/770-3000

NRCA	National Roofing Contractors Association 6250 River Road Rosemont, IL 60018 312/318-6722
OSHA	Occupational Safety & Health Administration (U.S. Dept. of Labor) Government Printing Office Washington, DC 20402 202/783-3238
RFCI	Resilient Floor Coverings Institute 966 Hungerford Drive, Suite 12-B Rockville, MD 20805 301/340-8580
UL	Underwriters Laboratories 333 Pfingsten Rd. Northbrook, IL 60062 312/272-8800

END OF SECTION 01 42 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 SUMMARY

1.1 General Explanation: A substantial amount of specification language constitutes definitions for terms found in other contract documents, including the drawings. (Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated thereon.) Certain terms used in Contract Documents are defined in this article.

2.0 DEFINITIONS

Child-occupied facility means a building, or portion of a building, constructed prior to 1978, visited regularly by the same child, under 6 years of age, on at least two different days within any week (Sunday through Saturday period), provided that each day's visit lasts at least 3 hours and the combined weekly visits last at least 6 hours, and the combined annual visits last at least 60 hours. Child-occupied facilities may include, but are not limited to, day care centers, preschools and kindergarten classrooms. Child-occupied facilities may be located in target housing or in public or commercial buildings. With respect to common areas in public or commercial buildings that contain child-occupied facilities, the child-occupied facility encompasses only those common areas that are routinely used by children under age 6, such as restrooms and cafeterias. Common areas that children under age 6 only pass through, such as hallways, stairways, and garages are not included. In addition, with respect to exteriors of public or commercial buildings that contain child-occupied facilities, the child-occupied facility encompasses only the exterior sides of the building that are immediately adjacent to the child-occupied facility or the common areas routinely used by children under age 6.

Cleaning verification card means a card developed and distributed, or otherwise approved, by EPA for the purpose of determining, through comparison of wet and dry disposable cleaning cloths with the card, whether post-renovation cleaning has been properly completed.

Component or building component means specific design or structural elements or fixtures of a building or residential dwelling that are distinguished from each other by form, function, and location. These include, but are not limited to, interior components such as: Ceilings, crown molding, walls, chair rails, doors, door trim, floors, fireplaces, radiators and other heating units, shelves, shelf supports, stair treads, stair risers, stair stringers, newel posts, railing caps, balustrades, windows and trim (including sashes, window heads, jambs, sills or stools and troughs), built in cabinets, columns, beams, bathroom vanities, counter tops, and air conditioners; and exterior components such as: Painted roofing, chimneys, flashing, gutters and downspouts, ceilings, soffits, fascias, rake boards, cornerboards, bulkheads, doors and door trim, fences, floors, joists, lattice work, railings and railing caps, siding, handrails, stair risers and treads, stair stringers, columns, balustrades, windowsills or stools and troughs, casings, sashes and wells, and air conditioners.

Dry disposable cleaning cloth means a commercially available dry, electrostatically charged, white disposable cloth designed to be used for cleaning hard surfaces such as uncarpeted floors or counter tops.

Firm means a company, partnership, corporation, sole proprietorship or individual doing business, association, or other business entity; a Federal, State, Tribal, or local government agency; or a nonprofit organization.

HEPA vacuum means a vacuum cleaner which has been designed with a high-efficiency particulate air (HEPA) filter as the last filtration stage. A HEPA filter is a filter that is capable of capturing particulates of 0.3 microns with 99.97% efficiency. The vacuum cleaner must be designed so that all the air drawn into the machine is expelled through the HEPA filter with none of the air leaking past it. HEPA vacuums must be operated and maintained in accordance with the manufacturer's instructions.

Interim controls means a set of measures designed to temporarily reduce human exposure or likely exposure to lead-based paint hazards, including specialized cleaning, repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards, and the establishment and operation of management and resident education programs.

Minor repair and maintenance activities are activities, including minor heating, ventilation or air conditioning work, electrical work, and plumbing, that disrupt 6 square feet or less of painted surface per room for interior activities or 20 square feet or less of painted surface for exterior activities where none of the work practices prohibited or restricted by §40 CFR 745.85(a)(3) are used and where the work does not involve window replacement or demolition of painted surface areas. When removing painted components, or portions of painted components, the entire surface area removed is the amount of painted surface disturbed. Jobs, other than emergency renovations, performed in the same room within the same 30 days must be considered the same job for the purpose of determining whether the job is a minor repair and maintenance activity.

Painted surface means a component surface covered in whole or in part with paint or other surface coatings.

Pamphlet means the EPA pamphlet titled Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools developed under section 406(a) of TSCA for use in complying with section 406(b) of TSCA, or any State or Tribal pamphlet approved by EPA pursuant to 40 CFR 745.326 that is developed for the same purpose. This includes reproductions of the pamphlet when copied in full and without revision or deletion of material from the pamphlet (except for the addition or revision of State or local sources of information). Before December 22, 2008, the term pamphlet also means any pamphlet developed by EPA under section 406(a) of TSCA or any State or Tribal pamphlet approved by EPA pursuant to §745.326.

Person means any natural or judicial person including any individual, corporation, partnership, or association; any Indian Tribe, State, or political subdivision thereof; any interstate body; and any department, agency, or instrumentality of the Federal Government.

Renovation means the modification of any existing structure, or portion thereof, that results in the disturbance of painted surfaces, unless that activity is performed as part of an abatement as defined by this part (40 CFR 745.223). The term renovation includes (but is not limited to): The removal, modification or repair of painted surfaces or painted components (e.g., modification of painted doors, surface restoration, window repair, surface preparation activity (such as sanding, scraping, or other such activities that may generate paint dust)); the removal of building components (e.g., walls, ceilings, plumbing, windows); weatherization projects (e.g., cutting holes in painted surfaces to install blown-in insulation or to gain access to attics, planing thresholds to install weather-stripping), and interim controls that disturb painted surfaces. A renovation performed for the purpose of converting a building, or part of a building, into target housing or a child-occupied facility is a renovation under this subpart. The term renovation does not include minor repair and maintenance activities.

Renovator means an individual who either performs or directs workers who perform renovations. A certified renovator is a renovator who has successfully completed a renovator course accredited by EPA or an EPA-authorized State or Tribal program.

Wet disposable cleaning cloth means a commercially available, pre-moistened white disposable cloth designed to be used for cleaning hard surfaces such as uncarpeted floors or counter tops.

Vertical containment means a vertical barrier consisting of plastic sheeting or other impermeable material over scaffolding or a rigid frame, or an equivalent system of containing the work area. Vertical containment is required for some exterior renovations but it may be used on any renovation.

Wet mopping system means a device with the following characteristics: A long handle, a mop head designed to be used with disposable absorbent cleaning pads, a reservoir for cleaning solution, and a built-in mechanism for distributing or spraying the cleaning solution onto a floor, or a method of equivalent efficacy.

Work area means the area that the certified renovator establishes to contain the dust and debris generated by a renovation.

3.0 INDUSTRY STANDARDS

3.1 Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the Project Site for reference.

3.2 Referenced industry standards take precedence over standards that are not referenced but recognized in the construction industry as applicable.

3.3 Unreferenced industry standards are not directly applicable to the work, except as a general requirement of whether the work complies with recognized construction industry standards.

3.4 Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Owner's Representative for a decision before proceeding.

3.5 Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Owner's Representative for decision before proceeding.

3.6 Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entities' construction activity. Copies of applicable standards are not bound with the Contract Documents.

Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

Although copies of standards needed for enforcement of requirements may be part of required submittal, the Owner's Representative reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

3.7 Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change, and are believed to be, but are not assured to be, accurate and up-to-date as of date of Contract Documents:

AIHA American Industrial Hygiene Association
3141 Fairview Park Drive, Suite 777
Falls Church, VA 22042
(703) 849-8888

AIA American Institute of Architects
1735 New York Ave. NW
Washington, DC 20006
202/626-7474

ANSI American National Standards Institute
25 West 43rd Street, 4th floor
New York, NY 10036
212-642-4900

ASHRAE American Society for Heating, Refrigerating, and Air Conditioning

Engineers
1791 Tullie Circle NE
Atlanta, GA 30329
404/636-8400

ASME American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
800-843-2763

ASPE American Society of Plumbing Engineers
6400 Shafer Ct., Suite 350
Rosemont, IL 60018-4914
847-296-0002

ASTM International
100 Bar Harbor Drive
PO Box C700
West Conshohocken, PA 19428
877-909-2786

AWCI Association of the Wall and Ceiling Industries-International
513 W Broad St,
Falls Church, VA 22046
(703) 538-1600

CFR Code of Federal Regulations
Available from Government Printing Office
Washington, DC 20402 (usually first published in Federal Register)
202/783-3238

CGA Compressed Gas Association
14501 George Carter Way
Suite 103
Chantilly, VA 20151
703-788-2700

NIST National Institute of Standards and Technology
100 Bureau Drive, Stop 1070
Gaithersburg, MD 20899-1070
(301) 975-6478

DOT Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590
202/426-4000

EPA Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

(202) 272-0167

FS Federal Specification (General Services Admin.)
Obtain from your Regional GSA Office, or purchase from GSA Specifications Unit (WFSIS)
7th and D Streets, S.W.
Washington, DC 20406
202/472-2205 or 2140

GA Gypsum Association
1603 Orrington Ave.
Evanston, IL 60201
312/491-1744

GSA General Services Administration
F St. and 18th St., NW
Washington, DC 20405
202/655-4000

IEEE Institute of Electrical and Electronic Engineers
345 E. 47th Street
New York, NY 10017
212/705-7900

MIL Military Standardization Documents
(U.S. Dept. of Defense)
Naval Publications and Forms Center
5801 Tabor Ave.
Philadelphia, PA 19120

NEC National Electrical Code (by NFPA)

NFPA National Fire Protection Association
Batterymarch Park
Quincy, MA 02269
617/770-3000

NRCA National Roofing Contractors Association
6250 River Road
Rosemont, IL 60018
312/318-6722

OSHA Occupational Safety & Health Administration
(U.S. Dept. of Labor)
Government Printing Office
Washington, DC 20402
202/783-3238

RFCI Resilient Floor Coverings Institute
966 Hungerford Drive, Suite 12-B

Rockville, MD 20805
301/340-8580

UL Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, IL 60062
312/272-8800

END OF SECTION 01 42 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 DESCRIPTION OF THE WORK

1.1 Not in Contract Sum: This section describes work being performed by the Owner's Representative/Consultant.

1.2 This section describes asbestos air monitoring carried out by the Owner's Representative/Consultant to verify that the building beyond the work area and the outside environment remains uncontaminated. This section also sets forth airborne fiber levels both inside and outside the work area as action levels, and describes the action required by the Contractor if an action level is met or exceeded.

Exposure monitoring required by OSHA is responsibility of the Contractor and is not covered in this section.

2.0 AIR MONITORING

2.1 Work Area Isolation: The purpose of the Owner's air monitoring is to detect faults in the work area isolation such as:

Contamination of the building outside of the work area with airborne asbestos fibers,

Failure of filtration or rupture in the differential pressure system,

Contamination of air outside the building envelope with airborne asbestos fibers.

2.1.1 Should any of the above occur immediately cease asbestos abatement activities until the fault is corrected. Do not recommence work until authorized by the Owner's Representative.

2.2 Work Area Airborne Fiber Count: The Owner's Representative/Consultant will monitor airborne fiber counts in the work area. The purpose of this air monitoring will be to detect airborne asbestos concentrations which may challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers.

2.3 Work Area Clearance: To determine if the elevated airborne fiber counts encountered during abatement operations have been reduced to an acceptable level, the Owner's Representative/Consultant will sample and analyze five air samples within the containment utilizing aggressive air sampling techniques.

2.4 The Owner's Representative/Consultant will be conducting air monitoring throughout the course of the project.

3.0 STOP ACTION LEVELS

3.1 Inside Work Area:

3.1.1 Maintain airborne fiber concentration in the work area of 1.0 fibers per cubic centimeter of air (f/cc) or less.

3.1.2 If Contractor opts for half-face negative pressure respirator usage, maximum airborne fiber concentration in the work area shall be 0.1 f/cc or less.

3.1.3 For glovebag removal operations and uncontained cleaning operations, maximum airborne fiber concentration shall be 0.01 f/cc or less.

3.1.4 If airborne fiber counts exceed the maximum allowable airborne fiber concentration for any period of time, cease all work except corrective action, until sampling has indicated that fiber concentrations fall below the maximum allowable airborne fiber concentration.

3.2 Outside Work Area: If any air sample collected outside of the work area exceeds 0.01 f/cc, immediately and automatically stop all work except corrective actions. Work shall not resume until the cause of the elevated fiber level has been determined and corrective action has been taken to alleviate the source of the elevated fiber level.

3.2.1 If the high reading was the result of a failure of work area isolation measures initiate the following actions:

3.2.1.1 Immediately erect new critical barriers to isolate the affected area from the balance of the building. The critical barriers shall be erected at the next existing structural isolation of the involved space (e.g. wall, ceiling, floor).

3.2.1.2 Decontaminate the affected area.

3.2.1.3 Require that respiratory protection as required under this specification be worn in affected area until area is cleared for re-occupancy in accordance with air sampling.

3.2.1.4 If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a decontamination facility consisting of a Shower Room and Changing Room at entry point to affected area.

3.3 It is the Contractor's option to have air samples re-analyzed using Transmission Electron Analysis (TEM), Level II, at the Contractor's time and expense, for PCM air samples which he feels may have been biased by non-asbestos fibers. No extension in time or adjustment to the contract sum will be permitted for such analysis(es).

4.0 ANALYTICAL METHODS

4.1 Phase Contrast Microscopy (PCM) will be performed by the Owner's Representative using the NIOSH 7400 method. This analysis will be carried out at the job site.

4.2 Laboratory Testing: The Owner's Representative shall be employed to perform laboratory analyses of the air samples. A mobile PCM laboratory and technician will be set up at the job site, so that verbal reports on air samples can be obtained immediately.

5.0 SAMPLE VOLUMES

5.1 General: The number and volume of air samples collected by the Owner's Representative and by the Contractor will be related to the type of activity in-progress, the airborne particulate level, and to the number of personnel involved with the removal activity. These samples shall be in accordance with currently accepted industrial hygiene practices and shall be in compliance with applicable State and Federal regulations.

5.2 Schedule of Air Samples:

5.2.1 Before Start of Work: The Owner's Representative will collect representative PCM air samples in the removal areas to determine background fiber concentrations, if background levels of fibers are suspected that may bias project air sample results.

5.2.2 Daily: From start of work of work area preparation until the area has passed clearance monitoring, daily samples shall be collected. These shall include the air sampling as required in this Manual. Additional samples will be collected as circumstances dictate.

Daily monitoring shall include, but not limited to the following:

Adjacent Sampling
Work Area Sampling
Air Filtration Monitoring
Monitoring of Waste Transfer
Decontamination Chamber Monitoring

5.2.3 Final Clearance shall be performed in accordance with the requirements of this Manual.

6.0 OSHA COMPLIANCE MONITORING

6.1 OSHA compliance monitoring shall be provided by the Contractor in accordance with OSHA 1926.1101 OSHA Reference Method Mandatory Appendix A.

6.2 The Contractor shall provide to Consultant evidence of satisfactory compliance with OSHA air monitoring requirements.

6.3 Air monitoring results shall be posted within 48 hours of collection.

6.4 OSHA compliance monitoring will be conducted from initiation of the Work to completion including preparation, abatement and tear-down.

END OF SECTION 01 45 29

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

1.0 CLEARANCE REQUIREMENTS

The Contractor shall be responsible for achieving the clearance requirements as generally stated below:

1.1 Dust clearance testing. Note: Cleaning verification procedures in Part 9.1 need not be performed if the contract between the renovation firm and the person contracting for the renovation or another Federal, State, Territorial, Tribal, or local law or regulation requires dust clearance sampling at the conclusion of a LBP hazard reduction and/or at the completion of renovation.

(THIS PROJECT WILL REQUIRE DUST WIPE CLEARANCE TESTING CONDUCTED BY AN INDEPENDENT THIRD PARTY)

Clearance examinations shall include a visual assessment, dust sampling, submission of samples for analysis for lead in dust, interpretation of sampling results, and preparation of a report. Soil sampling is not required. Clearance examinations shall be performed in dwelling units, common areas, and exterior areas. If clearance is being performed after lead-based paint hazard reduction, paint stabilization, maintenance, or rehabilitation of that affected exterior surfaces but did not disturb interior painted surfaces or involve elimination of an interior dust-lead hazard, interior clearance is not required provided window, door, ventilation, and other openings are sealed during the exterior work.

Please note; clearance testing will be required if the risk assessment identifies LBP Hazards on components which are shared surfaces with a component being removed. If clearance is being performed for more than 10 dwelling units of similar construction and maintenance, as in a multifamily property, random sampling for the purpose of clearance may be conducted in accordance with 40 CFR 745.227(e)(9).

1.1.1 Dust samples for clearance purposes shall be taken a minimum of 1 hour after completion of final post-abatement cleanup activities.

1.1.2 The following post-abatement clearance activities shall be conducted as appropriate based upon the extent or manner of abatement activities conducted in or to the residential dwelling or child-occupied facility:

1.1.2.1 After conducting an abatement with containment between abated and unabated areas, one dust sample shall be taken from one interior window sill and from one window trough (if present) and one dust sample shall be taken from the floors of each of no less than four rooms, hallways or stairwells within the containment area. In addition, one dust sample shall be taken from the floor outside the containment area. If there are less than four rooms, hallways or stairwells within the containment area, then all rooms, hallways or stairwells shall be sampled.

1.1.2.2 After conducting an abatement with no containment, two dust samples shall be taken from each of no less than four rooms, hallways or stairwells in the residential dwelling or child-occupied facility. One dust sample shall be taken from one interior window sill and window trough (if present) and one dust sample shall be taken from the floor of each room, hallway or stairwell selected. If there are less than four rooms, hallways or stairwells within the residential dwelling or child-occupied facility then all rooms, hallways or stairwells shall be sampled.

1.1.2.3 Following an exterior paint abatement, a visible inspection shall be conducted. All horizontal surfaces in the outdoor living area closest to the abated surface shall be found to be cleaned of visible dust and debris. In addition, a visual inspection shall be conducted to determine the presence of paint chips on the dripline or next to the foundation below any exterior surface abated. If paint chips are present, they must be removed from the site and properly disposed of, according to all applicable Federal, State and local requirements.

1.1.2.4 The rooms, hallways or stairwells selected for sampling shall be selected according to documented methodologies.

1.1.2.5 The North Dakota certified inspector or risk assessor shall compare the residual lead level (as determined by the laboratory analysis) from each single surface dust sample with clearance levels stated below;

The clearance standard/level(s) for lead in dust are 40 $\mu g/ft^2$ for floors, 250 $\mu g/ft^2$ for interior window sills, and 400 $\mu g/ft^2$ for window troughs.

1.1.2.6 If the if the clearance sample results in levels above the standard the Contractor shall re clean, at the Contractor expense, and the areas will be retested. This process will continue until the clearance standard is achieved.

1.1.2.7 An abatement report shall be prepared by a certified supervisor or project designer. The abatement report shall include the following information:

a. Start and completion dates of abatement.

b. The name and address of each certified firm conducting the abatement and the name of each supervisor assigned to the abatement project.

c. The name, address, and signature of each certified risk assessor or inspector conducting clearance sampling and the date of clearance testing.

d. The results of clearance testing and all soil analyses (if applicable) and the name of each recognized laboratory that conducted the analyses.

e. A detailed written description of the abatement, including abatement methods used, locations of rooms and/or components where abatement occurred, reason for selecting particular abatement methods for each component, and any suggested monitoring of encapsulants or enclosures.

1.1.3 In a multi-family dwelling with similarly constructed and maintained residential dwellings, random sampling for the purposes of clearance may be conducted provided:

1.1.3.1 The certified individuals who abate or clean the residential dwellings do not know which residential dwelling will be selected for the random sample.

1.1.3.2 A sufficient number of residential dwellings are selected for dust sampling to provide a 95 percent level of confidence that no more than 5 percent or 50 of the residential dwellings (whichever is smaller) in the randomly sampled population exceed the appropriate clearance levels.

1.1.3.4 The randomly selected residential dwellings shall be sampled and evaluated for clearance as stated above.

1.1.3.5 An abatement report shall be prepared by a certified supervisor or project designer. The abatement report shall include the following information:

a. Start and completion dates of abatement.

b. Abatement and the name of each supervisor assigned to the abatement project.

c. The name, address, and signature of each certified risk assessor or inspector conducting clearance sampling and the date of clearance testing.

d. The results of clearance testing and all soil analyses (if applicable) and the name of each recognized laboratory that conducted the analyses.

e. A detailed written description of the abatement, including abatement methods used, locations of rooms and/or components where abatement occurred, reason for selecting particular abatement methods for each component, and any suggested monitoring of encapsulants or enclosures.

END OF SECTION 01 45 30

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 WATER SERVICE

1.1 The owner will provide for water for the work of this project.

1.1.1 All water connections shall be made from outside the enclosure.

1.1.2 **Water supply shall be turned-off and connections shall be disconnected at the end of each work shift.**

1.2 Water Hoses: Employ heavy-duty abrasion-resistant hoses with a pressure rating greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.

1.3 Hot Water: Provide equipment for heating of water for decontamination showers. Building water heaters will be decommissioned prior to abatement activities.

2.0 ELECTRICAL SERVICE

2.1 General: Comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.

2.2 The owner will provide electrical service for the work of this project.

2.3 Voltage Differences: Provide identification warning signs at power outlets which are other than 110-120 volt power. Provide polarized outlets for plug-in type outlets, to prevent insertion of 110-120 volt plugs into higher voltage outlets. Dry type transformers shall be provided where required to provide voltages necessary for work operations.

2.4 Ground Fault Protection: Equip all circuits for any purpose entering work area with ground fault circuit interrupters (GFCI). Locate GFCIs exterior to work area so that all circuits are protected prior to entry to work area. Provide circuit breaker type GFCI equipped with test button and reset switch for all circuits to be used for any purpose in work area, decontamination units, exterior, or as otherwise required by national electrical code, OSHA or other authority. Locate in panel exterior to work area.

2.5 Electrical Power Cords: Use only grounded extension cords; use hard-service cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work.

2.6 Lamps and Light Fixtures: Provide general service incandescent lamps or fluorescent lamps of wattage indicated or required for adequate illumination as required by the work or this section. Protect lamps with guard cages or tempered glass enclosures, where fixtures are exposed to breakage by construction operations. Provide vapor tight fixtures in work area and decontamination units. Provide exterior fixtures where fixtures are exposed to the weather or moisture.

2.7 Lockout: Lockout all existing power to or through the work area as described below. Unless specifically noted otherwise existing power and lighting circuits to the work area are not to be used. All power and lighting to the work area and decontamination facilities are to be provided from temporary electrical panel described below.

2.8 Lockout Power to Work Area by switching off all breakers serving power or lighting circuits in work area. Label breakers with tape over breaker with notation "DANGER circuit being worked on." Lock panel and have all keys under control of Contractor's Superintendent or Owner's Designated Representative.

2.9 Lockout Power to Circuits Running Through Work Area wherever possible by switching off all breakers serving these circuits. Label breakers with tape over breaker with notation "DANGER circuit being worked on." Sign and date danger tag. Lock panel and supply keys to Contractor, Owner and Owner's Representative. If circuits cannot be shut down for any reason, label at intervals 4'-0" on center with tags reading, "DANGER live electric circuit. Electrocution hazard."

3.0 FIRST AID

3.1 First Aid Supplies: Comply with governing regulations and recognized recommendations within the construction industry.

4.0 FIRE EXTINGUISHERS

4.1 Provide Type A fire extinguisher for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type ABC dry chemical extinguisher, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.

4.2 Comply with the applicable recommendations of NFPA Standard 10 "Standard for Portable Fire Extinguisher." Locate fire extinguishers where they are most convenient and effective for their intended purpose, but provide not less than one extinguisher in each work area in Equipment Room and one outside work area in Clean Room.

5.0 TEMPORARY LIGHTING

5.1 Lockout: Lock out all existing power to lighting circuits. All lighting to the work area and decontamination facilities is to be provided from temporary electrical panel described above.

5.2 Number of Lighting Circuits: Provide sufficient lighting circuits as required by the work. All lighting circuits are to originate at temporary electrical panel.

6.0 SANITARY FACILITIES

6.1 Abatement Contractor must provide toilet facilities for its employees.

7.0 WASTE CONTAINER

7.1 A waste container dumpster may be placed on the grounds of the Property following coordination with the owner.

8.0 PARKING

8.1 Employee parking is the responsibility of the Abatement Contractor.

END OF SECTION 01 50 00

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions and the General Requirements apply to the Work of this Section.

1.0 PROJECT RECORD DOCUMENTS

Final payment will not be recommended by the Owners' Representative/Consultant until all Post-project submittals are received.

1.1. Daily entry logs documenting the names of all persons entering or leaving any containment areas where an asbestos contaminated or potentially contaminated atmosphere exists.

1.2 Results of all asbestos exposure monitoring data collected by Contractor.

1.3 Contractor's daily logs summarizing and documenting daily abatement activities, calibration of the manometer, unusual events and amount of waste material removed from the work site.

1.4 Pressure monitoring data.

1.5 Waste transport and disposal certificates (manifests) after load-out and transportation of the waste to the Landfill. Provide copy of manifest to the Consultant prior to shipment of materials from site. Submit the completed copy from the Landfill within 24 hours of receiving each manifest.

1.6 Records of emergency evacuations, emergency cleanup, and any injuries or other accidents after each occurrence. (Submit within 24-hours of the event.)

1.7 Amended regulatory notification(s). Submit within 24-hours of submitting to the appropriate agencies.

1.8 A log of all equipment repairs, filter changes, etc. on a weekly basis or as they occur.

2.0 FINAL PAYMENT

In requesting final inspection and accompanying the Contractor's Final Payment, prepare and submit all items and documents listed in this project Manual

END OF SECTION 01 77 00

Terracon

DIVISION 2

SITEWORK

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

1.0 GENERAL WORK PRACTICES

The Contractor shall be responsible for the development and implementation of the following general work practices:

1.1 Restrict access into the work area to only those employees or visitors previously approved to enter the area by the Owner or Consultant.

1.2 Emergency exits shall be established and clearly labeled as such. They shall be secured so as to prevent access from uncontaminated areas yet permit emergency exiting. Emergency exits may include the Decontamination Chamber, Equipment/Waste Transfer Chamber, or other alternative exits approved by the Owner or Consultant. All personnel shall be trained on emergency procedures.

1.3 Provide for an approved on-site superintendent (foreman) during asbestos abatement related procedures. A site superintendent shall be present at all times while work is being performed by the Contractor.

1.4 Practice safe work procedures in the work space. Eating, drinking, or smoking is not permitted within the containment area(s) or near any polyethylene sheeting.

1.5 Provide a smoke detection system capable of monitoring the entire containment area and sounding an alert when fire conditions are detected.

1.6 Provide for personal air monitoring for determination of exposures during the work on a daily basis.

1.7 Utilize safe work practices at all times to prevent accidents in and around the work area.

1.8 Minimize release of asbestos fibers during all stages of the project.

1.9 Be prepared to administer first aid to injured personnel at all times. Seriously injured personnel shall be treated immediately or removed without delay.

Note: Extreme caution and care must be taken when moving injured personnel. Certain types of injuries can be exacerbated by movement. Unless the injured person's life is threatened, they should not be moved except by medical personnel. Consult a physician if in doubt.

1.10 Maintain all barriers and engineering control systems. Perform regular examinations to identify and immediately correct any problems encountered.

1.11 Provision of fire extinguisher in containment as required by 29 CFR OSHA 1926.150 (a)(1). The fire extinguisher must be rated not less than 2A, with a least one extinguisher for every 3,000 square feet of containment area, with a travel distance not to exceed 100 feet.

1.12 Provision of worker training in the use of firefighting equipment as required by 29 CFR OSHA 1926.150 (a)(5).

1.13 Plastic film, including poly sheeting, installed on building elements shall be flame resistant as required for combustible decorative material in accordance with Section 1103.3.3 of the Uniform Fire Code.

2.0 WORKER TRAINING

2.1 State License: All workers are to be trained, certified and accredited as required by the State of North Dakota. All workers are to have in their possession, a current license from the State of North Dakota. A copy of each individual's license is to be submitted to the Owner's Representative as part of the pre-construction submittal.

2.2 Train, in accordance with 29 CFR 1926, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:

2.2.1 Methods of recognizing asbestos

2.2.2 Health effects associated with asbestos

2.2.3 Relationship between smoking and asbestos in producing lung cancer

2.2.4 Nature of operations that could result in exposure to asbestos

2.2.5 Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

Engineering controls
Work Practices
Respirators
Housekeeping procedures
Hygiene facilities
Protective clothing
Decontamination procedures
Emergency procedures
Waste disposal procedures

2.2.6 Purpose, proper use, fitting, instructions, and limitations of respirators as required by 29 CFR 1910.134

2.2.7 Appropriate work practices for the work

2.2.8 Requirements of medical surveillance program

2.2.9 Review of 29 CFR 1926

2.2.10 Pressure Differential Systems

2.2.11 Work practices including hands on or on-job training

2.2.12 Personal decontamination procedures

2.2.13 Air monitoring, personal and area

3.0 MEDICAL EXAMINATIONS

3.1 Provide Medical Examinations for all workers who will enter the work area for any reason. Examination shall as a minimum meet OSHA requirements as set forth in 29 CFR 1926.1101. In addition, provide an evaluation of the individual's ability to work in environments capable of producing heat stress in the worker.

3.2 Report from Medical Examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area. Submit, with the pre-construction submittal, at a minimum, for each worker the following:

3.2.1 Name and Social Security Number

3.2.2 Physicians Written Opinion from examining physician including at a minimum the following:

a. Whether worker has any detected medical conditions that would place the worker at an increased risk of material health impairment from exposure to asbestos.

b. Any recommended limitations on the worker or on the use of personal protective equipment such as respirators.

c. Statement that the worker has been informed by the physician of the results of the medical examination and of any medical conditions that may result from asbestos exposure.

3.2.3 Copy of information that was provided to physician in compliance with 29 CFR 1926

3.2.4 Statement that worker is able to wear and use the type of respiratory protection proposed for the project, and is able to work safely in an environment capable of producing heat stress in the worker.

4.0 CERTIFICATE WORKER ACKNOWLEDGEMENT

4.1 Submit an original signed copy of the Certificate of Worker's Acknowledgement for each worker who is to be at the job site or enter the work area.

5.0 NOTARIZED CERTIFICATIONS

5.1 Submit certification signed by an officer of the abatement contracting firm and notarized that exposure measurements, medical surveillance, and worker training records are being kept in conformance with 29 CFR 1926.

6.0 EQUIPMENT

6.1 Protective Clothing:

6.1.1 Coveralls: Provide disposable full-body coveralls with attached hoods and foot covers, and with elastic wrist bands, and require that they be worn by all personnel in the work area. Provide a sufficient number for all required changes, for all personnel in the work area. Provide coveralls for the Owner's Representative, Project Administrator, Owner, authorized site visitors, and for any State or Federal personnel who may have jurisdiction in relation to the project.

6.1.2 Boots: Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos-contaminated waste at the end of the work, or place and seal into disposal bags for reuse in another asbestos containment area.

6.1.3 Hard Hats: Provide head protectives (hard hats) as required by OSHA for all workers, and provide 4 spares for use by Owner's Representative, Project Administrator, Owner, authorized site visitors, and for any State or Federal personnel who may have jurisdiction in relation to the project. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats of type with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.

6.1.4 Goggles: Provide eye protective eyewear (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury. Thoroughly clean, decontaminate and bag goggles before removing them from work area at the end of the work.

6.1.5 Gloves: Provide work gloves to all workers and require that they be worn at all times in the work area Do not remove gloves from work area and dispose of as asbestos-contaminated waste at the end of the work.

7.0 RESPIRATORY PROTECTION

7.1 GENERAL

7.1.1 Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respirator use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.

7.1.2 Respiratory Protection Program: Comply with ANSI Z88.2 - 2015 "Practices for Respiratory Protection" and OSHA 29 CFR 1910 and 1926.

7.1.3 Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental, and at all times after asbestos containing material has been disturbed until the area has passed clearance monitoring.

7.1.4 The Contractor shall provide two sets of Powered Air Purifying Respirators or Supplied Air respirators for the Owner, Project Administrator, and regulatory personnel.

7.1.5 Extra batteries for Powered Air Purifying Respirators shall be provided at the rate of one extra for every two workers. If there are an odd number of workers, then one additional battery should be provided.

7.2 AIR QUALITY FOR SUPPLIED AIR RESPIRATORY SYSTEMS

7.2.1 Provide air used for breathing in Type C supplied air respiratory systems that meets or exceeds standards set for C.G.A. type 1 (Gaseous Air) Grade D:

7.3 EQUIPMENT

7.3.1 Air Purifying Respirators:

7.3.1.1 Respirator Bodies: Provide full face, tight fitting respirators, hood or helmet type respirators are not acceptable.

7.3.1.2 Filter Cartridges: Provide, at a minimum, P-100 (HEPA) type filters labeled with NIOSH Certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z88.7-2010 Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters. In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH Certification.

7.3.1.3 Non-permitted respirators: **Do not use single use, disposable or quarter face respirators**.

7.3.2 Supplied Air Respirator Systems:

7.3.2.1 Provide equipment capable of producing air of the quality and volume required by the above reference standards applied to the job site conditions and crew size. Comply with provisions of this specification if more stringent than the governing standard.

7.3.2.2 Face Piece and Hose: Provide full face piece and hose by same manufacturer that has been certified by NIOSH as an approved Type C respirator assembly operating in pressure demand mode with a positive pressure face piece.

7.3.2.3 Auxiliary backup system: In atmospheres which contain sufficient oxygen (greater than or equal to 19.5% oxygen) provide a pressure-demand full face piece supplied air respirator equipped with an emergency backup HEPA filter.

7.3.2.4 Escape air supply: In atmospheres which are oxygen deficient (less than 19.5% oxygen) provide a pressure-demand full face piece supplied air respirator incorporating an auxiliary self-contained breathing apparatus (SCBA) which automatically maintains an uninterrupted air supply in pressure demand mode with a positive pressure face piece.

7.3.2.5 Backup air supply: Provide a reservoir of compressed air located outside the work area which will automatically maintain a continuous uninterruptable source of air automatically available to each connected face piece and hose assembly in the event of compressor shut-down, contamination of air delivered by compressor, power loss or other failure. Provide sufficient capacity in the back-up air supply to allow a minimum escape time of one-half hour times the number of connections available to the work area. Air requirement at each connection is the air requirement of the respirators in use plus the air requirement of an average-sized adult male engaged in moderately strenuous activity.

7.3.2.6 Warning device: Provide a warning device that will operate independently of the building's power supply. Locate so that alarm is clearly audible above the noise level produced by equipment and work procedures in use, in all parts of the work area and at the compressor. Connect alarm to warn of:

a. Compressor shut down or other fault requiring use of backup air supply

b. Carbon Monoxide (CO) levels in excess of 5 PPM/V

7.3.2.7 Carbon Monoxide (CO) Monitor: Continuously monitor and record on a strip chart recorder Carbon Monoxide (CO) levels. Place monitors in the air line between compressor and back-up air supply and between backup air supply and workers. Connect monitors so that they also sound an alarm as specified under Warning Devices. A carbon monoxide monitor is not required if oil-less compressors are used.

7.3.2.8 Compressor Shut Down: Interconnect monitors, alarms and compressor so that compressor is automatically shut down and the alarms sounded if any of the following occur:

a. Carbon Monoxide (CO) concentrations exceed 5 PPM/v in the air line between the filter bank and backup air supply

b. Compressor temperature exceeds normal operating range

7.3.2.9 Compressor Location: Locate compressor outside of building in location that will not impede access to the building, and that will not cause a nuisance by virtue of noise or fumes to occupied portions of the building.

7.3.2.10 Air Intake: Locate air intake remotely from any source of automobile exhaust or any exhaust from engines, motors, auxiliary generator or buildings.

7.3.2.11 After-Cooler: Provide an after-cooler at entry to filter system which is capable of reducing temperatures to outside ambient air temperatures.

7.3.2.12 Self Contained Breathing Apparatus (SCBA): Configure system to permit the recharging of 1/2 hour 2260 PSI SCBA cylinders.

7.4 FIT TESTING

7.4.1 Initial Fitting: Provide initial fitting of respiratory protection. Fit types of respirator to be actually worn by each individual. Allow an individual to use only those respirators for which training and fit testing has been provided.

7.4.2 On a Weekly Basis, check the fit of each worker's respirator by having irritant smoke blown onto the respirator from a smoke tube.

7.4.3 Upon Each Wearing: Require that each time an air-purifying respirator is put on it be checked for fit with a positive and negative pressure fit test in accordance with the manufacturer's instructions or ANSI Z88.2 (2015).

7.5 RESPIRATOR MAINTENANCE

7.5.1 Respirators shall be identified with unique numbers and each respirator shall be assigned to one person.

7.5.2 In the Clean Change Chamber of the Personal Decontamination Unit, single use respirator disinfecting wipes shall be provided for respirator sanitation.

7.5.3 Respirators shall be inspected to insure that all valves are present and function as they are designed.

7.5.4 The rate of airflow for PAPRs should be checked for each respirator on a daily basis. The rate shall not drop below the manufacturer's recommendations.

7.5.5 Respirators filters shall be changed at least every forty hours or when the air-flow indicator shows an unacceptable rate of airflow.

7.5.6 At the Contractor's option, extra batteries for PAPRs can be stored inside the enclosure. If this is done, the workers may exchange batteries when one fails without leaving the enclosure. If no batteries are available or the Contractor chooses not to store charged batteries inside the enclosure, then the worker shall without delay, exit the enclosure using the Personal Decontamination Unit. The worker shall not re-enter the enclosure until he has a fully charged battery.

END OF SECTION 02 82 13

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

The following procedures shall be used when the removal of 25 linear feet or greater of pipe lagging or 10 square feet or greater of asbestos-containing material **per room** is to be conducted.

1.0 PREPARATION OF WORK AREA

1.1 Clean all surfaces of the containment area before abatement.

1.2 Uncontaminated movable items will be removed from the immediate work area by the Owner prior to initial set-up of the containment area.

1.3 Shutdown air handling system to the work area.

1.4 Clean contaminated objects to remove visible asbestos-containing bulk materials.

1.5 Clean all existing electrical wires, valve dampers, utility boxes, speakers, light panels, phone connections, etc., and cover with a minimum of one layer of six mil poly sealed to prevent any water or encapsulation damage or contamination thereof. The Contractor shall take precautions to avoid any heat build-up and subsequent damage or potential fires.

1.6 Pipe insulation not to be removed under the scope of this project, shall be protected to prevent water damage and to prevent contamination.

1.7 Seal all openings between the containment area and uncontaminated areas with a “critical barrier” of at least one layer of six mil poly securely fastened to achieve and airtight seal around the opening.

1.8 Seal all penetrations leading into or out of the containment area (critical barrier areas), with one layer of six mil poly sheeting, duct tape, expanding foam sealant, or other suitable method.

1.9 Clean the exterior surfaces of all ventilation ductwork. Seal any HVAC openings and seams with two layers of six mil poly.

1.10 Seal all porous (non-cleanable) ceiling surfaces with at least one layer of four mil poly sheeting, unless ceiling materials are object of abatement. Seal all other porous (non-cleanable) surfaces with at least one layer of six mil poly sheeting.

1.11 Establish containment constructed to separate and isolate the containment area from the rest of the building. The containment must be airtight and leakproof.

1.12 All containment area floors excluding carpeted surfaces, shall have a minimum of two layers of six mil poly sheeting. All carpeted floors shall have three layers of six mil poly sheeting. Extend sheeting at least twelve inches up the pre-existing side walls to avoid contaminated water run-off. Overlap wall poly and secure to the floor poly. Stagger floor seams, so as to not have two seams laying on top of each other.

1.13 All containment walls shall have a minimum of two layers of four mil poly sheeting, overlapping to provide an airtight and leakproof seal. Frame freestanding containment walls with materials painted with a nonporous paint to allow proper cleaning.

1.14 Install a twelve inch by twelve inch clear viewing window, where feasible, to allow for a view of the work area.

1.15 Provide Warning Signs at each locked door leading to work area.

1.16 Immediately inside door and outside critical barriers post an approximately 20 inch by 14 inch manufactured caution sign displaying the following legend with letter sizes and styles of a visibility required by 29 CFR 1926:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY

In addition, where the use of respirators and protective clothing is required in the regulated area under this section, the warning signs shall include the following:

WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA

2.0 PERSONNEL DECONTAMINATION CHAMBER

2.1 Establish a decontamination chamber, contiguous with the asbestos work area.

2.2. The decontamination chamber shall consist of three distinct sections as a minimum. These include the clean room, shower, and equipment room (dirty room). The overall size of the decontamination chamber is dependent on the availability of space; however, it shall be constructed so as to accompany at least four to five individuals at one time.

2.3 The decontamination chamber shall be constructed of two separate layers of six mil poly. Opaque poly shall be installed on the outside of the decontamination chamber. Each distinct section shall be separated from its adjacent room by an airlock door which consists of three distinct poly door flaps or two sets of two distinct poly door flaps with a minimum of three feet of space between doorways.

2.4 Clean Room

2.4.1 The clean room shall remain free from asbestos contamination throughout the entirety of the project. The floor surface shall remain free from any water accumulations. The Contractor shall wet-wipe all inside surfaces within the clean room on a daily basis or more frequently as needed.

2.4.2 The clean room shall serve as a change room where workers remove all street clothing, including undergarments, and suit-up in disposable full-body protective suits. Gym shorts or other articles of clothing to be worn over the disposable suits are permitted but are required to be left inside the abatement area or Equipment Room.

2.4.3 Provide all personnel, including the Owner, Consultant and all other Authorized Visitors, with clean full-body disposable protective suits allowing for an adequate number of changes and towels for drying purposes.

2.4.4 Emergency procedures, phone numbers, and other applicable references shall be posted and be readily accessible in the clean room.

2.4.5 Provide for a fully charged dry chemical, multi-purpose type (Class ABC) fire extinguisher to be stored in the clean room.

2.5 Shower

2.5.1 Provide a completely watertight operational shower to be used for access from the clean room into the equipment room and for showering by workers exiting the work area into the clean room.

2.5.2 Provide leak tight shower enclosure with integrated drain pan fabricated from fiberglass or other durable waterproof material, approximately 3' x 3' square with minimum 6' high sides and back. Structurally support as necessary for stability. Connect drain to a reservoir, pump water from reservoir through five micron filters to a drain or store and bag for disposal.

2.5.3 Provide totally submersible waterproof sump pump with integral float switch. Provide unit sized to pump 2 times the flow capacity of all showers or hoses supplying water to the sump, through the filters specified herein when they are loaded to the extent that replacement is required. Provide unit capable of pumping debris, sand, plaster or other materials washed off during decontamination procedures without damage to mechanism of pump. Adjust float switch so that a minimum of 3" remains between top of liquid and top of sump pan.

2.5.4 The shower shall have a floor drain which collects all water run-off. All water shall be directed through a water-filtering device effective for filtering particulate matter five microns in size or larger. Water filters shall be treated as contaminated waste and changed on a routine basis or as needed so as to prevent water build-up in the shower basin. Filtered shower water may be discharged into a facility floor drain.

2.5.5 The shower shall provide both hot and cold water, controllable from inside the shower. Absolutely no cold showering is permitted.

2.5.6 The shower shall have separate openings for ingress and egress. Single-opening showers are not permitted. Access to the containment area must pass through the shower.

2.5.7 Provide soap and shampoo in the shower room.

2.6 Equipment Room

2.6.1 The equipment room shall serve as storage for re-usable outer wear, gloves, boots, and other clothing and equipment.

2.6.2 Workers shall remove and dispose of their disposable protective clothing in this room prior to entering the Shower. All suits shall be placed into a labeled, six mil, and asbestos waste disposal bag.

2.7 Clean the decontamination chamber frequently to prevent water build-up or accumulation of bulk debris.

3.0 PERSONNEL DECONTAMINATION PROCEDURES

3.1 Entering Work Area

3.1.1 Workers shall remove all street clothing and undergarments and change into a clean full-body disposable protective suit. A respirator, as specified herein, equipped with HEPA cartridges shall be put on and properly fitted prior to entering the shower room.

3.1.2 The worker shall then proceed through the shower room or by-pass area into equipment room. Any reusable clothing, such as gloves or rubber boots, are put on at this point prior to entering work area.

3.2 Leaving Work Area

3.2.1 Require all workers to adhere to the following personal decontamination procedures whenever they leave the work area:

3.2.1.1 When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the equipment room.

3.2.1.2 Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:

3.2.1.3 Thoroughly wet body including hair and face. If using a Powered Air-Purifying Respirator (PAPR) hold blower unit above head to keep canisters dry.

3.2.1.4 With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.

3.2.1.5 Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breath.

3.2.1.6 Carefully wash facepiece of respirator inside and out.

3.2.2 If using PAPR shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.

3.2.3 Shower completely with soap and water. Rinse thoroughly.

3.2.4 Rinse shower room walls and floor prior to exit.

3.2.5 Proceed from shower to Changing Room and change into street clothes or into new disposable work items.

4.0 EQUIPMENT/WASTE TRANSFER CHAMBER

4.1 Provide an equipment/waste transfer chamber consisting of two separate areas: The dirty room (adjacent to and directly off of the containment area) and the clean room. The rooms shall be separated by airlock doors, including ingress/egress doors between the containment area and the dirty room and between the clean room and outside area. The entire equipment/waste transfer chamber shall be constructed of two separate layers of 6 mil poly.

4.2 All personnel working in the chamber shall wear full-body protective clothing and respirators as specified herein. Keep the equipment/waste transfer chamber clean and free from any waste or bulk asbestos build-up. Do not allow the chamber to become contaminated with asbestos-containing debris.

4.3 Prior to moving any equipment or supplies from the containment area through the dirty room, thoroughly wash or wet-wipe all surfaces to remove any visible asbestos contamination. When transferring equipment/supplies that are difficult to clean or are suspected of asbestos contamination, they shall be wrapped in two layer of 6 mil poly and have the appropriate OSHA asbestos label affixed. All equipment/supplies are then transferred into the clean room where they may be temporarily stored or transferred to the outside.

4.4 All bagged asbestos waste shall be sprayed-off or wet-wiped prior to transfer into the dirty room (or equipment room, if a separate equipment/waste transfer chamber is not being used). Once inside the dirty room, the bagged waste shall be goosenecked, sealed, and placed into a second 6 mil, labeled waste bag taking precautions to minimize the amount of residual air left inside the outer bag prior to sealing it shut. Gooseneck, seal, and wet-wiped the outer bag with clean water and rags prior to transfer into the clean room. All double-bagged waste is then transferred into the clean room.

4.5 All material to be disposed of as contaminated waste which cannot be bagged shall be wrapped in a layer of 6 mil poly while still inside the containment area. The outer poly surface shall be sprayed-off with water prior to transfer into the Dirty Room. The material shall be wrapped in another layer of 6 mil poly and the appropriate OSHA asbestos warning label affixed.

4.6 Waste containing sharp objects or edges shall be placed in metal or fiber drums with locking ring tops, unless the sharps can be covered or blunted.

5.0 ENGINEERING CONTROLS

Alternative work area ventilation systems may be proposed, but must be approved by the North Dakota Commissioner of Health, the Owner, and the Consultant.

5.1 Provide portable HEPA filtration systems positioned within the containment area. Each unit shall have a calibrated pressure gauge or equivalent device to measure the pressure drop across the internal HEPA filter. In addition, each unit shall be equipped with an audible alarm or an automatic unit shutdown mechanism to signal abnormal operation or power loss.

5.2 Provide HEPA filters that are individually tested and certified by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3 um dioctylphthalate (DOP) particles when tested in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions, and that are marked with: the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.

5.3 All HEPA filtration systems shall be equipped with pre-filters for the collection of larger-sized particulate matter to prolong the operating life of the internal HEPA filter. Pre-filters shall be replaced with new ones, while the unit is still running, whenever the pressure drop across the filter becomes excessive.

5.4 Prior to start-up, inspect all gaskets and seals for any signs of damage or openings.

5.5 Each unit shall be serviced by a dedicated minimum 115V-20A circuit with an overload device tied into an existing building electrical panel which has sufficient capacity to accommodate the load of all units connected to it.

5.6 All HEPA filtration systems shall remain in operation 24 hours per day, 7 days per week until all final clearance criteria has been met. Upon receiving approval from the

Consultant, the Contractor may shutdown the systems during encapsulation.

5.7 The Contractor shall provide for 1 additional HEPA filtration system to be left on site as a back-up unit. The Contractor's site superintendent shall document the number of hours of use for each individual unit's internal HEPA filter. The total operational time on each internal HEPA filter shall not exceed the manufacturer's specified life span for the filter.

5.8 The Contractor shall provide enough systems to maintain a negative pressure differential within the containment area. Negative pressure shall be demonstrated by the following:

5.8.1 Visual detection of negative pressure on the poly barriers or airlock doors.

5.8.2 The minimum pressure differential to be maintained in the containment area shall be a negative 0.02 inches of water (-0.02" H_2O) as compared to outside the containment area.

5.8.3 Use a recording manometer hooked up to a strip chart recorder. Negative pressure readings shall be recorded continuously until final clearance levels have been achieved. The monitor shall be located as far away from the HEPA filtration system intakes as possible.

5.8.3.1 The recording manometer shall be calibrated annually, and zeroed on a daily basis by the Contractor prior to each work-shift start-up. Monitor the operation of the recording manometer every two hours. When the manometer is zeroed, the following information shall be recorded on the recording paper:

a. Person performing the calibration
b. Time and date of calibration
c. Pressure level after calibration

5.8.3.2 In the event of failure of a recording manometer, hourly pressure readings shall be documented. The recording manometer shall be repaired or replaced within 24 hours. Recording manometer failure monitoring documentation must be maintained on-site for the duration of the project.

5.9 All HEPA filtration system discharge air shall be exhausted through flexible duct which shall be directed through windows to the outside of the building. Where possible, the Contractor shall install a temporary wood window in place of the glass with an opening cut-to-size with respect to the flexible duct diameter. The Contractor shall seal the space between the duct and the wood window opening with duct tape or a caulking compound. The HEPA exhaust outlet shall be at least 25 feet away from all building entrances, vents or other openings.

5.10 The amount of air exhausted from the containment must provide for at least four air changes per hour. If it is not possible to establish or maintain required negative pressure, the amount of air exhausted must be increased to six air changes per hour. Documentation shall be maintained.

5.11 If loss of power to the work area occurs, the Contractor shall immediately stop all work and proceed to seal up all openings into the work area prior to exiting the containment area. No removal work shall take place until power to the work area has been restored and all HEPA filtration systems are operating. Bagging/cleaning activities employing wet methods may take place, however.

5.12 The Contractor shall position the HEPA filtration systems so that airborne fiber levels are minimized throughout the work area.

5.13 The pipe tunnels are considered a Class IA confined space as per the North Dakota Confined Space Standard. The following conditions must be met when conducting abatement in a pipe tunnel. Either:

5.13.1 The work area (enclosed by the critical barriers) must have six air changes per hour; and make-up air must be ducted from outside the tunnel (non-ambient), or:

5.13.2 A monitoring device measuring the following levels shall be worn by at least one (1) worker at all times when workers are in the confined space:

5.13.2.1 Oxygen level must be between 19.5% and 23.5% by volume.

5.13.2.2 Combustible gases (including methane) concentration shall not exceed 10% of the Lower Explosive Limit (LEL) of any combustible material existing or introduced into the confined space.

5.13.2.3 If levels are found outside the above parameters, all employees will exit the confined space immediately and shall not re-enter the confined space until safe oxygen and air contamination levels have been verified.

6.0 FINAL PREPARATION

6.1 The Contractor shall place asbestos warning signs, in accordance with OSHA requirements, along any potential access points into the work area.

6.2 Prior to the start-up of any abatement work, the Contractor shall receive verbal approval from the Consultant. Approval shall be based on the establishment of all barriers, Decontamination Chambers, the engagement of all engineering controls, and smoke tests to determine air-flow direction and the presence of leaks.

7.0 GROSS REMOVAL PROCEDURES

7.1 Continually wet all ACM with an amended water solution using an airless sprayer or Hudson sprayer with a fine mist nozzle during abatement. Use a HEPA wet-vacuum or any other approved means to avoid water accumulation on the floor poly.

7.2 Strip or remove designated wetted ACM from facility components. Do not allow to dry.

7.3 Frequently mist the ambient air in the work area with an amended water solution or removal encapsulant to minimize airborne fiber levels.

7.4 Bag all asbestos-containing waste as work progresses to prevent any ACM from drying or being re disturbed.

7.5 Thoroughly brush or scrub all pipe and pipe fitting surfaces, especially where corrosion or threaded pipe fittings exist.

7.6 Immediately contain any water run-off occurring outside of the containment area, using an appropriate HEPA wet-dry vacuum or other approved methods. Treat all water collected as contaminated and dispose of accordingly.

7.7 If the Owner's Representative/Environmental Consultant reports a fiber concentration outside the containment exceeding the indoor air standard, occupied areas immediately adjacent to the asbestos work area must be evacuated. Reoccupation may not occur until:

7.7.1 The integrity of the containment is checked, and repaired if necessary;

7.7.2 The negative pressure is checked and brought into compliance if necessary;

7.7.3 The adjacent areas are cleaned via wet-wipe and HEPA vacuum methods;

7.7.4 The adjacent area where elevated fiber levels occurred is below the indoor air standard based on the collection and analysis of five PCM air samples collected simultaneously.

7.7.5 If non-asbestos contamination is suspected of interfering in PCM analysis and causing the elevated fiber level, evacuation of adjacent areas may be delayed pending collection and analysis of TEM samples.

7.8 If the critical or primary barrier falls or is breached in any manner stop work immediately. Do not start work until authorized in writing by the Owner's Representative. If the critical barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add affected area to the work area.

8.0 INITIAL POST ABATEMENT CLEANING

8.1 Upon completion of gross removal, clean all visible bulk material and water accumulations from the floor, walls, and other surfaces of the containment, equipment, and the decontamination unit using HEPA vacuums and/or wet wipe methods.

8.2 No visible bulk ACM shall remain upon completion of the cleaning.

8.3 All water or debris collected shall be bagged or barreled as asbestos waste.

8.4 A visual inspection of the containment and decontamination unit shall be performed after drying completely. The Contractor and Consultant shall conduct a thorough visual examination of all surfaces to determine that no visible bulk insulation or residual dust remains. Cleaning and inspections shall be repeated until the area passes visual inspection.

9.0 ENCAPSULATION AFTER POST ABATEMENT CLEANING

9.1 Apply a minimum of one coat of an approved lockdown encapsulant to all surfaces within the containment area and the decontamination unit equipment room and the equipment/waste transfer chamber's dirty room.

9.2 The Contractor shall allow the first coat to dry thoroughly prior to applying a second coat or proceeding to the final cleaning process.

9.3 Application shall be based on manufacturer's recommended mixture and techniques. A suitable colored dye additive shall be used in the encapsulant mixture which can be visually identified when dry.

10.0 REMOVAL OF CONTAINMENT WALLS AND FLOORS

10.1 Once the encapsulation process is completed, remove the walls and floor poly sheeting, and poly covering wires, utility boxes, etc. All critical barriers shall be left intact. All poly removed shall be bagged or barreled as asbestos-contaminated waste.

10.2 Wet-wipe or HEPA-vacuum all surfaces where poly was removed. This includes inside the shower and clean rooms of the decontamination unit.

10.3 Remove all bagged waste and equipment from the containment area. Refer to Section 02089 for disposal specifications.

10.4 With HEPA filtration systems still in operation, the Contractor shall remove and bag existing pre-filters and replace with new ones or clean pre-filters. All surfaces of the HEPA filtration systems shall be free of any visible particulate material.

10.5 The Contractor and Consultant shall conduct another thorough visual examination of all surfaces where wall and floor poly was present to determine that no visible bulk insulation or residual dust remains. Any observed contamination must be cleaned until the area passes visual inspection.

10.6 Representatives of the Contractor and the Testing Laboratory shall then complete a Pre-Final Inspection form (found in Appendix A).

10.7 Clearance air sampling shall be performed by the Consultant as outlined in Section 01 45 29.

10.8 Only after successful completion of the above activities and permission of the Owner and Consultant, critical barriers may be removed.

10.9 The Contractor and Consultant shall conduct a thorough visual examination of all surfaces where critical barriers were present to determine that no visible bulk insulation or residual dust remains. Any observed contamination must be cleaned until the area passes visual inspection.

10.10 Upon successful completion of the tasks of this section, the Contractor may apply for a Certificate of Substantial Completion, issued by the Consultant.

11.0 FINAL CLEAN-UP OF WORK AREA

After all final clearance criteria have been met, the Contractor shall perform the following prior to re-insulation or continuation of work:

11.1 All remaining critical barriers, the Decontamination Chamber and the Equipment/Waste Transfer Chamber shall be removed.

11.2 Poly sheeting, tape, and any other debris associated with the above shall be treated and disposed of as contaminated waste.

11.3 All surfaces behind critical barriers or those surfaces previously covered by the Decontamination or Equipment/Waste Transfer Chambers shall be wet-wiped or HEPA-vacuumed and be visually free of any residual dust.

11.4 All walls, floors, trim, doors, furniture, or other fixtures are to remain in their original condition, but if damaged during the work shall be repaired and finished to match the existing material.

11.5 All fixtures such as fire sensors, lights, etc. removed by the Contractor prior to the abatement activities shall be remounted at this time, if it will not hinder re-insulation activities.

11.6 All HEPA filtration systems' air inlet openings shall be wrapped in one layer (minimum) of six mil poly prior to transporting the systems away from the project site.

END OF SECTION 02 82 14

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

The following are procedures that may be used in rooms where asbestos abatement will consist of the removal of less than 25 lineal feet of pipe lagging or 10 square feet of asbestos-containing material per room. Alternatively, glovebag removal (Section 02 82 17) or full containment (Section 02 82 13) methods may also be used in this circumstance, at the option of the Contractor, unless specifically directed to use a particular method by this Project Manual.

1.0 MINI-CONTAINMENT SETUP

1.1 Shutdown air handling equipment and isolate the area by restricting access to other personnel.

1.2 Remove from the work area all moveable objects to protect them from asbestos contamination and to prevent damage to surfaces or equipment. Objects that cannot be removed will be covered with 6 mil poly sheeting. If the objects have already been contaminated, they will be cleaned with a HEPA vacuum or wet-wiped before being removed or covered with poly.

1.3 Clean the area within ten feet of the mini-containment operation until no dust or debris is visible.

1.4 A mini-containment area must be constructed of at least one layer of 6 mil poly sheeting.

1.4.1 Construct critical barriers over doors, air vents and any other openings using one layer of 6 mil poly.

1.4.2 This area shall be equipped with a HEPA-filtered vacuum or portable ventilation system with HEPA-filtration to create a negative pressure within the mini-containment area with respect to the area outside of the mini-containment area. Negative pressure must be maintained until acceptable clearance air monitoring results indicate that the removal and cleaning procedures are complete.

1.4.3 The mini-containment area will have a two unit Decontamination Chamber with two flap ingress and egress openings between chambers for equipment and workers.

1.4.4 If it is necessary to remove suspended ceiling tile to gain access to pipes, the Contractor shall carefully remove the tiles from the metal grid system, and wet-wipe or HEPA-vacuum ceiling tile surfaces. The ceiling tiles shall be stored out of the work area in a location designated by the Owner or Consultant.

1.5 The Contractor shall place properly labeled asbestos warning signs, in accordance with

OSHA requirements, by any potential access point into the work area.

1.6 A remote decontamination unit must be provided for and used by any worker performing abatement work inside a mini-containment area. This remote decontamination unit must be located to minimize potential contamination of the area between the asbestos work area and the remote decontamination unit.

2.0 PERSONNEL PROTECTIVE EQUIPMENT

2.1 Personnel working inside the mini-containment area must wear at least two layers of full-body protective clothing and an air-purifying respirator equipped with HEPA cartridges. Before leaving the mini-containment area he/she must remove and properly bag their outer layer of protective clothing and HEPA vacuum or wet-wipe their respirator, face, and hands. The worker shall put on a new full-body suit prior to exiting the mini-containment area. The worker shall then proceed to the remote decontamination chamber with their respirator on.

3.0 ABATEMENT AND CLEANING

3.1 ACM exposed as a result of the abatement activity must be encapsulated so that the edges do not release asbestos fibers to the atmosphere.

3.2 The interior of the containment area must be cleaned using a HEPA-filtered vacuum or wet-wipe techniques.

3.3 A lockdown encapsulant must be applied to the inside of the mini-containment area to lock-down any asbestos fibers or debris.

3.4 A visual examination of the containment area shall be conducted by the Contractor and Consultant. During the examination, the containment area shall be checked for any visual debris and that all surfaces have been thoroughly cleaned. Reclean and reinspect until passing.

4.0 CLEARANCE AND TEARDOWN

4.1 The mini-containment must be removed by:

4.1.1 Sealing the door and collapsing the mini-containment using a HEPA-filtered vacuum; or

4.1.2 Conducting final clearance air sampling in accordance with Section 01 45 29.

4.2 Disposal of asbestos waste shall be conducted in accordance with section 02 82 33.

END OF SECTION 02 82 15

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

The following are procedures that may be used in rooms where asbestos abatement will consist of the removal of less than 25 lineal feet of pipe lagging or 10 square feet of asbestos-containing material per room. Alternatively, glove bag removal (Section 02 82 17) or full containment (Section 02 82 13) methods may also be used in this circumstance, at the option of the Contractor, unless specifically directed to use a particular method by this Project Manual.

1.0 GLOVEBAG SETUP

1.1 Glovebags must be constructed of transparent 6 mil polyethylene plastic (poly) or comparable material with thermally welded seams.

1.2 Each glovebag may be used on only one section of pipe insulation. Sliding or moving the glove bag during the abatement procedure is not permitted.

1.3 All air handling equipment servicing the area where abatement is to occur must be shutdown. Controls should be locked off, or marked to prevent tampering of people unaware of the abatement.

1.4 Clean the area within 10 feet of the glovebag operation before any disturbance of asbestos-containing material.

1.5 The work area should be a restricted access area. Entrances to the work area shall be posted with appropriate warning signs.

1.6 Provide a remote decontamination unit.

1.7 Construct critical barriers over doors, air vents, and any other openings using six 6 mil poly and duct tape. The purpose of this is to prevent the unrestricted spread of asbestos contamination should a fiber release occur. Critical barriers shall be used in both occupied and unoccupied areas.

1.8 Place a drop cloth of 6 mil poly on the floor under the work-site. It should extend 10 feet away from the work-site.

2.0 PERSONAL PROTECTIVE EQUIPMENT

2.1 Personnel working within the immediate area shall wear two full-body disposable suits and an air-purifying respirator equipped with P-100 cartridge(s) while in the glovebag area. Only one suit shall be required if a decontamination unit is directly connected and accessible from the glovebag area.

3.0 REMOVAL PROCEDURES

3.1 Use glovebags according to the manufacturer's directions.

3.1.1 Insert hand tools into tool pouch.

3.1.2 Using duct tape, seal the upper flaps of the glovebag over the pipe or pipe fitting insulation. The seal must be airtight. Plan ahead so that the glovebag can be removed without damaging the remaining asbestos-containing material.

3.1.3 Smoke test the glovebag to detect any breach in the seal. Repair any leaks and retest before commencing asbestos removal.

3.1.4 Insert airless sprayer nozzle inside port of glovebag and thoroughly wet the area to be removed with an encapsulant or wetting solution.

3.1.5 Insert the HEPA filtered vacuum hose into the side port and seal around it with tape. OSHA regulations require that glovebag operations must be conducted under negative air pressure. Use the vacuum as necessary to maintain a lower air pressure inside the bag than ambient pressure. (As an alternative, the entire area inside the critical barriers may be kept under negative pressure.)

3.1.6 Insert arms into arm sleeves and gloves. Remove asbestos utilizing utility knife or other means. If asbestos-containing insulation is to remain on the pipe, cut the exposed edge to a smooth surface. If fitting insulation is being removed from a pipe that is insulated with fiberglass lagging, be sure to cut away enough of the fiberglass insulation to remove any asbestos contamination present.

3.1.7 Scrub, brush, or wet-wipe pipe/fitting surface to remove any residue. Pay special attention to threaded surfaces or surfaces where corrosion exists.

3.1.8 Using sprayer, wash debris on pipe/fitting and sides of the bag to the bottom of bag. Wet-wipe if necessary. Also, clean gloves and arm sleeves. Encapsulate any exposed edges of ACM that will remain following removal.

3.1.9 The Contractor and Consultant shall perform a visual inspection of the abated surface to verify the absence of ACM on the surface.

3.1.10 Invert one arm sleeve, turning it inside-out. Insert cleaned hand tools into arm sleeve. Tape around the arm sleeve, pinching the sleeve closed above the tools. Cut the glove off, cutting through the midpoint of the taped seal. Save the sealed glove to be inserted into the next glovebag used.

3.1.11 Evacuate all remaining air from the glovebag, using the HEPA-filtered vacuum.

3.1.12 Squeeze the bag tightly, near the top. Twist the bag several times and tap tightly around the twisted area. All removed ACM should be below the sealed point.

3.1.13 Remove the vacuum hose from the bag. Seal the side port with tape.

3.1.14 Place a 6 mil asbestos disposal bag around the glovebag. Cut the glovebag down by cutting through the midpoint of the taped area, and place it inside the disposal bag. Seal the disposal bag.

3.2 Any exposed ACM remaining must be sealed using a palm grade mastic. The resulting surface must be air tight, resilient, and impact resistant.

4.0 AIR MONITORING AND CLEARANCE

4.1 Air sampling shall be conducted in accordance with Section 01 45 29.

4.2 A final visual examination of the abated area must be performed by the Consultant. The work is not complete unless no visible asbestos-containing residue remains. Encapsulated areas must have an airtight seal.

5.0 PERSONNEL DECONTAMINATION

5.1 Prior to exiting the glovebag area, the worker shall remove the outer disposable suit and wet-wipe their face, hands and respirator. The worker, with the innermost disposable suite and respirator still on, shall proceed to the remote Decontamination Chamber.

6.0 DISPOSAL

6.1 The drop cloth and disposable suits shall be treated as contaminated waste and disposed of as such.

6.2 Disposal of asbestos waste shall be conducted in accordance with Section 02 82 33.

END OF SECTION 02 82 17

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

The procedures of this section apply to indoor removal of non-friable asbestos-containing materials (such as vinyl asbestos floor tile, adhesives and mastics), that are maintained in a non-friable condition throughout the entire removal process.

1.0 PREPARATION

1.1 Baseline clean all areas, HEPA vacuum visible debris.

1.2 Install one 6-mil critical barrier, and visual barrier if appropriate.

1.3 Install one 3-foot high 4-mil splashguard.

1.4 Place negative air filtration devices to establish negative pressure of 0.02" of water and 4 air changes per hour.

1.5 Construct three-stage decontamination unit, and three-stage waste decontamination unit (optional).

2.0 PERSONNEL PROTECTIVE EQUIPMENT

2.1 Personnel working within the containment area shall wear personal protective equipment including full-body disposable suits and an air-purifying respirator equipped with P-100 cartridge(s).

3.0 CLEANING AND CLEARANCE

3.1 Perform secondary cleaning procedures and final cleaning procedures.

3.2 Remove first layer of polyethylene sheeting and perform visual inspection of the removal area.

3.3 Obtain certification of completion of final cleaning from Terracon on-site representative, and release of area for lockdown encapsulation.

3.4 Encapsulate exposed surfaces including polyethylene, with 24 hour drying time if necessary.

3.5 Obtain results of inside-containment and outside-containment air sampling performed during abatement. If inside-containment and outside-containment samples during removal meet the project clearance criteria of 0.01 fibers per cubic centimeter of air by PCM analysis, final clearance sampling is not required. Otherwise, obtain passing results of non-aggressive final air clearance testing from Terracon representative.

3.6 Tear down enclosure system.

4.0 DISPOSAL

4.1 Disposal of asbestos waste shall be conducted in accordance with Section 02 82 33.

END OF SECTION 02 82 18

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

The procedures of this section apply to outdoor removal of the Non-Friable ACM.

1.0 PREPARATION

1.1 Install a 6-mil drop cloth under work area on roof and on ground, suitably placed to capture falling debris generated by the work, and allowing for wind drift. Cordon off the entire potential drop zone, using a radius equal to the vertical height of the work plus 20 feet, using construction warning tape, and other suitable means.

1.2 Install a 6-mil drop cloth at a work station established for staging of material, and for wrapping for disposal. Cordon off the work station using construction warning tape, and other suitable means.

1.3 Consult with Terracon regarding adjacent building doorways and walkways within the potential drop zone to confirm shutdown of these routes during the work.

2.0 PERSONNEL PROTECTIVE EQUIPMENT

2.1 Personnel performing work of this section shall wear full-body disposable suits and an air-purifying respirator equipped with P-100 cartridge(s).

2.2 Comply with all OSHA requirements for man lift safety.

3.0 REMOVAL

3.1 Using an airless sprayer with amended water wet the sections to be removed. Remove sections intact, minimizing breakage. Do not drop sections to the ground.

3.2 Convey sections to the work station. Use airless sprayer with amended water to render the waste adequately wet. Wrap in two layers of 6-mil poly sealed with tape, and/or containerize in leak tight containers and label properly for disposal.

4.0 CLEANING AND CLEARANCE

4.1 Collect all debris generated.

4.2 Remove polyethylene sheeting drop cloth and perform visual inspection of the removal area.

4.3 Clearance will consist of a visual inspection performed by Terracon.

5.0 DISPOSAL

5.1 Disposal of asbestos waste shall be conducted in accordance with Section 02 82 33.

END OF SECTION 02 82 19

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

Procedures of this section may be used when removing asbestos-containing thermal system insulation from a facility via wrap-and-cut methods, whereby insulated piping is cut into sections and disposed of intact as asbestos-containing waste. All work of this type is subject to the provisions of Section 02 82 17, this section.

1.0 PROCEDURES

1.1 Verify from Consultant or Owner that piping is no longer in service.

1.2 Asbestos-containing insulation or its cover must not be damaged to qualify for removal under this section.

1.3 Clean the area within 10 feet of the ACM to be removed.

1.4 Wet the ACM with amended water. Do not break the covering to wet the ACM. Maintain the ACM in a wet condition until final disposal.

1.5 Wrap the component with two layers of 6 mil poly and provide an airtight seal with tape.

1.6 Attach glovebags to the poly wrap. Remove sufficient ACM, using glovebag methods as in Section 02 82 17, to provide clearance for the cutting of the component into manageable sections without disturbance of ACM.

1.7 Cover the encapsulated ends of the ACM with 6 mil poly and provide an airtight seal with tape.

1.8 Cut into sections at glovebag points, lowering the section to the ground (do not drop).

2.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION

2.1 Personnel shall comply with personnel protective equipment and decontamination requirements of Section 02 82 17.

3.0 DISPOSAL

3.1 Label sections properly for transport and disposal. Dispose according to Section 02 82 33.

END OF SECTION 02 82 20

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

This section applies to the disposal of asbestos-containing waste generated by the work of this project. Disposal includes packaging and labeling of asbestos-containing waste materials.

1.0 PRODUCTS

1.1 Disposal Bags: Provide 6 mil leak-tight polyethylene bags labeled as follows:

First Label:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

Second Label:

RQ., NA2212, Asbestos, 9, PGIII

Third Label:

Name of Generator
Address of Work Site
Telephone Number

2.0 GENERAL

2.1 All waste is to be hauled by a waste hauler with all required licenses from all state and local authority with jurisdiction.

2.2 Load all asbestos-containing waste material in leak-tight drums or disposal bags. All materials are to be contained in one of the following:

2.2.1 Two 6 mil disposal bags (When the bagged waste material is passed into the holding room, place the first bag directly into a second bag and seal the second bag. If the bag of debris contains sharp objects or floor tile, place the first bag into a fiber barrel for disposal.)

2.2.2 Two 6 mil disposal bags and a fiberboard drum.

2.3 Protect interior of truck or dumpster with a single layer of 6-mil poly.

2.4 Carefully load containerized waste in fully enclosed dumpsters, trucks or other appropriate vehicles for transport. Exercise care before and during transport, to insure that no unauthorized persons have access to the material. That is, the transport vehicle shall be locked at all times.

2.5 Do not store containerized materials outside of the work area. Take containers from the work area directly to a sealed truck or dumpster.

2.6 Do not transport disposal bagged materials on open trucks. Label drums with same warning labels as bags. Uncontaminated drums may be reused. Treat drums that have been contaminated as asbestos-containing waste and dispose of in accordance with this specification.

2.7 Advise the landfill operator or processor, with adequate warning in advance of transport, of the quantity of material to be delivered.

2.8 Dumpster Placement: Dumpster is to be placed in the loading dock area for asbestos abatement activity.

3.0 LANDFILL

3.1 Carefully unload containerized waste at a disposal site.

3.2 If bags are broken or damaged, return to work site for rebagging. Clean entire truck and contents using wet cleaning methods.

3.3 Retain receipts from landfill or processor for materials disposed of.

3.4 At completion of hauling and disposal of each load submit copy of waste manifest, chain of custody form, and landfill receipt to Owner's Representative within seven calendar days.

END OF SECTION 02 82 33

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

1.0 GENERAL WORK PRACTICES

The Contractor shall be responsible for the development and implementation of the following general work practices:

1.1 Restrict access into the work area to only those employees or visitors previously approved to enter the area by the Owner or Consultant.

1.2 Emergency exits shall be established and clearly labeled as such. They shall be secured so as to prevent access from uncontaminated areas yet permit emergency exiting. Emergency exits may include the Decontamination Chamber, Equipment/Waste Transfer Chamber, or other alternative exits approved by the Owner or Consultant. All personnel shall be trained on emergency procedures.

1.3 Provide for an approved on-site superintendent (foreman) during lead abatement related procedures. A site superintendent shall be present at all times while work is being performed by the Contractor.

1.4 Practice safe work procedures in the work space. Eating, drinking, or smoking is not permitted within the containment area(s) or near any polyethylene sheeting.

1.5 Provide for personal air monitoring for determination of exposures during the work on a daily basis.

1.6 Utilize safe work practices at all times to prevent accidents in and around the work area.

1.7 Minimize release of lead tracking during all stages of the project.

1.8 Be prepared to administer first aid to injured personnel at all times. Seriously injured personnel shall be treated immediately or removed without delay.

Note: Extreme caution and care must be taken when moving injured personnel. Certain types of injuries can be exacerbated by movement. Unless the injured person's life is threatened, they should not be moved except by medical personnel. Consult a physician if in doubt.

1.9 Maintain all barriers and engineering control systems. Perform regular examinations to identify and immediately correct any problems encountered.

1.10 Provision of fire extinguisher in containment as required by 29 CFR OSHA 1926.150 (a)(1). The fire extinguisher must be rated not less than 2A, with a least one extinguisher for every 3,000 square feet of containment area, with a travel distance not to exceed 100 feet.

1.11 Provision of worker training in the use of firefighting equipment as required by 29 CFR OSHA 1926.150 (a)(5).

1.12 Plastic film, including poly sheeting, installed on building elements shall be flame resistant as required for combustible decorative material in accordance with Section 1103.3.3 of the Uniform Fire Code.

2.0 OCCUPANT PROTECTION PLAN

The Contractor shall be responsible for the development and implementation of an Occupant Protection Plan, according to the North Dakota Department of Health, which shall include the following provisions:

2.1 Occupants shall not be permitted to enter the worksite during hazard reduction activities, until after hazard reduction work has been completed and clearance has been achieved.

2.2 **Occupant relocation will not be required**. If applicable; Occupants shall be temporarily relocated before and during hazard reduction activities to a suitable, decent, safe, and similarly accessible dwelling unit that does not have lead-based paint hazards, except if:

2.2.1 Treatment will not disturb lead-based paint, dust-lead hazards or soil-lead hazards;

2.2.2 Only the exterior of the dwelling unit is treated, and windows, doors, ventilation intakes and other openings in or near the worksite are sealed during hazard control work and cleaned afterward, and entry free of dust-lead hazards, soil-lead hazards, and debris is provided;

2.2.3 Treatment of the interior will be completed within one period of 8-daytime hours, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, and treatment does not create other safety, health or environmental hazards (e.g., exposed live electrical wiring, release of toxic fumes, or on-site disposal of hazardous waste); or

2.2.4 Treatment of the interior will be completed within 5 calendar days, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, treatment does not create other safety, health or environmental hazards; and, at the end of work on each day, the worksite and the area within at least 10 feet (3 meters) of the containment area is cleaned to remove any visible dust or debris, and occupants have safe access to sleeping areas, and bathroom and kitchen facilities.

2.3 The dwelling unit and the worksite shall be secured against unauthorized entry, and occupants' belongings protected from contamination by dust-lead hazards and debris during hazard reduction activities. Occupants' belongings in the containment area shall be relocated to a safe and secure area outside the containment area, or covered with an impermeable covering with all seams and edges taped or otherwise sealed.

2.4 The worksite shall be prepared to prevent the release of leaded dust, and contain lead-based paint chips and other debris from hazard reduction activities within the worksite until they can be safely removed. Practices that minimize the spread of leaded dust, paint chips, soil and debris shall be used during worksite preparation.

2.5 A warning sign shall be posted at each entry to a room where hazard reduction activities are conducted when occupants are present; or at each main and secondary entryway to a building from which occupants have been relocated; or, for an exterior hazard reduction activity, where it is easily read 20 feet (6 meters) from the edge of the hazard reduction activity worksite. Each warning sign shall be as described in 29 CFR 1926.62(m), except that it shall be posted irrespective of employees' lead exposure and, to the extent practicable, provided in the occupants' primary language.

3.0 INFORMATION DISTRIBUTION REQUIREMENTS

The Contractor shall be responsible for information distribution requirements for conducting lead hazard reduction work. When hazard reduction activities are undertaken with occupants present, the Contractor shall:

3.1 Provide a notice to occupants not more than 15 calendar days after the hazard reduction activities (including paint stabilization) have been completed. Notice of hazard reduction shall include, but not be limited to:

3.1.1 A summary of the nature, dates, scope, and results (including clearance) of the hazard reduction activities;

3.1.2 A contact name, address, and telephone number for more information;

3.1.3 Available information on the location of any remaining lead-based paint in the rooms, spaces, or areas where hazard reduction activities were conducted, on a surface-by-surface basis; and

3.1.4 The date of the notice.

3.2 Update the notice, based on reevaluation of the residential property and as any additional hazard reduction work is conducted.

3.3 Provision of a notice of hazard reduction is not required if a clearance examination is not required.

3.4 The notices of evaluation, presumption, and hazard reduction shall be of a size and type that is easily read by occupants.

3.5 To the extent practicable, each notice shall be made available, upon request, in a format accessible to persons with disabilities (e.g., Braille, large type, computer disk, audio tape).

3.6 Each notice shall be provided in the occupants' primary language or in the language of the occupants' contract or lease.

3.7 The Contractor shall provide each notice to the occupants by:

3.7.1 Posting and maintaining it in centrally located common areas and distributing it to any dwelling unit if necessary because the head of household is a person with a known disability; or

3.7.2 Distributing it to each occupied dwelling unit affected by the evaluation, presumption, or hazard reduction activity or serviced by common areas in which an evaluation, presumption or hazard reduction has taken place.

4.0 RECORDKEEPING AND REPORTING REQUIREMENTS

The Contractor shall be responsible for recordkeeping and reporting requirements as generally stated below:

4.1 The Contractor performing Remediation must retain and, if requested, make available all records necessary to demonstrate compliance with applicable regulations for a period of 3 years following completion of the remediation. This 3-year retention requirement does not supersede longer obligations required by other provisions for retaining the same documentation, including any applicable State regulations.

4.2 Records that must be retained pursuant to paragraph (a) of this section shall include (where applicable):

4.2.1 Records or reports certifying that a determination had been made that lead-based paint was not present on the components affected by the remediation

4.3 Signed and dated acknowledgments of mailing, delivery or receipt for Lead Hazard Reduction Notification(s).

4.4 Documentation of compliance that a Supervisor was assigned to the project, that the Supervisor provided oversight of Workers used on the project. The Supervisor shall provide documentation which shall include a copy of the training certificate, and a certification by the certified renovator assigned to the project that:

4.4.1 Trained Supervisors and Workers were utilized on the project.

4.4.2 Warning signs were posted at the entrances to the work area.

4.4.3 The work area was contained by lead safe work practices:

4.4.3.1 Removing and cleaning all objects in the work area (interiors).

4.4.3.2 Closing and covering all HVAC ducts in the work area (interiors).

4.4.3.3 Closing all windows in the work area (interiors) or closing all windows in and within 20 feet of the work area (exteriors).

4.4.3.4 Closing and sealing all doors in the work area (interiors) or closing and sealing all doors in and within 20 feet of the work area (exteriors).

4.4.3.5 Covering doors in the work area that were being used to allow passage but prevent spread of dust.

4.4.3.6 Covering the floor surface of recently cleaned areas, including installed carpet, with taped-down plastic sheeting or other impermeable material in the work area 6 feet beyond the perimeter of surfaces undergoing remediation or a sufficient distance to contain the dust, whichever is greater (interiors) or covering the ground with plastic sheeting or other disposable impermeable material anchored to the building extending 10 feet beyond the perimeter of surfaces undergoing remediation or a sufficient distance to collect falling paint debris, whichever is greater, unless the property line prevents 10 feet of such ground covering, weighted down by heavy objects (exteriors).

4.4.3.7 Installing (if necessary) vertical containment to prevent migration of dust and debris to adjacent property (exteriors).

4.4.3.8 If paint chip samples were collected, that the samples were collected at the specified locations, that the specified NLLAP-recognized laboratory analyzed the samples, and that the results were as specified.

4.4.3.9 Waste was contained on-site and while being transported off-site.

4.4.3.10 The work area was properly cleaned after the remediation by; picking up all chips and debris, misting protective sheeting, folding it dirty side inward, and taping it for removal. Cleaning the work area surfaces and objects using a HEPA vacuum and/or wet cloths or mops (interiors).

4.4.3.11 That trained Supervisor and/or Workers performed the cleaning in accordance with the Project Manual.

4.5 Occupant Protection Plan

4.6 Firm Certification(s)

4.7 Individual Certification(s) and Medical Approval Records

4.8 Dust Clearance Testing Results

5.0 CERTIFICATION REQUIREMENTS

The Contractor shall be responsible for providing certified individuals and firms who will be engaged in LBP activities which meet applicable regulatory requirements.

6.0 WORKER TRAINING

6.1 The Contractor shall be responsible for providing certified individuals and firms who will be engaged in LBP activities. All workers are to have in their possession, a current license from the State of North Dakota. A copy of each individual's license is to be submitted to the Owner's Representative as part of the pre-construction submittal.

6.2 Train, in accordance with 29 CFR 1926, all workers in the dangers inherent in handling lead and breathing lead dust and in proper work procedures and personal and area protective measures.

Include but do not limit the topics covered in the course to the following:

6.2.1 Health effects associated with lead

6.2.2 Nature of operations that could result in exposure to lead

6.2.3 Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

Engineering controls
Work Practices
Respirators
Housekeeping procedures
Hygiene facilities
Protective clothing
Decontamination procedures
Emergency procedures
Waste disposal procedures

6.2.4 Purpose, proper use, fitting, instructions, and limitations of respirators as required by 29 CFR 1910.134

6.2.5 Appropriate work practices for the work

6.2.6 Requirements of medical surveillance program

6.2.7 Review of 29 CFR 1926

6.2.8 Pressure Differential Systems

6.2.9 Work practices including hands on or on-job training

6.2.10 Personal decontamination procedures

7.0 MEDICAL EXAMINATIONS

7.1 Provide Medical Examinations for all workers who will enter the work area for any reason. Examination shall as a minimum meet OSHA requirements as set forth in 29 CFR 1926.62.

7.2 Report from Medical Examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.

7.2.1 Copy of information that was provided to physician in compliance with 29 CFR 1926.

7.2.2 Statement that worker is able to wear and use the type of respiratory protection proposed for the project, and is able to work safely in an environment capable of producing heat stress in the worker.

8.0 GENERAL WORK PRACTICE STANDARDS

The Contractor shall be responsible for the development and implementation of the following Work Practice Standards:

8.1 Renovations must be performed by certified firms using certified individuals.

8.2 The Contractor must post signs clearly defining the work area and warning occupants and other persons not involved in LBP reduction activities to remain outside of the work area. To the extent practicable, these signs must be in the primary language of the occupants. These signs must be posted before beginning the renovation and must remain in place and readable until the renovation and the post-renovation cleaning verification and/or testing have been completed.

8.3 Before beginning the renovation, the Contractor must isolate the work area so that no dust or debris leaves the work area while the renovation is being performed. In addition, the firm must maintain the integrity of the containment by ensuring that any plastic or other impermeable materials are not torn or displaced, and taking any other steps necessary to ensure that no dust or debris leaves the work area while the renovation is being performed. The firm must also ensure that containment is installed in such a manner that it does not interfere with occupant and worker egress in an emergency.

8.4 Interior renovations – The Contractor shall:

8.4.1 Remove all objects from the work area, including furniture, rugs, and window coverings, or cover them with plastic sheeting or other impermeable material with all seams and edges taped or otherwise sealed.

8.4.2 Close and cover all ducts opening in the work area with taped-down plastic sheeting or other impermeable material.

8.4.3 Close windows and doors in the work area. Doors must be covered with plastic sheeting or other impermeable material. Doors used as an entrance to the work area must be covered with plastic sheeting or other impermeable material in a manner that allows workers to pass through while confining dust and debris to the work area.

8.4.4 Cover the floor surface, including installed carpet, with taped-down plastic sheeting or other impermeable material in the work area 6 feet beyond the perimeter of surfaces undergoing renovation or a sufficient distance to contain the dust, whichever is greater. Floor containment measures may stop at the edge of the vertical barrier when using a vertical containment system consisting of impermeable barriers that extend from the floor to the ceiling and are tightly sealed at joints with the floor, ceiling and walls.

8.4.5 Use precautions to ensure that all personnel, tools, and other items, including the exteriors of containers of waste, are free of dust and debris before leaving the work area.

8.5 Exterior renovations – The Contractor shall:

8.5.1 Close all doors and windows within 20 feet of the renovation. On multi-story buildings, close all doors and windows within 20 feet of the renovation on the same floor as the renovation, and close all doors and windows on all floors below that are the same horizontal distance from the renovation.

8.5.2 Ensure that doors within the work area that will be used while the job is being performed are covered with plastic sheeting or other impermeable material in a manner that allows workers to pass through while confining dust and debris to the work area.

8.5.3 Cover the ground with plastic sheeting or other disposable impermeable material extending 10 feet beyond the perimeter of surfaces undergoing renovation or a sufficient distance to collect falling paint debris, whichever is greater, unless the property line prevents 10 feet of such ground covering. Ground containment measures may stop at the edge of the vertical barrier when using a vertical containment system.

8.5.4 If the renovation will affect surfaces within 10 feet of the property line, the renovation firm must erect vertical containment or equivalent extra precautions in containing the work area to ensure that dust and debris from the renovation does not contaminate adjacent buildings or migrate to adjacent properties. Vertical containment or equivalent extra precautions in containing the work area may also be necessary in other situations in order to prevent contamination of other buildings, other areas of the property, or adjacent buildings or properties.

8.6 The work practices listed below are prohibited or restricted during a renovation as follows:

8.6.1 Open-flame burning or torching of painted surfaces is prohibited.

8.6.2 The use of machines designed to remove paint or other surface coatings through high speed operation such as sanding, grinding, power planing, needle gun, abrasive blasting, or sandblasting, is prohibited on painted surfaces unless such machines have shrouds or containment systems and are equipped with a HEPA vacuum attachment to collect dust and debris at the point of generation. Machines must be operated so that no visible dust or release of air occurs outside the shroud or containment system.

8.6.3 Operating a heat gun on painted surfaces is permitted only at temperatures below 700 degrees Fahrenheit.

8.7 Waste from renovation activities must be contained to prevent releases of dust and debris before the waste is removed from the work area for storage or disposal. If a chute is used to remove waste from the work area, it must be covered. At the conclusion of each work day and at the conclusion of the renovation, waste that has been collected from renovation activities must be stored under containment, in an enclosure, or behind a barrier that prevents release of dust and debris out of the work area and prevents access to dust and debris. When the firm transports waste from renovation activities, the firm must contain the waste to prevent release of dust and debris.

8.8 After the renovation has been completed, the firm must clean the work area until no dust, debris or residue remains. The Contractor shall:

8.8.1 Collect all paint chips and debris and, without dispersing any of it, seal this material in a heavy-duty bag.

8.8.2 Remove the protective sheeting. Mist the sheeting before folding it, fold the dirty side inward, and either tape shut to seal or seal in heavy-duty bags. Sheeting used to isolate contaminated rooms from non-contaminated rooms must remain in place until after the cleaning and removal of other sheeting. Dispose of the sheeting as waste.

8.8.3 The firm must clean all objects and surfaces in the work area and within 5 feet of the work area in the following manner, cleaning from higher to lower:

8.8.3.1 Clean walls starting at the ceiling and working down to the floor by either vacuuming with a HEPA vacuum or wiping with a damp cloth.

8.8.3.2 Thoroughly vacuum all remaining surfaces and objects in the work area, including furniture and fixtures, with a HEPA vacuum. The HEPA vacuum must be equipped with a beater bar when vacuuming carpets and rugs.

8.8.3.3 Wipe all remaining surfaces and objects in the work area, except for carpeted or upholstered surfaces, with a damp cloth. Mop uncarpeted floors thoroughly, using a mopping method that keeps the wash water separate from the rinse water, such as the 2-bucket mopping method, or using a wet mopping system.

9.0 CLEARANCE REQUIREMENTS

The Contractor shall be responsible for achieving the clearance requirements as generally stated below:

9.1 <u>Dust clearance testing</u>. Note: Cleaning verification procedures in Part 9.1 need not be performed if the contract between the renovation firm and the person contracting for the renovation or another Federal, State, Territorial, Tribal, or local law or regulation requires dust clearance sampling at the conclusion of a LBP hazard reduction and/or at the completion of renovation.

(THIS PROJECT WILL REQUIRE DUST WIPE CLEARANCE TESTING CONDUCTED BY AN INDEPENDENT THIRD PARTY)

Clearance examinations shall include a visual assessment, dust sampling, submission of samples for analysis for lead in dust, interpretation of sampling results, and preparation of a report. Soil sampling is not required. Clearance examinations shall be performed in dwelling units, common areas, and exterior areas. If clearance is being performed after lead-based paint hazard reduction, paint stabilization, maintenance, or rehabilitation of that affected exterior surfaces but did not disturb interior painted surfaces or involve elimination of an interior dust-lead hazard, interior clearance is not required provided window, door, ventilation, and other openings are sealed during the exterior work.

Please note; clearance testing will be required if the risk assessment identifies LBP Hazards on components which are shared surfaces with a component being removed. If clearance is being performed for more than 10 dwelling units of similar construction and maintenance, as in a multifamily property, random sampling for the purpose of clearance may be conducted in accordance with 40 CFR 745.227(e)(9).

9.1.1 Dust samples for clearance purposes shall be taken a minimum of 1 hour after completion of final post-abatement cleanup activities.

9.1.2 The following post-abatement clearance activities shall be conducted as appropriate based upon the extent or manner of abatement activities conducted in or to the residential dwelling or child-occupied facility:

9.1.2.1 After conducting an abatement with containment between abated and unabated areas, one dust sample shall be taken from one interior window sill and from one window trough (if present) and one dust sample shall be taken from the floors of each of no less than four rooms, hallways or stairwells within the containment area. In addition, one dust sample shall be taken from the floor outside the containment area. If there are less than four rooms, hallways or stairwells within the containment area, then all rooms, hallways or stairwells shall be sampled.

9.1.2.2 After conducting an abatement with no containment, two dust samples shall be taken from each of no less than four rooms, hallways or stairwells in the residential dwelling or child-occupied facility. One dust sample shall be taken from one interior window sill and window trough (if present) and one dust sample shall be taken from the floor of each room, hallway or stairwell selected. If there are less than four rooms, hallways or stairwells within the residential dwelling or child-occupied facility then all rooms, hallways or stairwells shall be sampled.

9.1.2.3 Following an exterior paint abatement, a visible inspection shall be conducted. All horizontal surfaces in the outdoor living area closest to the abated surface shall be found to be cleaned of visible dust and debris. In addition, a visual inspection shall be conducted to determine the presence of paint chips on the dripline or next to the foundation below any exterior surface abated. If paint chips are present, they must be removed from the site and properly disposed of, according to all applicable Federal, State and local requirements.

9.1.2.4 The rooms, hallways or stairwells selected for sampling shall be selected according to documented methodologies.

9.1.2.5 The MDH certified inspector or risk assessor shall compare the residual lead level (as determined by the laboratory analysis) from each single surface dust sample with clearance levels stated below;

The clearance standard/level(s) for lead in dust are 40 µg/ft^2 for floors, 250 µg/ft^2 for interior window sills, and 400 µg/ft^2 for window troughs.

9.1.2.6 If the if the clearance sample results in levels above the standard the Contractor shall re-cleaned, at the Contractor expense, and the areas will be retested. This process will continue until the clearance standard is achieved.

9.1.2.7 An abatement report shall be prepared by a certified supervisor or project designer. The abatement report shall include the following information:

a. Start and completion dates of abatement.

b. The name and address of each certified firm conducting the abatement and the name of each supervisor assigned to the abatement project.

c. The name, address, and signature of each certified risk assessor or inspector conducting clearance sampling and the date of clearance testing.

d. The results of clearance testing and all soil analyses (if applicable) and the name of each recognized laboratory that conducted the analyses.

e. A detailed written description of the abatement, including abatement methods used, locations of rooms and/or components where abatement occurred, reason for selecting particular abatement methods for each component, and any suggested monitoring of encapsulants or enclosures.

9.1.3 In a multi-family dwelling with similarly constructed and maintained residential dwellings, random sampling for the purposes of clearance may be conducted provided:

9.1.3.1 The certified individuals who abate or clean the residential dwellings do not know which residential dwelling will be selected for the random sample.

9.1.3.2 A sufficient number of residential dwellings are selected for dust sampling to provide a 95 percent level of confidence that no more than 5 percent or 50 of the residential dwellings (whichever is smaller) in the randomly sampled population exceed the appropriate clearance levels.

9.1.3.4 The randomly selected residential dwellings shall be sampled and evaluated for clearance as stated above.

9.1.3.5 An abatement report shall be prepared by a certified supervisor or project designer. The abatement report shall include the following information:

f. Start and completion dates of abatement.

g. abatement and the name of each supervisor assigned to the abatement project.

h. The name, address, and signature of each certified risk assessor or inspector conducting clearance sampling and the date of clearance testing.

i. The results of clearance testing and all soil analyses (if applicable) and the name of each recognized laboratory that conducted the analyses.

j. A detailed written description of the abatement, including abatement methods used, locations of rooms and/or components where abatement occurred, reason for selecting particular abatement methods for each component, and any suggested monitoring of encapsulants or enclosures.

END OF SECTION 02 83 01

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and the General Requirements apply to the Work of this Section.

APPLICABILITY

This section describes lead-contaminated dust and debris removal and cleaning. Cleaning is the process of removing visible debris and particles too small to be seen by the naked eye. The methods in this part must be used when performing lead dust hazard reduction.

1.0 STANDARD PROCEDURES FOR INTERIM CONTROLS

Interim controls of lead-based paint hazards identified in Project Manual shall be conducted in accordance with these provisions. Interim control measures include paint stabilization of deteriorated paint, treatments for friction and impact surfaces where levels of lead dust levels are elevated above clearance standards, dust control, and lead-contaminated soil control. Only those interim control methods identified as acceptable methods in Project Manual shall be used to control identified hazards. Occupants of dwelling units where interim controls are being performed shall be protected during the course of the work. Clearance testing shall be performed at the conclusion of interim control activities in accordance with Section 01 45 30. A person performing interim controls must be trained in accordance with the hazard communication standard for the construction industry issued by the Occupational Safety and Health Administration of the U.S. Department of Labor at 29 CFR 1926.59, and either be supervised by an individual certified as a lead-based paint abatement supervisor or have completed successfully lead-safe work practices.

The Contractor shall be responsible for implementing standard procedures for Interim Controls as generally stated below:

1.1 Paint stabilization - Interim control treatments used to stabilize deteriorated lead-based paint shall be performed in accordance with the requirements of this section. Interim control treatments of intact, factory applied prime coatings on metal surfaces are not required. Finish coatings on such surfaces shall be treated by interim controls if those coatings contain lead-based paint.

1.1.1 Any physical defect in the substrate of a painted surface or component that is causing deterioration of the surface or component shall be repaired before treating the surface or component. Examples of defective substrate conditions include dry-rot, rust, moisture-related defects, crumbling plaster, and missing siding or other components that are not securely fastened.

1.1.2 Before applying new paint, all loose paint and other loose material shall be removed from the surface to be treated. Acceptable methods for preparing the surface to be treated include wet scraping, wet sanding, and power sanding performed in conjunction with a HEPA filtered local exhaust attachment operated according to the manufacturer's instructions.

1.1.3 Dry sanding or dry scraping is permitted only in accordance with §35.140(e) (i.e., for electrical safety reasons or for specified minor amounts of work).

1.1.4 Paint stabilization shall include the application of a new protective coating or paint. The surface substrate shall be dry and protected from future moisture damage before applying a new protective coating or paint. All protective coatings and paints shall be applied in accordance with the manufacturer's recommendations.

1.1.5 Paint stabilization shall incorporate the use of safe work practices in Section 02 83 01.

1.2 Friction and impact surfaces.

1.2.1 Interim control treatments for friction surfaces shall eliminate friction points or treat the friction surface so that paint is not subject to abrasion. Examples of acceptable treatments include rehanging and/or planing doors so that the door does not rub against the door frame, and installing window channel guides that reduce or eliminate abrasion of painted surfaces. Paint on stair treads and floors shall be protected with a durable cover or coating that will prevent abrasion of the painted surfaces. Examples of acceptable materials include carpeting, tile, and sheet flooring.

1.2.2 Interim control treatments for impact surfaces shall protect the paint from impact. Examples of acceptable treatments include treatments that eliminate impact with the paint surface, such as a door stop to prevent a door from striking a wall or baseboard.

1.2.3 Interim control for impact or friction surfaces does not include covering such a surface with a coating or other treatment (such as painting over the surface) that does not protect lead-based paint from impact or abrasion.

1.3 Chewable surfaces

1.3.1 Interim control treatments for chewable surfaces shall make the lead-based paint inaccessible for chewing by children of less than 6 years of age. Examples include enclosures or coatings that cannot be penetrated by the teeth of such children.

1.4 Dust-lead hazard control.

1.4.1 Dust control shall involve a thorough cleaning of all horizontal surfaces, such as interior window sills, window troughs, floors, and stairs, but excluding ceilings. All horizontal surfaces, such as floors, stairs, window sills and window troughs, that are rough, pitted, or porous shall be covered with a smooth, cleanable covering or coating, such as metal coil stock, plastic, polyurethane, or linoleum.

1.4.2 Surfaces covered by a rug or carpeting shall be cleaned as follows:

1.4.2.1 The floor surface under a rug or carpeting shall be cleaned where feasible, including upon removal of the rug or carpeting, with a HEPA vacuum or other method of equivalent efficacy.

1.4.2.2 An unattached rug or an attached carpet that is to be removed, and padding associated with such rug or carpet, located in an area of the dwelling unit with dust-lead hazards on the floor, shall be thoroughly vacuumed with a HEPA vacuum or other method of equivalent efficacy. Protective measures shall be used to prevent the spread of dust during removal of a rug, carpet or padding from the dwelling. For example, it shall be misted to reduce dust generation during removal. The item(s) being removed shall be wrapped or otherwise sealed before removal from the worksite.

1.4.2.3 An attached carpet located in an area of the dwelling unit with dust-lead hazards on the floor shall be thoroughly vacuumed with a HEPA vacuum or other method of equivalent efficacy if it is not to be removed.

1.5 Soil-lead hazards - Soil with a lead concentration equal to or greater than 5,000 µg/g of lead shall be abated in accordance with 40 CFR 745.227(e). Acceptable interim control methods for soil lead are impermanent surface coverings and land use controls. Impermanent surface coverings may be used to treat lead-contaminated soil if applied in accordance with the following requirements. Examples of acceptable impermanent coverings include gravel, bark, sod, and artificial turf.

1.5.1 Impermanent surface coverings selected shall be designed to withstand the reasonably-expected traffic. For example, if the area to be treated is heavily traveled, neither grass or sod shall be used.

1.5.2 When loose impermanent surface coverings such as bark or gravel are used, they shall be applied in a thickness not less than six inches deep.

1.5.3 The impermanent surface covering material shall not contain more than 400 µg/g of lead.

1.5.4 Adequate controls to prevent erosion shall be used in conjunction with impermanent surface coverings.

1.5.5 Land use controls may be used to reduce exposure to soil-lead hazards only if they effectively control access to areas with soil-lead hazards. Examples of land use controls include: fencing, warning signs, and landscaping.

1.5.6 Land use controls shall be implemented only if residents have reasonable alternatives to using the area to be controlled.

1.5.7 If land use controls are used for a soil area that is subject to erosion, measures shall be taken to contain the soil and control dispersion of lead.

END OF SECTION 02 83 16

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and the General Requirements apply to the Work of this Section.

APPLICABILITY

This section describes lead-contaminated dust and debris removal and cleaning. Cleaning is the process of removing visible debris and particles too small to be seen by the naked eye. The methods in this part must be used when performing lead dust hazard reduction.

1.0 STANDARD PROCEDURES FOR ABATEMENT

Abatement shall be performed in accordance with methods and standards established by EPA, or by EPA at 40 CFR 745.227(e), and shall be completed by achieving clearance in accordance with §35.1340. If encapsulation or enclosure is used as a method of abatement, ongoing lead-based paint maintenance activities shall be performed as required by the applicable subpart of this part in accordance with §35.1355. Abatement of an intact, factory-applied prime coating on metal surfaces is not required unless the surface is a friction surface.

The Contractor shall be responsible for implementing standard procedures for Abatement Controls as generally stated below:

1.1 Building Component Removal

The methods in this part must be used when performing lead hazard reduction to remove intact building components with intact lead-based paint. The removal methods must not disturb the paint or create paint chips or dust. Removing intact building components includes, but is not limited to, removing only a door or window sash from a door or window frame. All work must be completed in one working day as follows:

1.1.1 Work area preparation - Before lead hazard reduction begins, the floor or ground surface must be cleaned using a vacuum with a HEPA filter to remove all visible paint chips that are present beneath the affected work surface and extending at least five feet beyond the affected surface in all directions.

1.1.2 If residents remain in the residence while work is ongoing, the residents must be provided with lead-safe passage to a bathroom, at least one living area, and an entry and egress route. Unless actually performing lead hazard reduction, residents must not be allowed in the work area until all work is completed, no visible dust or debris remains in the work area, the clearance inspection is passed, and clearance dust samples are collected. The residents must be informed to avoid the work area until clearance results are below the clearance standards

1.1.3 Warning signs must be placed at the entry to the rooms or work areas where lead hazard reduction is actually occurring.

1.1.4 Temporary fencing or barrier tape must be erected at a ten-foot perimeter around an exterior work area to keep out unauthorized persons. The barrier distance may be less if the distance to an adjacent building or sidewalk is less than ten feet.

1.1.5 The certified lead firm performing lead hazard reduction must provide proper washing facilities for workers to thoroughly wash hands, face, and other exposed body surfaces. If existing facilities are used at the work site to decontaminate, the Contractor must:

1.1.5.1 Provide workers with soap and disposable towels; and

1.1.5.2 Clean the existing facility until no visible dust, dirt, or debris remains each day before leaving the site.

1.1.6 When lead hazard reduction is completed, the certified lead firm, lead supervisor must:

1.1.6.1 Inspect all work surfaces where lead hazard reduction was conducted and visually determine that no suspect lead dust or debris remains in the work area;

1.1.6.2 Clean all surfaces within the work area using a vacuum with a HEPA filter or using any other EPA-documented methodology and extend the cleaning beyond the perimeter of the work area if visible dust and debris exists from the lead hazard reduction;

1.1.6.3 Clean all floors and ground surfaces in adjacent areas that were used for pathways to the work area and any areas used to store equipment and waste materials using a vacuum with a HEPA filter;

1.1.6.4 Visually re inspect all areas if visible dust or debris remains, the cleaning procedures must be repeated; and

1.1.7 Conduct clearance inspections according to Section 01 45 30 **(conducted by an independent third party)**

1.2 <u>Encapsulation</u>

1.2.1 Materials to be used for encapsulation of lead-based paint must meet all documented methodologies and have from the manufacturer of the encapsulant material:

1.2.1.1 A written, 20-year warranty for any defects in the encapsulant material;

1.2.1.2 A recommended maintenance plan for the encapsulant; and

1.2.1.3 Documentation that the material has been determined by an independent laboratory to meet the criteria of the American Society for Testing and Materials for the specified type of encapsulant.

1.2.2 Surface preparation must be conducted as per manufacturer recommendations, and according to the work procedures as outlined in this Specification, to include;

1.2.2.1 Cleaning
1.2.2.2 Deglossing
1.2.2.3 Removal of loose paint
1.2.2.4 Preparing exposed base substrates

1.2.3 The lead supervisor shall verify that the surface to be encapsulated will successfully pass the patch and adhesion tests described in HUD's Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

1.2.4 The lead supervisor is responsible for determining that the surface to be encapsulated is:

1.2.4.1 Is structurally sound;
1.2.4.2 Is not an impact surface or a friction surface in normal usage; and
1.2.4.3 Will support the application of an encapsulant.

1.3 <u>Enclosure Methods</u>

The following procedures are to be used for the Enclosure coated surfaces.

1.3.1 The surface to be enclosed should be labeled (behind the enclosure), horizontally and vertically, approximately every 2-feet with a warning, “Danger Lead-Based Paint” in permanent ink.

1.3.2 Correct unsound substrates.

1.3.3 Select enclosure materials which meet or exceed applicable building codes and manufactory application requirements.

1.3.4 Attach the enclosing material securely to the substrate using both screws and adhesives, to prevent a bellows effect after installation.

1.3.5 Caulk and seal all seams, penetrations, etc. New surface shall be airtight to the substrate.

1.3.6 Cleaning shall include wet-mopping and wiping of visible dust. Dry debris shall be misted before cleanup. Dry sweeping is prohibited. Use of vacuums without HEPA filtration is prohibited.

1.3.7 Cleaning shall include the HEPA vacuuming of all surfaces in the work area, followed by a high-phosphate wash. The wash solution shall contain at least one ounce of detergent per gallon of water. The detergent shall contain at least 5 percent trisodium phosphate (TSP). All surfaces of the work area shall be cleaned, starting with the ceiling and working down. Change wash solution regularly. A final rinse of clean water shall follow the TSP cleaning.

1.3.8 Inspection requirements.

1.3.8.1 The inspector shall first determine that all components have been enclosed according to plan.

1.3.8.2 The work area shall be examined for visible dust. A damp cloth should be used to confirm the absence of visible dust from surfaces (this is a qualitative test and should not be confused with dust monitoring.)

1.3.8.3 Surface dust sampling shall be conducted by the testing laboratory no sooner than 24 hours after completion of post-abatement cleaning to allow airborne dust to settle onto surfaces to be tested.

1.3.8.4 Dust sample collection locations shall be randomly selected.

1.3.8.5 Clearance criteria: Dust must not contain lead in a concentration of 40 micrograms or more per square foot on floors; 250 micrograms or more per square foot on accessible, below ceiling components; and 400 micrograms or more per square foot on ceiling level and above ceiling components.

1.3.8.6 If any of the residual lead dust level results exceed the clearance criteria, the containment area shall be re-cleaned by the Contractor.

1.4 <u>Interior Paint Removal Methods</u>

1.4.1 A containment must be prepared prior to lead hazard reduction begins.

1.4.2 The heating, ventilating, and air conditioning systems to the containment must be restricted.

1.4.3 All objects that are contaminated or suspected of being contaminated with lead-based paint chips or lead-contaminated dust must be: vacuumed with a HEPA-filtered vacuum; wet wiped; or disposed of as lead-contaminated waste.

1.4.4 All movable objects must be removed from the containment.

1.4.5 The floor of the containment must be cleaned using a vacuum with a HEPA filter to remove all visible paint chips.

1.4.6 Objects that cannot be removed from the containment must be covered and secured with at least one layer of 1 mil plastic sheeting.

1.4.7 At least one layer of 6 mil plastic sheeting must be placed over the entire floor of the containment. Plastic sheeting must be sealed to the perimeter of the containment where the walls and floors meet to prevent lead contamination of the floor surface.

1.4.8 Temporary barriers of no less than six-mil plastic sheeting may divide a room to restrict the size of the room.

1.4.9 Any openings to the containment must be covered with at least 1 mil plastic sheeting to prevent the escape of dust and debris unless the opening can be secured from inside the containment.

1.4.10 All heating, ventilating, and air conditioning vents within the containment must be sealed with an airtight seal of at least 6mil plastic sheeting.

1.4.11 If exterior windows, doors, or associated components are to be treated or replaced from the interior, two layers of plastic sheeting must be attached to the exterior wall to cover the window or door opening. If the window or door being treated has an intact and operational storm window or door that will not be disturbed during the window or door treatment, no exterior plastic is required.

1.4.12 Residents must not be present in the residence while work is ongoing.

1.4.13 Residents may return to the residence for overnight occupancy when lead hazard reduction ceases for the day and cleanup is completed in the containment.

1.4.14 Returning residents must be provided with lead-safe passage to a bathroom, at least one living area, and an entry and egress route.

1.4.15 Residents must be restricted from gaining access to the containment until all work is completed, the clearance inspection is conducted and clearance dust sample results meet the standards.

1.4.16 Warning signs must be placed at all entries to the residence and all entries to containments within the residence. Signs must remain posted overnight if work is to continue the following day.

1.4.17 The Contractor performing the lead hazard reduction must provide proper washing facilities for workers to thoroughly wash hands, face, and other exposed body surfaces.

1.4.18 If existing facilities are used at the work site to decontaminate, the Contractor must:

1.4.18.1 Provide workers with soap and disposable towels; and
1.4.18.2 Clean the existing facility until no visible dust, dirt, or debris remains each day before leaving the site.

1.4.19 If plastic floor sheeting is left in place for the next day, it must be cleaned of visible dust and debris using a vacuum with a HEPA filter or using any other EPA-documented method. Holes in the plastic must be sealed.

1.4.20 If plastic floor sheeting is removed, it must be removed in a way to contain all lead-contaminated dust and debris and discarded as lead-contaminated. The exposed floor surface must be cleaned using a vacuum with a HEPA filter or using any other EPA-documented methodology.

1.4.21 All floors in adjacent areas, areas used as pathways to the containment, and any areas used to store equipment and waste materials must be cleaned using a vacuum with a HEPA filter and wet wiped or cleaned using any other EPA-documented method

1.4.22 When lead hazard reduction is completed, Contractor must:

1.4.22.1 Inspect all work surfaces where lead hazard reduction was conducted and visually determine that no dust, debris, or deteriorated paint remains;

1.4.22.2 Remove all plastic sheeting from the floor and window and door openings and dispose of plastic sheeting as lead-contaminated waste;

1.4.22.3 Clean all surfaces in the containment using a vacuum with a HEPA filter and wet wipe and clean a second and third time using a vacuum with a HEPA filter or clean using any other EPA-documented method;

1.4.22.4 Clean all floors in adjacent areas used as pathways to the containment and any areas used to store equipment and waste materials. Cleaning must be conducted using a vacuum with a HEPA filter and wet wipe or using any other EPA-documented method;

1.4.22.5 If windows or doors were treated or replaced and the plastic sheeting on the exterior was breached, wet wipe that side of the window or door or clean using any other EPA-documented method;

1.4.22.6 Re inspect all areas if visible dust or debris is observed, the cleaning procedures shall be repeated until no visible dust or debris remains;

1.4.22.7 If paint was removed from building components, paint or seal the surfaces;

1.4.22.8 Remove all remaining plastic sheeting and dispose of it as lead-contaminated waste and inspect the areas and items for dust and debris. If dust or debris is observed, surfaces must be cleaned using a vacuum with a HEPA filter; and

1.4.22.9 Conduct clearance testing according to Section 01 45 30.

1.5 Soil and Exterior Dust Abatement

1.5.1 All windows and doors in the affected property must be kept closed on the side where work is occurring until the final removals have been achieved.

1.5.2 Residents of adjacent buildings that are within 20 feet of the work area must be notified of the lead hazard reduction to be done. Doors and windows of the adjacent buildings must be kept closed on the side that is adjacent to where the lead hazard reduction is occurring.

1.5.3 All movable objects that are within 20 feet of the work area must be moved.

1.5.4 Objects that cannot be removed from the work area must be covered and secured with at least 6 mil plastic sheeting.

1.5.5 Temporary fencing or barrier tape must be erected at a 20-foot perimeter around the work area to keep out unauthorized persons. The barrier distance may be less if the distance to an adjacent building or other obstacle is less than 20 feet.

1.5.6 Non-certified individuals must not be present in the work area.

1.5.7 Warning signs must be posted on the building and at the 20-foot perimeter around the work area. The distance may be less if the distance to an adjacent building or other obstacle is less than 20 feet.

1.5.8 The Contractor performing the lead hazard work must provide proper washing facilities for workers to thoroughly wash hands, face, and other exposed body surfaces.

1.5.9 Work may not start and/or continue if wind speeds exceed 20 miles per hour or if it is raining.

1.5.10 At the end of each workday and when lead hazard reduction is completed, the Contractor must:

1.5.10.1 Remove all plastic sheeting on immovable objects and bushes in such a manner as to contain all debris and dispose of the plastic sheeting as lead-contaminated waste. Plastic sheeting may not be reused or left out overnight;

1.5.10.2 If the plastic sheeting is punctured or otherwise breached, clean the areas of all visible paint debris or soil;

1.5.10.3 Inspect all exterior building components with horizontal surfaces that may have been exposed to dust and debris from the lead hazard reduction and clean the surfaces of visible dust and debris using a vacuum with a HEPA filter and wet wipe or clean using any other EPA-documented methodology;

1.5.10.4 Inspect all ground surfaces on the property, the neighboring property, and any areas used to store equipment and waste materials for visible dust and debris generated by the lead hazard reduction and, if suspect dust and debris is observed, clean the ground surfaces; and

1.5.11 Conduct clearance inspections according to Section 01 45 30.

END OF SECTION 02 83 20

RELATED DOCUMENTS

The Drawings, the provisions of the Contract including the General and Supplementary Conditions, and the General Requirements apply to the Work of this Section.

APPLICABILITY

This section applies to the disposal of lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may contain concentrations of lead particles, generated by the work of this project. Disposal includes packaging and labeling of lead-contaminated waste materials.

1.0 GENERAL

1.1 Lead waste shall be managed as hazardous waste, unless it meets one of the following:

1.1.1 Less than 5 milligrams per liter (mg/L) by Toxicity Characteristic Leaching Procedure (TCLP) analysis; OR

1.1.2 Less than 100 parts per million (ppm) total lead.

1.2 If analysis indicates concentrations below the standards above the waste may be disposed of as non-hazardous at a permitted industrial or mixed solid waste landfill within leak tight containers during transport.

1.3 Accumulate lead-containing and lead-contaminated waste in closed, compatible containers labeled in accordance with 29 CFR 1926.62. Secure any lead waste containers that will not be transported off site at the end of the working day. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled.

1.4 Accumulate non-hazardous lead waste in closed containers or other compatible units that will protect it from precipitation and prevent a release of the debris to the environment.

2.0 DISPOSAL

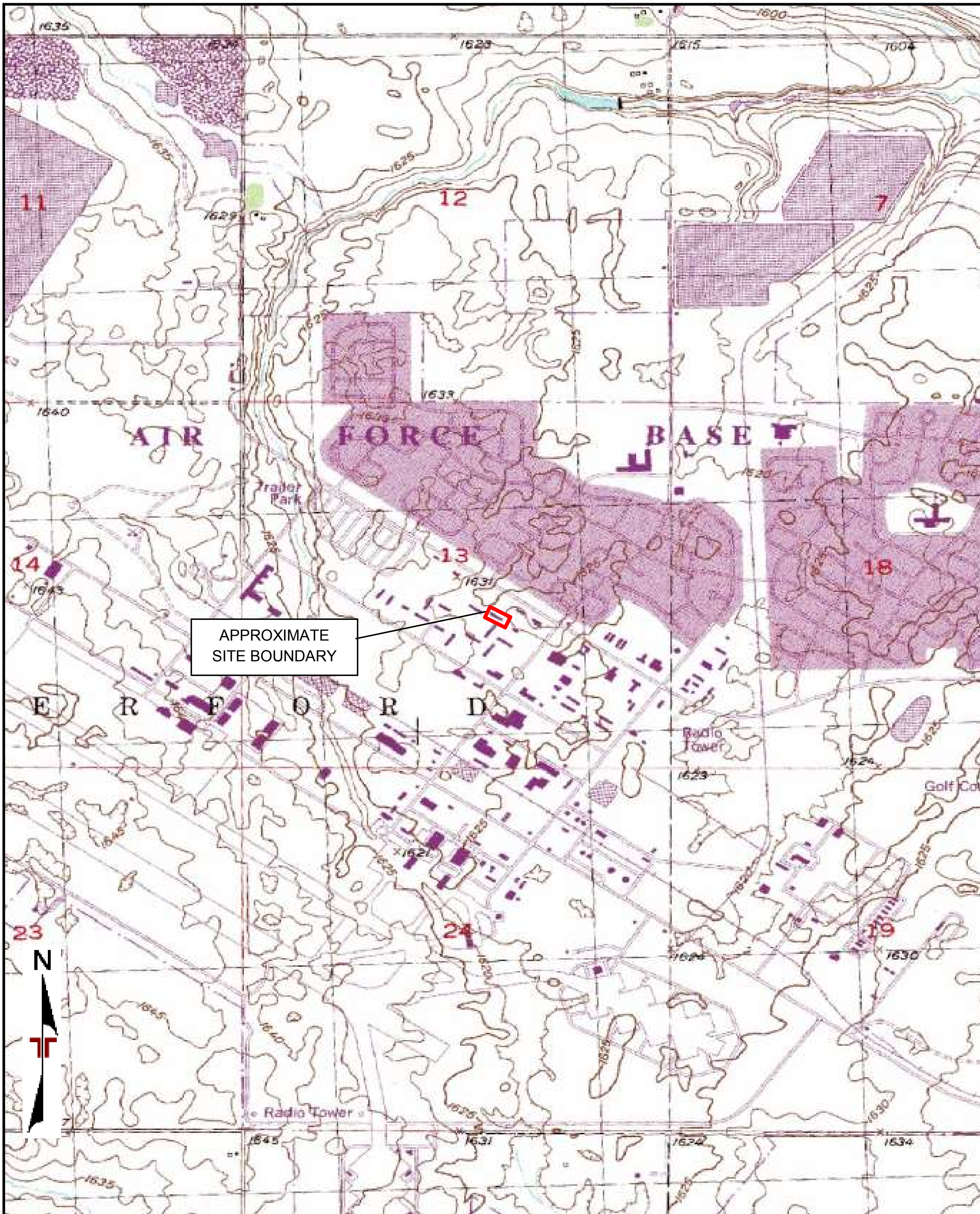
2.1 Lead hazardous waste must be shipped for disposal to a permitted hazardous waste Treatment Storage or Disposal Facility (TSDF).

2.2 Manage non-hazardous lead waste as an industrial solid waste.

2.3 At completion of hauling and disposal of each load submit copy of waste manifest, chain of custody form, and landfill receipt to Owner's Representative within seven calendar days.

END OF SECTION 02 83 30

APPENDIX A



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: BURLINGTON NE, ND (1/1/1979).

Project Manager: STM	Project No. MU157011	Terracon	TOPOGRAPHIC MAP	Exhibit
Drawn by: MKG	Scale: 1"=24,000 SF	6701 4th St. SW	Minot Air Force Base Building 276	1
Checked by: MJW	File Name: Exhibit 1&2	Minot, ND 58701	Building 276	
Approved by: MJW	Date: 12/2015		Minot Air Force Base, ND	

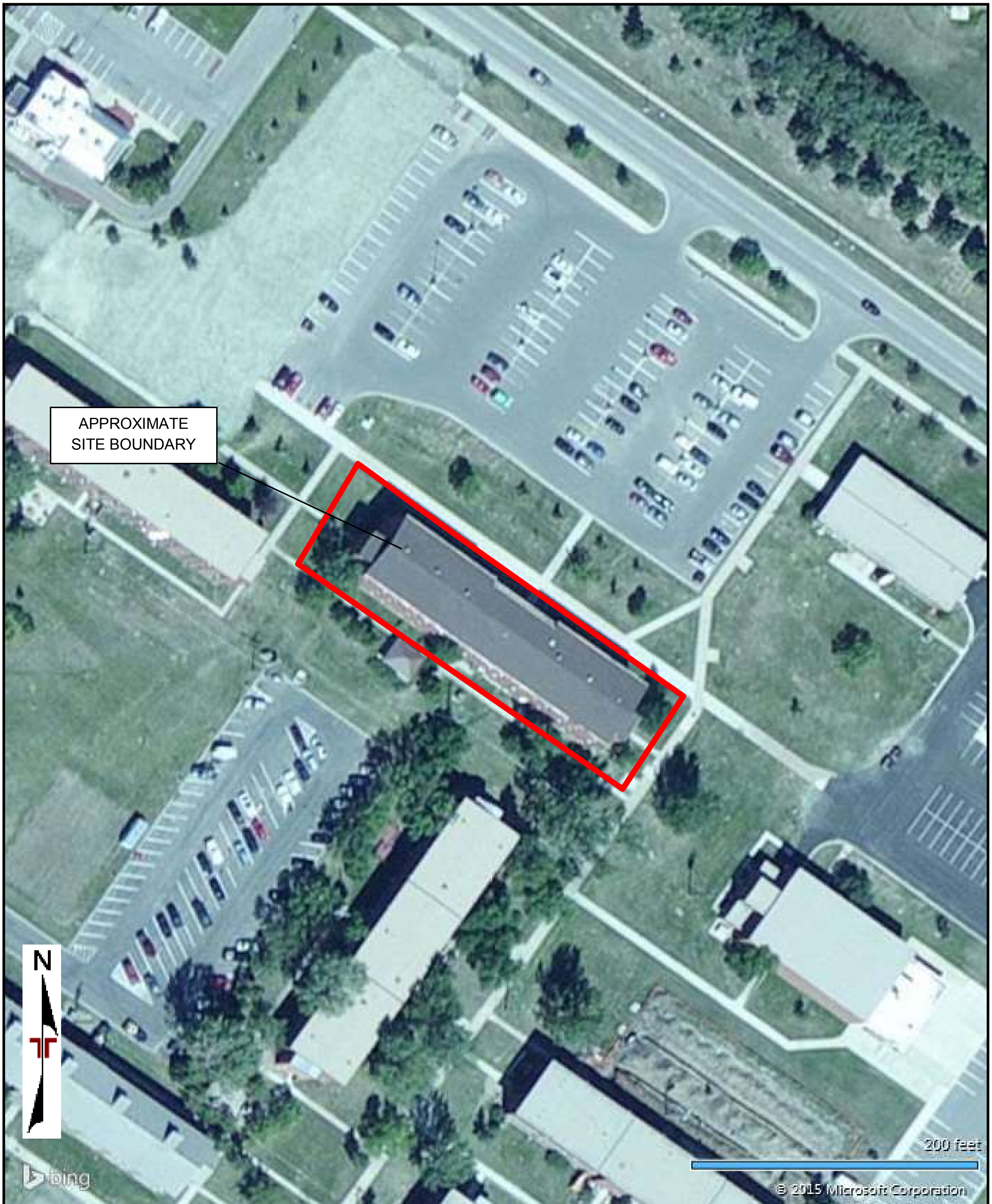
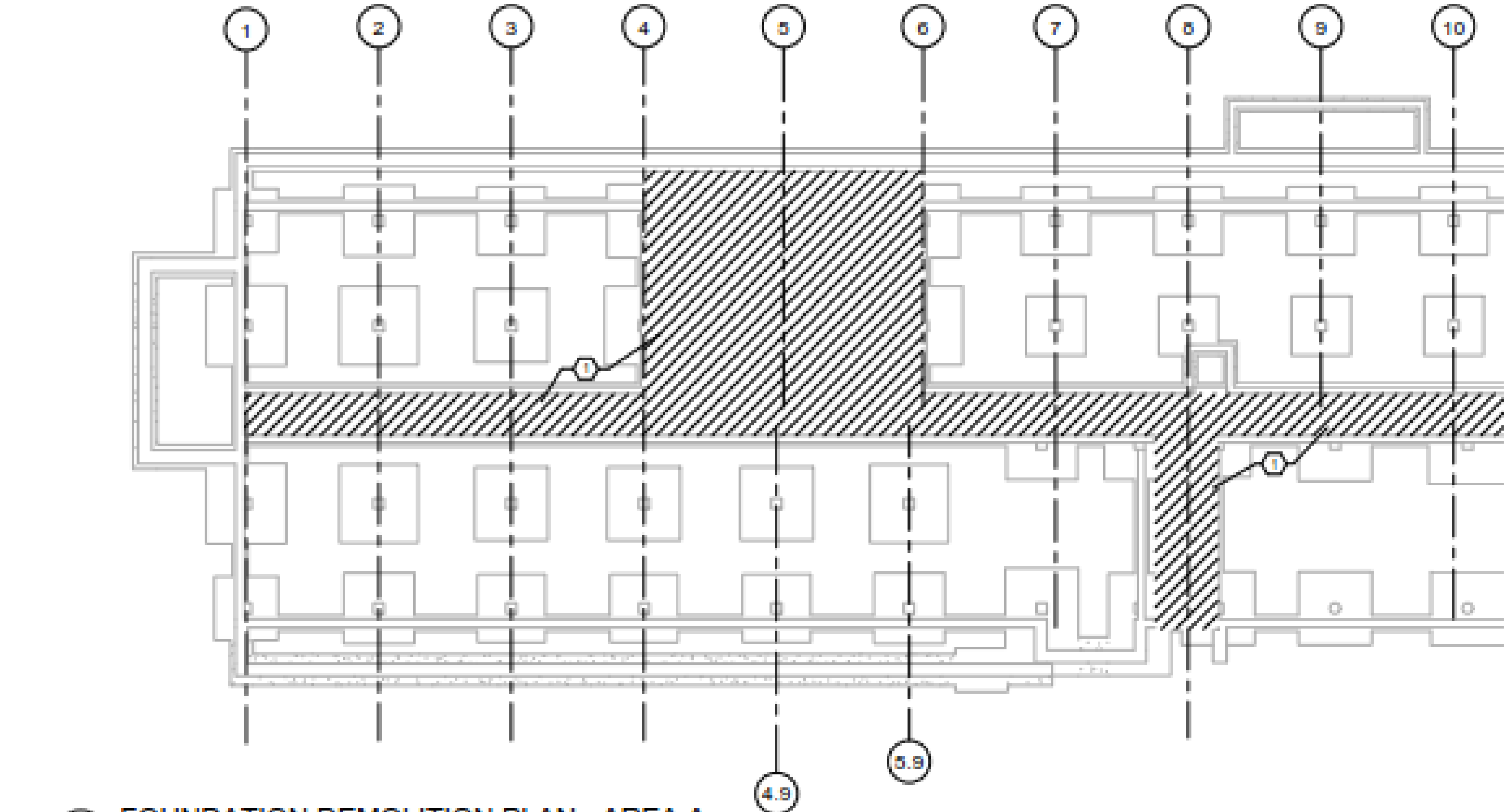


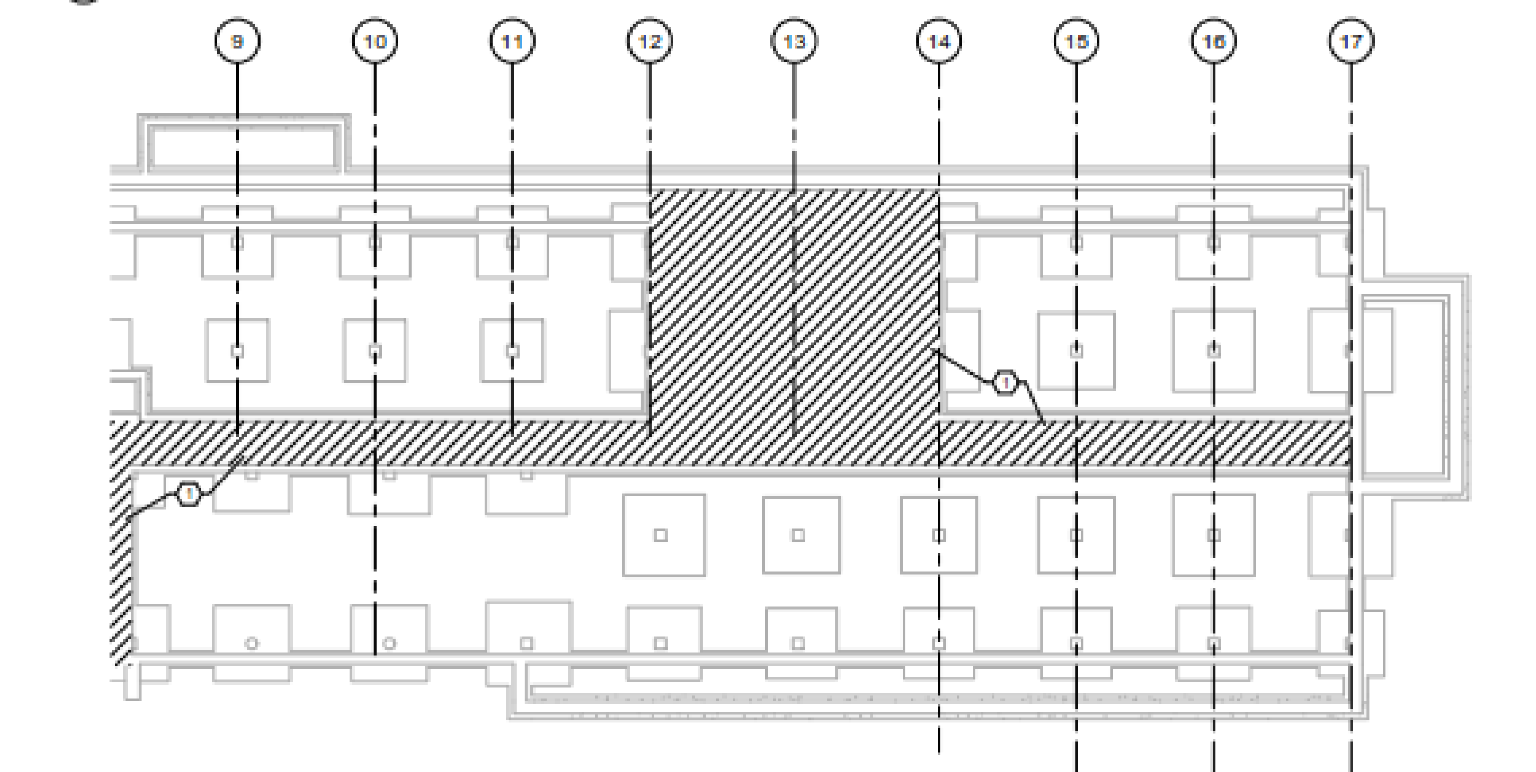
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: STM	Project No. M6157011	Terracon	SITE DIAGRAM	Exhibit
Drawn by: MKG	Scale: AS SHOWN	6701 4th St. SW	Minot Air Force Base Building 276	2
Checked by: MJW	File Name: Exhibit 1&2	Minot, ND 58701	**Building 276**	
Approved by: MJW	Date: 12/2015		**Minot Air Force Base, ND**	



FOUNDATION DEMOLITION PLAN - AREA A
1/8" = 1'-0"



FOUNDATION DEMOLITION PLAN - AREA B
1/8" = 1'-0"

SHEET NOTES

1. CONTRACTOR SHALL SAWCUT, REMOVE AND REPLACE FLOOR SLAB AS REQUIRED FOR INSTALLATION OF NEW WORK. SEE ARCHITECTURAL DOCUMENTS FOR CONCRETE INSTALLATION REQUIREMENTS.

KEYED NOTES (THIS SHEET) AS- DENOTED BY

1. DEMOLISH AND REMOVE ALL EXISTING EXPOSED PLUMBING PIPING AND DEVICES WITH-IN UTILITY TUNNEL. PIPING PASSING THROUGH SIDEWALLS TO BE TERMINATED FLUSH WITH WALL AND PERMANENTLY SEALED AIR AND WATER TIGHT.

SCALE IN FEET - 1/8" = 1'-0"

PROFESSIONAL SEAL

Source: Air Force Civil Engineer Center, modified by Terracon

Scale: N/A

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Foundation	Dec 18
Minot Air Force Base Building 276 **Building 276** **Minot Air Force Base, ND**	**Exhibit 3**

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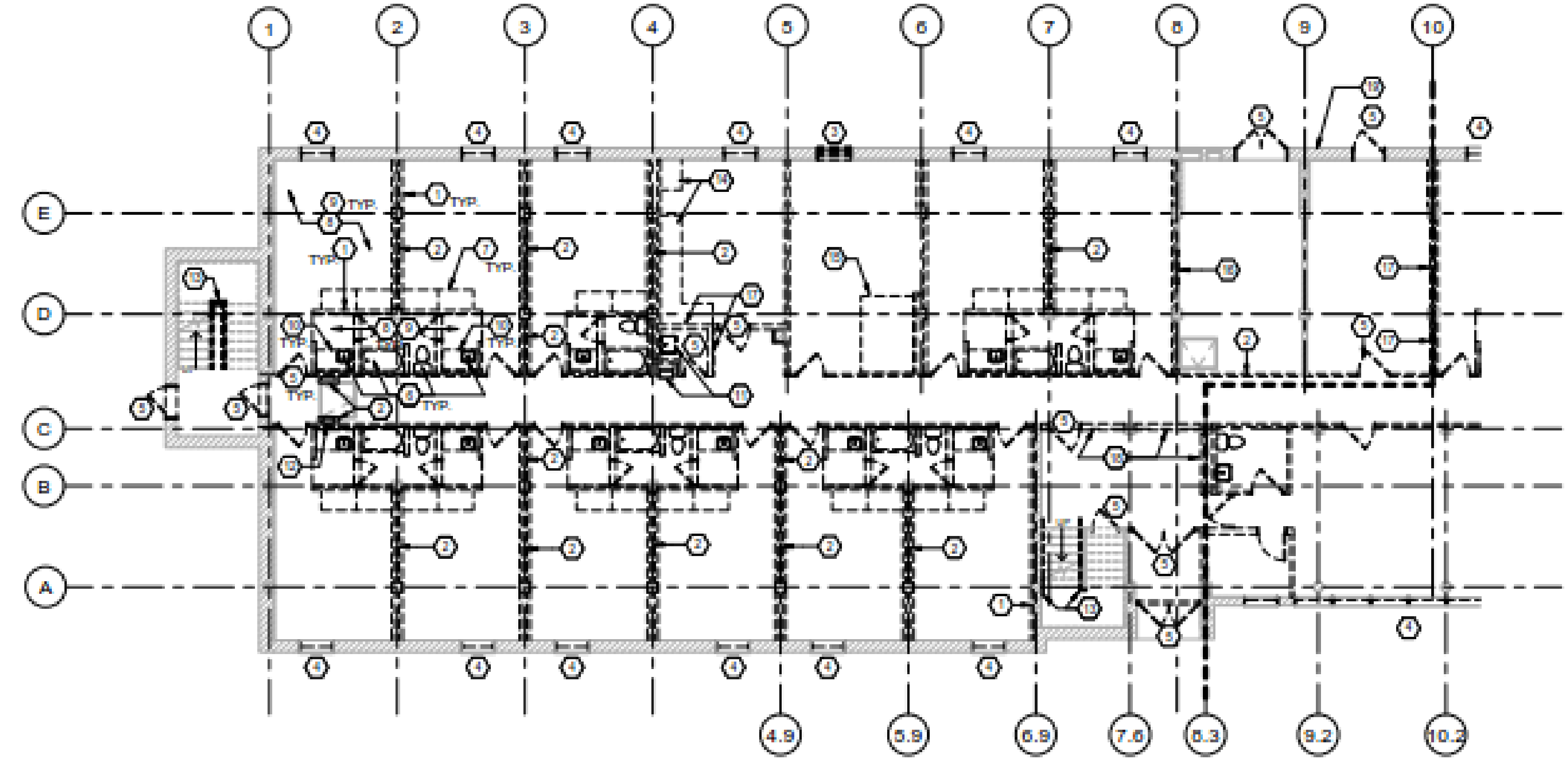
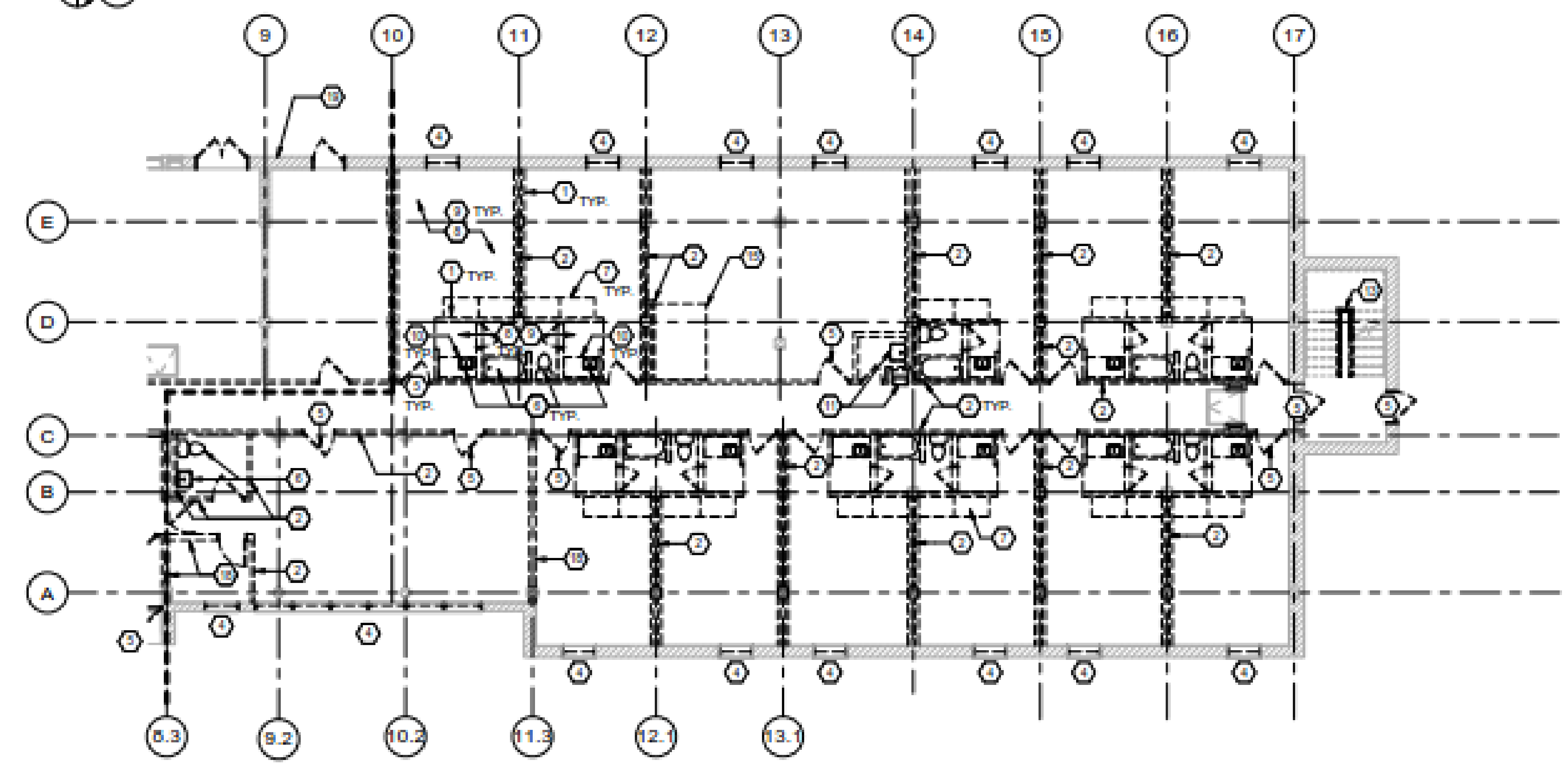


LEVEL ONE - DEMOLITION FLOOR PLAN - AREA A
1/8" = 1'-0"



A - LEVEL ONE - DEMOLITION FLOOR PLAN - AREA B
1/8" = 1'-0"

GENERAL NOTES

1. ITEMS INDICATED AS DASHED TO BE REMOVED.
2. SEE SHEET A-001 FOR DEMOLITION GENERAL NOTES.
3. REFER TO FIRE PROTECTION, PLUMBING, MECHANICAL, ELECTRICAL, TELECOMMUNICATIONS AND SECURITY DRAWINGS FOR WORK REQUIRING SAW CUTTING AND REMOVAL OF SLAB ON GRADE.

KEYED NOTES (THIS SHEET)

AS- DENOTED BY

1 REMOVE GYPSUM BOARD PARTITION AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
2 REMOVE 4" MASONRY WALL
3 REMOVE LOUVER
4 REMOVE WINDOW AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
5 REMOVE DOOR, DOOR FRAME AND ASSOCIATED HARDWARE IN THEIR ENTIRETY
6 REMOVE PLUMBING FIXTURES IN THIS AREA AND ASSOCIATED PIPING. CAP PIPES AS REQUIRED
7 REMOVE BUILT-IN WARDROBES
8 REMOVE FLOOR FINISH AND BASE IN THIS AREA
9 REMOVE CEILINGS, SOFFITS AND ASSOCIATED FIXTURES IN THIS AREA
10 REMOVE CABINETS
11 REMOVE JANITOR'S SINK AND DRINKING FOUNTAIN
12 REMOVE FIRE EXTINGUISHER CABINET, SALVAGE FIRE EXTINGUISHER FOR REUSE BY THE GOVERNMENT
13 REMOVE GUARDRAILS AND HANDRAILS
14 REMOVE BASE CABINETS, WALL CABINETS AND OVERHEAD CABINETS
15 REMOVE RAISED CERAMIC TILE AND CONCRETE FLOOR IN THIS AREA. FINISH LEVEL WITH EXISTING CONCRETE SLAB.
16 SAW CUT OPENING FOR NEW DOOR - COORDINATE WITH EXISTING MASONRY JOINTS AND NEW WORK
17 REMOVE 6" MASONRY WALL
18 REMOVE 8" MASONRY WALL
19 REMOVE EXISTING DRYER EXHAUST VENTS (6 TOTAL) AT EXTERIOR OF BUILDING (6 TOTAL) AND ASSOCIATED DRYER DUCTWORK

DEMOLITION LEGEND

EXISTING WALL/PARTITION TO BE REMOVED
EXISTING WALL/PARTITION TO REMAIN
EXISTING DOOR, FRAME AND HARDWARE TO BE REMOVED
EXISTING DOOR, FRAME AND HARDWARE TO REMAIN

PROFESSIONAL SEAL

Source: Air Force Civil Engineer Center, modified by Terracon

Scale: N/A

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Level One

Minot Air Force Base Building 276
Building 276
Minot Air Force Base, ND

Dec 18

Exhibit 4

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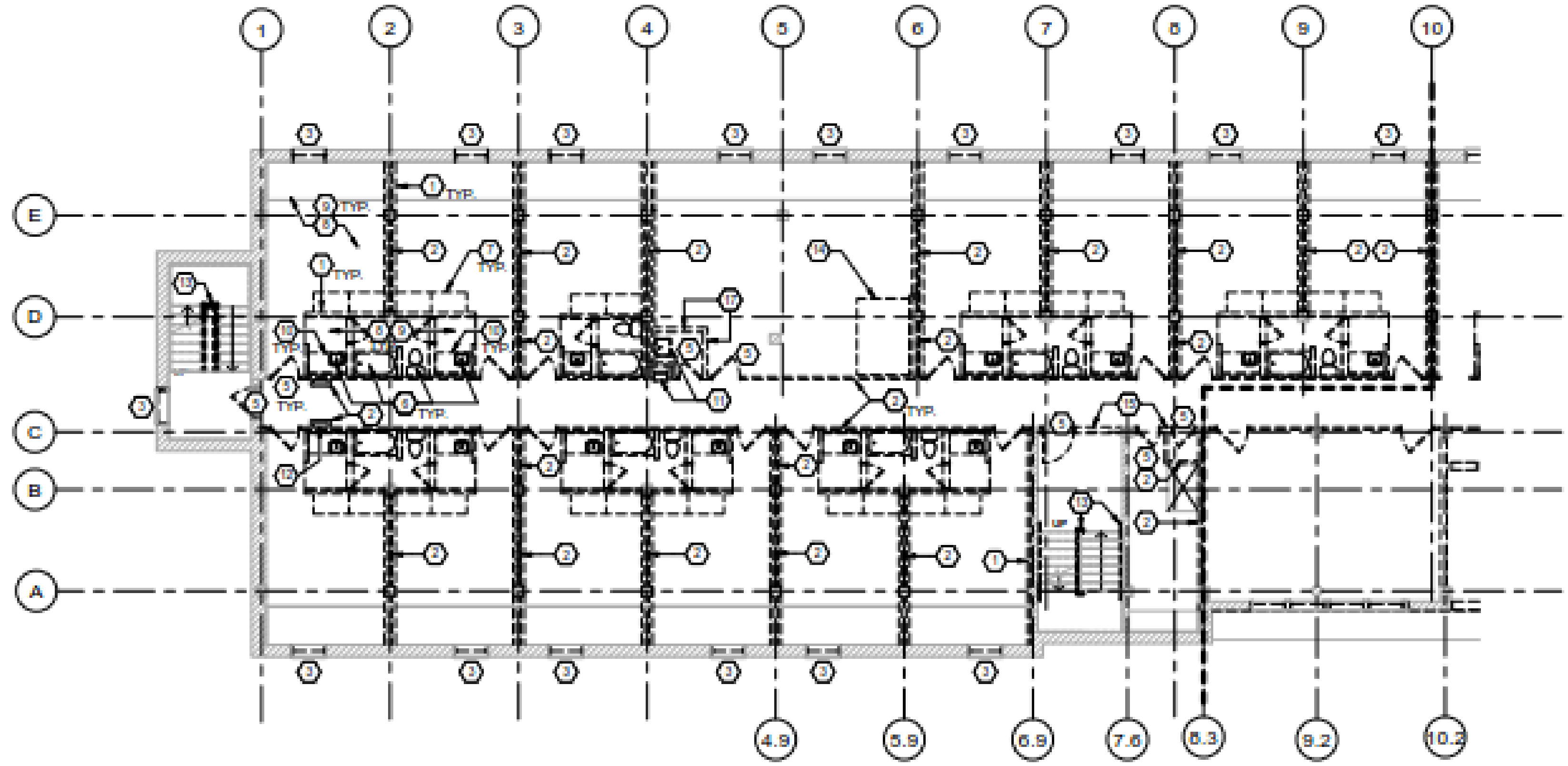
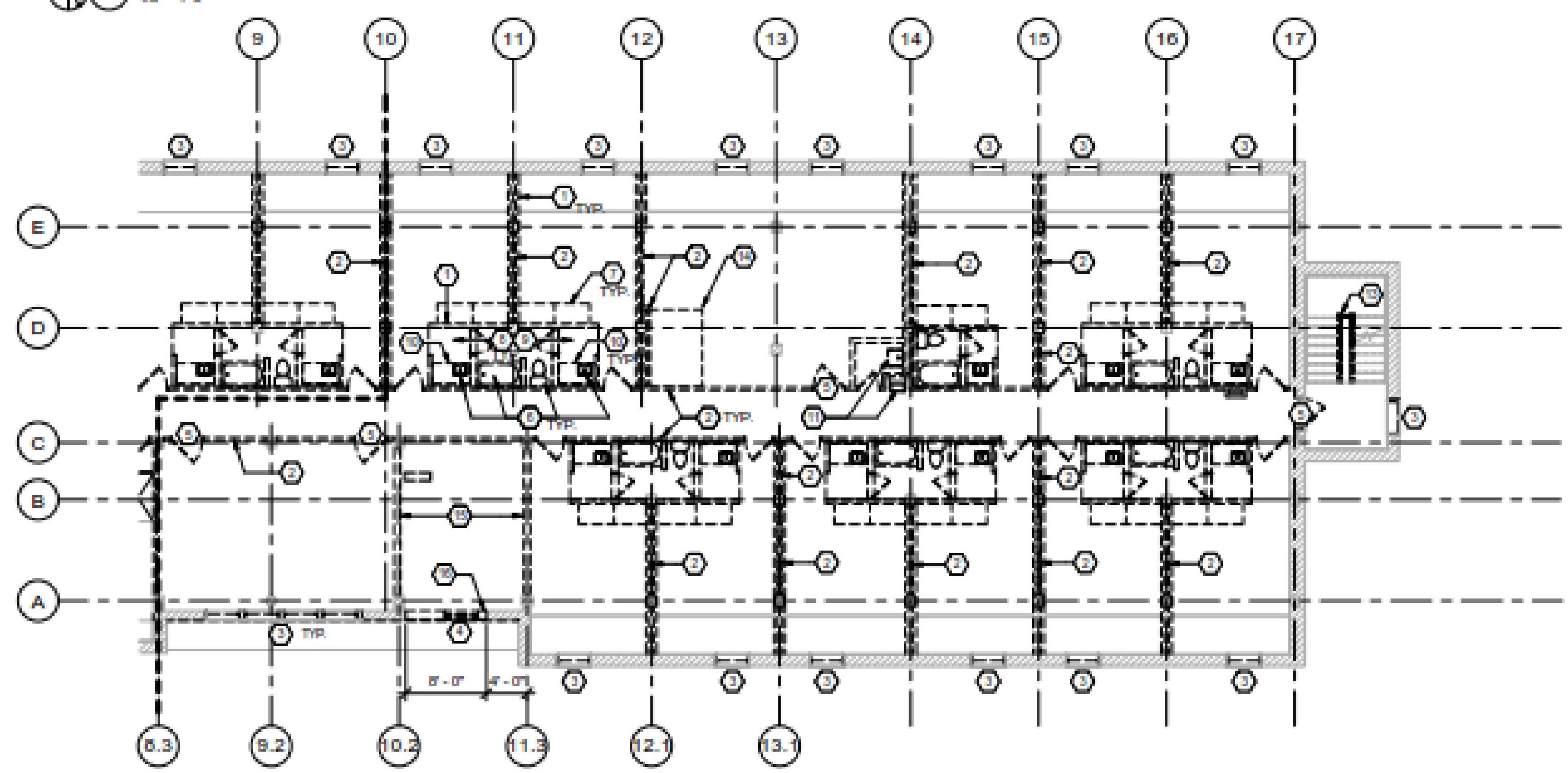


1 LEVEL TWO - DEMOLITION FLOOR PLAN - AREA A

1/8" = 1'-0"



2 LEVEL TWO - DEMOLITION FLOOR PLAN - AREA B

1/8" = 1'-0"

GENERAL NOTES

1. ITEMS INDICATED AS DASHED TO BE REMOVED.
2. SEE SHEET A-C01 FOR DEMOLITION GENERAL NOTES

KEYED NOTES (THIS SHEET) AS- DENOTED BY

1 REMOVE GYPSUM BOARD PARTITION AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
2 REMOVE 4" MASONRY WALL
3 REMOVE WINDOW AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
4 REMOVE LOUVER
5 REMOVE DOOR, DOOR FRAME AND ASSOCIATED HARDWARE IN THEIR ENTIRETY
6 REMOVE PLUMBING FIXTURES IN THIS AREA AND ASSOCIATED PIPING. CAP PIPES AS REQUIRED
7 REMOVE BUILT-IN WARDROBES
8 REMOVE FLOOR FINISH AND BASE IN THIS AREA
9 REMOVE CEILINGS, SOFFITS AND ASSOCIATED FIXTURES IN THIS AREA
10 REMOVE CABINETS
11 REMOVE JANITORS SINK AND DRINKING FOUNTAIN
12 REMOVE FIRE EXTINGUISHER CABINET, SALVAGE FIRE EXTINGUISHER FOR REUSE BY THE GOVERNMENT
13 REMOVE GUARDRAILS AND HANDRAILS
14 REMOVE RAISED CERAMIC TILE AND CONCRETE FLOOR IN THIS AREA. FINISH LEVEL WITH EXISTING CONCRETE SLAB.
15 REMOVE 8" MASONRY WALL
16 SAW CUT WALL FOR INSTALLATION OF NEW LOUVER - COORDINATE WITH EXISITNG MASONRY AND NEW WORK
17 REMOVE 6" MASONRY WALL

DEMOLITION LEGEND

EXISTING WALL/PARTITION TO BE REMOVED
EXISTING WALL/PARTITION TO REMAIN
EXISTING DOOR, FRAME AND HARDWARE TO BE REMOVED
EXISTING DOOR, FRAME AND HARDWARE TO REMAIN

PROFESSIONAL SEAL

Source: Air Force Civil Engineer Center, modified by Terracon

Scale: N/A

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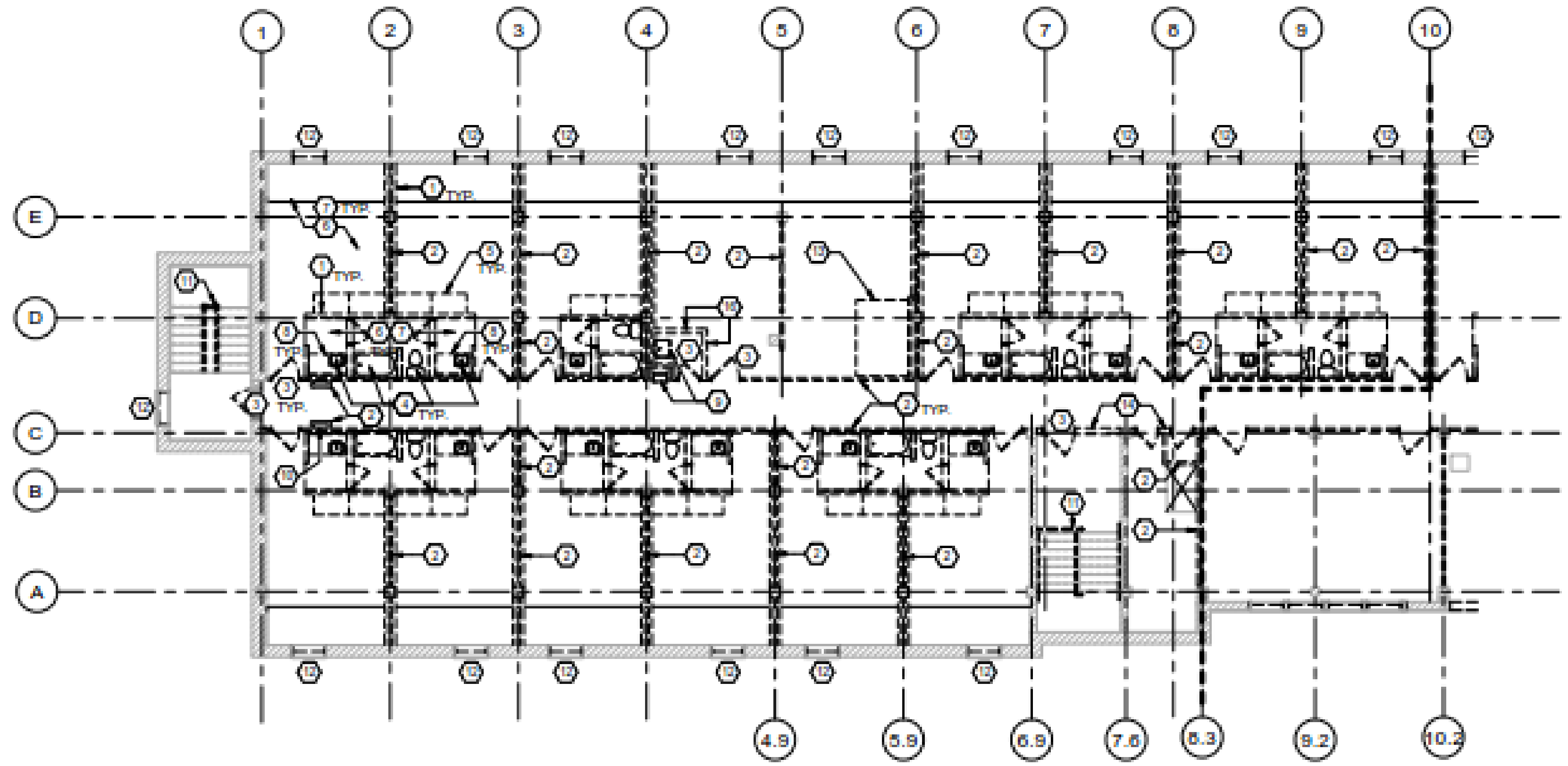
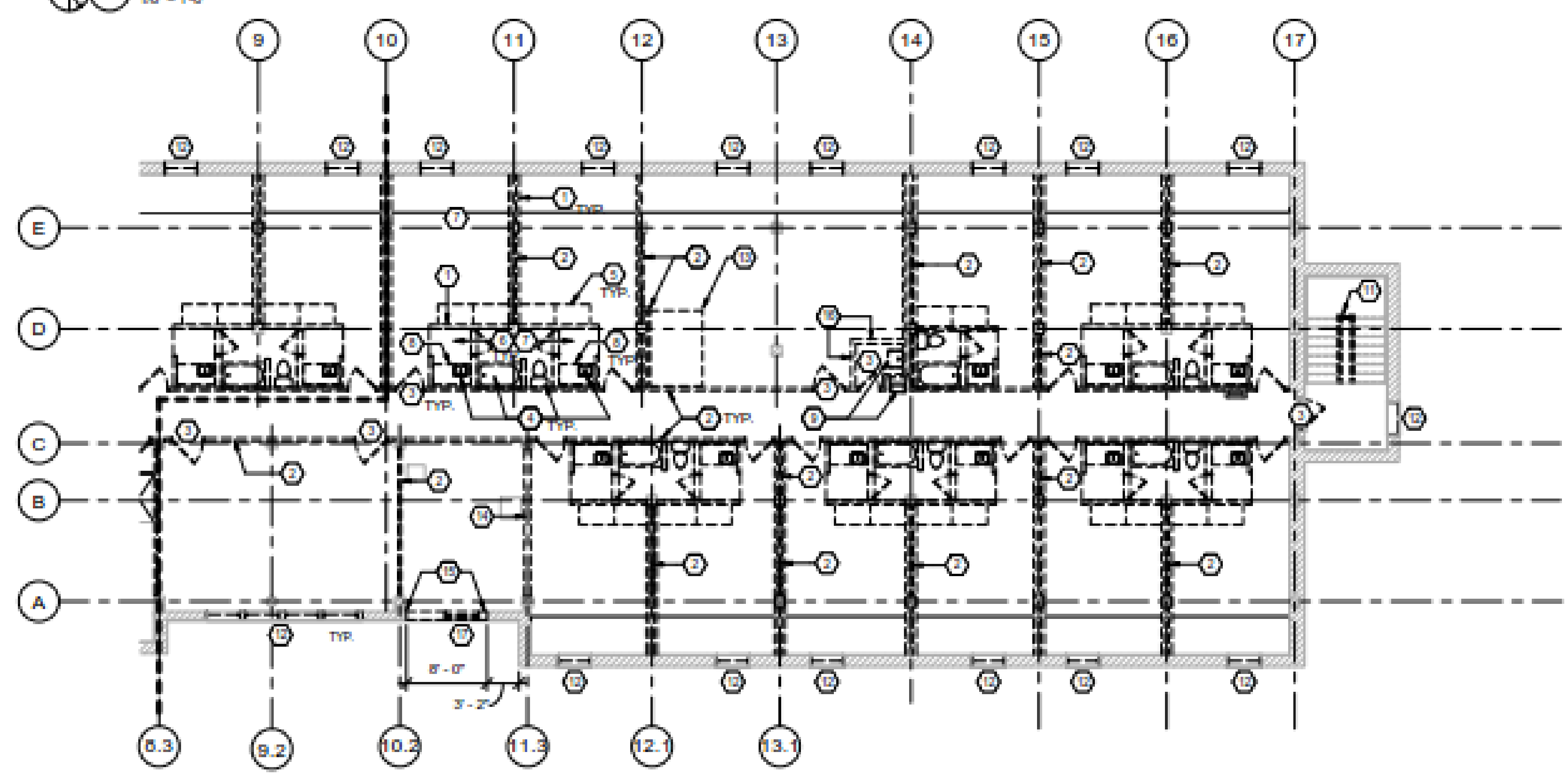
Level 2	Dec 18
Minot Air Force Base Building 276 **Building 276** **Minot Air Force Base, ND**	**Exhibit 5**



LEVEL THREE - DEMOLITION FLOOR PLAN - AREA A

1/8" = 1'-0"



LEVEL THREE - DEMOLITION FLOOR PLAN - AREA B

1/8" = 1'-0"

GENERAL NOTES

1. ITEMS INDICATED AS DASHED TO BE REMOVED.
2. SEE SHEET A-001 FOR DEMOLITION GENERAL NOTES

KEYED NOTES (THIS SHEET) AS- DENOTED BY

1. REMOVE GYPSUM BOARD PARTITION AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
2. REMOVE 4" MASONRY WALL
3. REMOVE DOOR, DOOR FRAME AND ASSOCIATED HARDWARE IN THEIR ENTIRETY
4. REMOVE PLUMBING FIXTURES IN THIS AREA AND ASSOCIATED PIPING. CAP PIPES AS REQUIRED
5. REMOVE BUILT-IN WARDROBES
6. REMOVE FLOOR FINISH AND BASE IN THIS AREA
7. REMOVE CEILINGS, SOFFITS AND ASSOCIATED FIXTURES IN THIS AREA
8. REMOVE CABINETS
9. REMOVE JANITOR'S SINK AND DRINKING FOUNTAIN
10. REMOVE FIRE EXTINGUISHER CABINET, SALVAGE FIRE EXTINGUISHER FOR REUSE BY THE GOVERNMENT
11. REMOVE GUARDRAILS AND HANDRAILS
12. REMOVE WINDOW AND ASSOCIATED CONSTRUCTION IN ITS ENTIRETY
13. REMOVE RAISED CERAMIC TILE AND CONCRETE FLOOR IN THIS AREA. FINISH LEVEL WITH EXISTING CONCRETE SLAB.
14. REMOVE 8" MASONRY WALL
15. SAW CUT WALL FOR INSTALLATION OF NEW LOUVER - COORDINATE WITH EXISITNG MASONRY AND NEW WORK
16. REMOVE 6" MASONRY WALL
17. REMOVE LOUVER

DEMOLITION LEGEND

- - - - -	EXISTING WALL/PARTITION TO BE REMOVED
═══	EXISTING WALL/PARTITION TO REMAIN
	EXISTING DOOR, FRAME AND HARDWARE TO BE REMOVED
	EXISTING DOOR, FRAME AND HARDWARE TO REMAIN

PROFESSIONAL SEAL

Source: Air Force Civil Engineer Center, modified by Terracon

Scale: N/A

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Level 3	Dec 18
Minot Air Force Base Building 276 **Building 276** **Minot Air Force Base, ND**	**Exhibit 6**

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APPENDIX B

Asbestos and Mold Surveys and Lead-Based Paint Screening

Renovate Dormitory
Building 276
Minot Air Force Base, North Dakota

December 17, 2015

Revised

Terracon Project No. M6157011

Prepared for:
Leidos Engineering LLC
Reston, Virginia

Prepared by:
Terracon Consultants, Inc.
Minot, North Dakota

December 17, 2015

Leidos Engineering, LLC
11951 Freedom Drive
Reston, Virginia 20190

Attn: Mr. Ronald Brumfield
P: 405-478-5353
E: Ronald.C.Brumfield@leidos.com

Re: Asbestos and Mold Surveys and Lead-Based Paint Screening - Revised
Building 276
Minot Air Force Base, North Dakota
Terracon Project No. M6157011

Dear Mr. Brumfield:

Terracon Consultants, Inc. (Terracon) is pleased to submit the attached report for the above referenced site to Leidos Engineering, LLC. The purpose of this report is to present the results of asbestos and mold surveys and lead-based paint screening conducted from July 28-30, 2015. The survey was conducted in general accordance with the Subcontract Agreement dated July 21, 2015. We understand this survey was requested due to planned renovation of the building. The report has been revised to include additional work conducted to confirm quantities.

Terracon appreciates the opportunity to provide this service to Leidos Engineering, LLC. If you have questions regarding this report, please contact the undersigned at 701-792-2615.

Sincerely,
Terracon Consultants, Inc.

Stephen T. Maliszeski
Field Geologist

Cindy A. Baldwin, CIH, FAIHA
Senior Industrial Hygienist

TABLE OF CONTENTS

ASBESTOS AND MOLD SURVEYS AND LEAD-BASED PAINT SCREENING – REVISED
Building 276
Minot Air Force Base

Terracon Project No. M6157011
December 17, 2015

EXECUTIVE SUMMARY

Terracon Consultants, Inc. (Terracon) conducted an asbestos survey, mold survey, and lead-based paint (LBP) screening of the Building 276 dormitory at the Minot Air Force Base, North Dakota. We understand the activities were requested to sample and identify suspect asbestos-containing materials (ACM) and provide information regarding their identity, location, condition, and approximate quantities, if present. The services also included identifying the presence and type of airborne mold spores and screening of surface coatings for LBP and mold spores. The services were conducted from July 27-30, 2015 by a team of North Dakota certified asbestos inspectors and a North Dakota certified lead-based paint inspector in general accordance with our proposal dated July 21, 2015 and the Leidos Engineering, LLC (Leidos) Subcontract Agreement dated July 21, 2015. The asbestos survey was conducted in accordance with the sampling protocols established in United States Environmental Protection Agency (USEPA) 40 Code of Federal Regulations Part 763-Asbestos, Subpart E 763-Asbestos-Containing Materials in Schools (40 CFR 763). Terracon collected approximately 96 bulk samples of suspect ACM from the building that were separated by the analytical laboratory into 137 individual layers for analysis.

The following ACMs were identified as a result of laboratory analysis:

Confirmed Asbestos-Containing Materials	
Air duct insulation	White mudded joints and fittings

The following materials are assumed ACM until they can be tested:

Assumed Asbestos-Containing Materials	
Metal fire doors	Wood doors
Roofing components	Vent insulation
2 inch water piping insulation	4 inch water piping insulation

Materials identified to contain more than 1% asbestos should be removed by a qualified and North Dakota-certified asbestos abatement firm.

As part of the proposed scope of work, air samples were collected using a Bio-Pump with Air-O-Cell cassettes to analyze for the presence and types of airborne mold. Several varieties of mold were found to exist in the air samples.

In conjunction with the asbestos and mold surveys, various surface coatings were screened for the presence of lead. Based on direct reading measurements conducted during the screening, LBP, as defined by the USEPA, was identified on the following interior portions of the dormitory:

- Brown handrails and supports in center stairwell with evidence of a green layer.
- White on lower wall of smooth concrete masonry units (CMU) in the storage locker room on first floor.
- White on concrete ceiling in laundry room.

Other coatings contained lead in concentrations below the USEPA definition. Anyone completing work scheduled to disturb any of the above noted areas should be notified of the presence of lead so that necessary precautions can be taken to protect personnel from potential exposures.

Please Note: Terracon understands the building on the property is not currently considered target housing as defined by the USEPA and the project is not receiving federal assistance or Department of Housing and Urban Development (HUD) financing.

ASBESTOS AND MOLD SURVEYS AND LEAD-BASED PAINT SCREENING – REVISED
Building 276
Minot Air Force Base

Terracon Project No. M6157011
December 17, 2015

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) conducted asbestos and mold surveys and lead-based paint (LBP) screening of the Building 276 dormitory at the Minot Air Force Base in North Dakota. The services were conducted from July 27-30, 2015 by a team of North Dakota certified asbestos inspectors in general accordance with Terracon Proposal No. PM6150090 and the Leidos Engineering, LLC (Leidos) Subcontract Agreement dated July 21, 2015. Accessible interior building components were surveyed and homogeneous areas of suspect asbestos-containing materials (ACM) were visually identified and documented. Additional samples were collected at a later date. Although reasonable effort was made to survey all suspect materials, some suspect materials were not sampled due to the occupied status of the building and limitations on disturbing building finishes. Suspect ACM samples were collected in general accordance with the sampling protocols outlined in United States Environmental Protection Agency (USEPA) regulations under 40 Code of Federal Regulations Part 763-Asbestos, Subpart E-Asbestos-Containing Materials in Schools (40 CFR 763). Samples were delivered to an accredited laboratory for analysis by polarized light microscopy (PLM).

We understand that the project services were requested to assess the building for asbestos, mold, and LBP. USEPA regulation 40 CFR 61, Subpart M, National Emission Standards for Hazardous Air Pollutants (NESHAP), prohibits the release of asbestos fibers to the atmosphere during renovation or demolition activities. The asbestos NESHAP requires that potentially regulated ACM must be identified, classified, and quantified prior to planned disturbances.

Although regulations requiring pre-renovation surveys for LBP have not been established, contractors should be informed of the presence of LBP in areas where renovation activities might result in potential worker exposure to lead. Therefore, screening for LBP is recommended so that necessary actions may be identified and initiated to comply with Occupational Safety and Health Administration (OSHA) and landfill disposal requirements.

1.1 Reliance

This report is for the exclusive use of Leidos for the project being discussed. Reliance on this report by other parties is prohibited without written authorization of Terracon and Leidos. Reliance on this report by Leidos and all authorized parties will be subject to the terms, conditions, and limitations stated in the proposal, this report, and the Subcontract Agreement dated July 21, 2015. The limitation of liability defined in the Subcontract Agreement is the aggregate limit of Terracon's liability to Leidos.

2.0 BUILDING DESCRIPTION

Building 276 lies on the Minot Air Force Base and was built in the 1960s. It is a three-story structure approximately 50 feet by 200 feet. It and is currently being used as a dormitory with approximately 80 dorm rooms. Each floor contains approximately 24 dorm rooms, with a shared bathroom between every two rooms as well as a lounge, one to two storage locker rooms, a common hallway, janitorial closets, a mechanical room containing air handling equipment and access to each of the three stairwells. In addition, the first floor contains one extra mechanical room accessed from the exterior of the building containing the heating and electrical equipment, a laundry room, kitchen, and entryway. The structure has a concrete lined piping chase which runs under the length of the first floor hallway containing five pipes which have insulation assumed to be asbestos containing, two labeled as potable water, two labeled as "M.T.W.S. 200," and one which is unlabeled. In addition, one metal pipe runs the length of the building, which may be inferred to be sanitary outflow. Each of these pipes elbows off toward each of the dorm restrooms through the concrete. The heating system is assumed to run along the outside perimeter of the building on each floor. The air handling system is within inaccessible areas and the presence of insulation materials could not be determined. Due to these areas not being accessible, any material encountered must be assumed as asbestos containing. The ceiling of the center stairwell contains a hatch allowing roof access to the original flat roof. A pitched shingle roof was added at a later date creating an attic crawl space and an additional hatch to the exterior roofing.

3.0 FIELD ACTIVITIES

3.1 Asbestos

The asbestos survey was conducted by Mr. Stephen Maliszeski and Ms. Terri Fields; North Dakota certified asbestos inspectors (certificate numbers 5680 and 5781, respectively). Copies of their asbestos inspector certificates are included in Appendix I. The survey was conducted in general accordance with the sample collection protocols established in USEPA 40 CFR 763.86, Sampling. A summary of the survey activities is provided in the following subsections.

3.1.1 Visual Assessment

Survey activities were initiated with visual assessments of accessible interior areas of the building to identify homogeneous areas of suspect ACM. A homogeneous area (HA) consists of building materials that appear similar throughout in terms of color and texture, with consideration given to the date of application.

3.1.2 Physical Assessment

A physical assessment of each HA of suspect ACM was conducted to assess the friability and condition of the materials. A friable material is defined by the USEPA as a material that can be crumbled, pulverized, or reduced to powder by hand pressure when dry. Friability was assessed by physically touching suspect materials.

3.1.3 Sample Collection

Based on results of the visual assessment, bulk samples of suspect ACM were collected in general accordance with USEPA sampling protocols. Samples of suspect materials were collected from randomly selected locations in each homogeneous area. Bulk samples were collected using wet methods as applicable to reduce the potential for fiber release. Samples were placed in sealable containers and labeled with unique sample numbers using an indelible marker.

The selection of sample locations and frequency of sampling were based on Terracon's observations and the assumption that like materials in the same area are homogeneous in content.

Terracon collected 96 bulk samples of suspect ACM from the building. The analytical laboratory separated some those samples into individual layers, resulting in analysis of 137 samples. A summary of suspect ACM samples collected during the survey is included in Appendix B.

Terracon had limited or no access in some areas due to safety and/or security considerations. The following general areas (not exclusive) could be concealing additional ACM. Several areas, such as material around ventilation systems and piping were unable to be sampled at this time as the building is still occupied; these areas will need to be evaluated further once the building is no longer occupied. Samples of suspect materials should be collected from the following areas before they are disturbed during renovation activities.

Table 1.0. Functional Areas with Limited Access with Assumed ACM

Inside heating, ventilating, and air handling equipment	Inside electrical panels, ducts, and switchgears
Inside door systems	Above hard ceilings
Utility piping chases under inaccessible flooring and within wall cavities	Roofing material

3.1.4 Sample Analysis

The bulk samples were submitted under chain of custody (COC) to International Asbestos Testing Laboratories (IATL) of Mt. Laurel, NJ for analysis by PLM with dispersion staining techniques per USEPA's *Method for the Determination of Asbestos in Bulk Building Materials* (600/R-93/116). The percentage of asbestos, if present, was determined by microscopic visual estimation. The laboratory reanalyzes samples with an initial reported asbestos concentration of less than or equal to (≤) 10% by point counting, as established by 40 CFR 763, Appendix E, Section 1.7.2.4. The point counting method allows for a more definitive analysis of asbestos content to establish if the material is asbestos-containing. IATL is accredited under the National Voluntary Laboratory Accreditation Program [(NVLAP) Accreditation No. 101165-00]. The findings are presented in Section 5.1 and the laboratory analytical report is included in Appendix D.

3.2 Mold

3.2.1 Physical Inspection

The physical survey was conducted to determine whether building materials were impacted by moisture intrusion or condensate formation, and to assess the interior for the possible presence of visible fungal growth. The assessment focused primarily on collecting observational data (i.e., information obtained by physical inspection of the building and interviews with the building management, owners, and occupants). The physical survey can help to formulate plans for more in-depth assessments.

The physical survey included:

- Examination of the interior physical structure and potential sources of moisture intrusion;
- Identification of discoloration or odors that could indicate moisture intrusion, water damage, and/or fungal growth; and
- Examination of the heating and cooling units.

Destructive sampling or testing to inspect interior wall cavity spaces or mechanical enclosures were not within the scope of work for this project. Terracon did not attempt to identify sources of moisture intrusion. A summary of general building information and results of the physical inspection are contained below.

3.2.2 Sample Collection and Analysis

High variability in airborne fungal spore concentrations can exist in different geographic locations, during different seasons, and weather patterns, and over the course of a given day. As a general rule, indoor air fungal spore concentrations in a heating, ventilating, and air-conditioning (HVAC)-supplied building are typically less than, but qualitatively similar to, fungal spore concentrations found in the outside environment. To help interpret the sampling results, we compared indoor air and outdoor air measurements.

Terracon collected 22 total non-viable (non-culturable) fungal spore trap samples using Air-O-Cell® sampling cassettes and a Zefon Bio-Pump® Plus, at a flow rate of 15 liters per minute for 10 minutes per sample. Air-O-Cell® sampling cassettes were collected at representative indoor and outdoor sample locations. After air sample collection, the sample cassettes were shipped under COC protocol to EMSL Analytical, Inc. (EMSL), in Cinnaminson, New Jersey. EMSL is accredited by the AIHA® Laboratory Accreditation Programs, LLC under the Environmental Microbiology Laboratory Accreditation Program (EMLAP #157245). The findings are presented in Section 5.2 and the laboratory analytical report is included in Appendix F.

3.3 Lead-Based Paint (LBP) Screening

LBP screening was conducted by Mr. Maliszeski on July 30, 2015. The screening services included visual observations of coated surfaces (i.e., paint, varnish, colored tiles) to identify potential LBP-coated components. Based on the visual observations, an x-ray fluorescence (XRF) analyzer was used to analyze and identify lead-containing materials on interior areas of the dormitory building. The purpose of the screening was to assess for the presence of LBP on building components that should be communicated to contractors involved in renovation so that they can take the necessary precautions to reduce potential exposures to personnel. A summary of the survey activities is provided below.

3.3.1 Sampling

An XRF analyzer was used to conduct direct reading measurements of lead content in interior surfaces. An XRF is a portable electronic device containing a small, sealed nuclear source. The device emits x-rays at various energy levels. The x-ray energy excites electrons in the outer orbits of lead atoms. The detector in the XRF unit reads this excitation and translates it into a semi-quantitative reading of lead present by surface area. XRF technology allows detection of lead in a painted surface, even several layers below the surface, without disturbing the painted surface. XRF is an industry standard for determining lead in painted surfaces. Using the XRF, Terracon conducted 137 measurements on painted surfaces in the spaces assessed to evaluate the presence of LBP. The XRF was calibrated prior to, during, and at the end of use.

Surfaces that were tested included, but were not limited to:

- Interior door components,
- Interior window components,
- Interior walls and wall components, and
- Ceilings.

The table below lists the materials that were identified as containing lead-based paint. A full list of the materials tested for lead content, including the associated results, is provided in Section 5.3 and field-testing results are presented in Appendix H.

Table 2.0. Confirmed Lead-Based Paint Containing Materials

First floor locker room, lower half	Laundry room ceiling	Handrail, center stairwell

4.0 REGULATORY OVERVIEW

4.1 Asbestos

In North Dakota, asbestos activities are regulated by the North Dakota Department of Health (NDDH). NDDH adopted the USEPA's asbestos NESHAP (40 CFR Part 61, Subpart M) by reference. Subpart M regulates asbestos fiber emissions and asbestos waste disposal practices. It also requires the identification and classification of existing building materials prior to demolition or renovation activity. Under NESHAP, asbestos-containing building materials are classified as friable, Category I nonfriable, or Category II nonfriable ACM. Friable materials are those that, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure. Category I nonfriable ACM includes packings, gaskets, resilient floor coverings, and asphalt roofing products containing more than 1% asbestos. Category II nonfriable ACM are any materials other than Category I materials that contain more than 1% asbestos.

Regulated ACM (RACM) must be removed before renovation or demolition activities that will disturb the materials. RACM includes:

- Friable ACM;
- Category I nonfriable ACM that has become friable or will be subjected to drilling, sanding, grinding, cutting, or abrading; and
- Category II nonfriable ACM that could be crumbled, pulverized, or reduced to powder during renovation or demolition activities.

The owner or operator must provide the NDDH with written notification of planned removal activities at least 10 working days prior to the commencement of asbestos abatement activities. Removal of RACM must be conducted by a North Dakota-permitted asbestos abatement contractor.

ACM must be assessed by North Dakota-certified inspectors. Asbestos abatement must be performed by North Dakota-certified asbestos abatement contractors. Management plans developed for the in-place management of asbestos-containing materials must be developed by a

North Dakota-certified management planner. When an abatement project design is prepared, it must be prepared by an NDDH-certified abatement project designer.

The Occupational Safety and Health Administration (OSHA) regulates employee exposure to asbestos in construction under 29 CFR 1926.1101. The OSHA standard requires that employee exposure to airborne asbestos fibers be maintained below the permissible exposure limits (PEL) of 0.1 asbestos fibers per cubic centimeter of air (0.1 f/cc) as an 8-hour time-weighted average and 1.0 f/cc as a 30-minute excursion. The OSHA standard classifies construction and maintenance activities that could disturb ACM and specifies work practices and precautions that employers must follow when engaging in each class of regulated work.

4.2 Mold

State or federal exposure limits have not been established for fungal aerosols. Regulatory standards or medically based threshold limit or dose-response relationships have not been determined for exposure to airborne or surface concentrations of mold spores. Terracon relies upon experience, professional judgment, current scientific literature, guidelines and recommendations made by professional organizations and experts, and statistical methods in interpreting mold sampling results.

4.3 LBP

Lead is regulated by the USEPA and OSHA. USEPA regulates lead use, removal, and disposal, and OSHA regulates worker exposure to lead. USEPA defines LBP as paint, varnish, stain or other applied coating that contains lead equal to or greater than 1.0 milligram per square centimeter (mg/cm^2), 5,000 milligrams per kilogram (mg/kg), or 0.5% by dry weight as determined by laboratory analysis. For the purpose of the OSHA lead standard, lead includes metallic lead, all inorganic lead compounds, and organic lead soaps. The OSHA standard does not define the amount of lead in paint that constitutes lead-based paint.

USEPA regulates disposal of hazardous materials. The USEPA has stated that components removed with intact LBP that is not delaminating from the substrate may be disposed as general demolition debris. If the LBP is stripped from components, or if it is delaminating from the substrate, the waste may be subject to hazardous waste rules [i.e., Toxicity Characteristics Leaching Procedure (TCLP)].

USEPA issued the Renovation, Repair, and Painting (RRP) rule (40 CFR Part 745) requiring the use of lead-safe practices and other actions aimed at preventing lead poisoning. Under the rule, beginning in April 2010, contractors performing renovation, repair, and painting projects that disturb LBP in homes, childcare facilities, and schools built before 1978 must be certified and must follow specific work practices to prevent lead contamination. The NDDH has adopted similar regulations.

The OSHA Lead Standard for Construction (29 CFR 1926.62) applies to all construction work where an employee may be occupationally exposed to lead. IAC 875–10 adopts 29 CFR 1926.62 by reference. All work related to construction, alteration or repair (including painting and decorating) is included. The lead-in-construction standard applies to any detectable concentration of lead in paint, as even small concentrations of lead can result in unacceptable employee exposures depending upon on the method of removal and other workplace conditions. Under this standard, construction includes, but is not limited to, the following:

- Demolition or salvage of structures where lead or materials containing lead are present.
- Removal or encapsulation of materials containing lead
- New construction, alteration, repair, or renovation of structures, substrates, or portions containing lead, or materials containing lead
- Installation of products containing lead
- Lead contamination/emergency clean-up
- Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed
- Maintenance operations associated with construction activities described above

Employers must assure that no employee will be exposed to lead at concentrations greater than the PEL of 50 micrograms per cubic meter ($\mu g/m^3$) averaged over an eight-hour period without adequate protection. The OSHA standard also establishes an action level of 30 $\mu g/m^3$, which if exceeded, triggers certain requirements, including periodic exposure monitoring and medical monitoring.

5.0 FINDINGS AND RECOMMENDATIONS

5.1 Asbestos Survey

The following ACMs were identified as a result of laboratory analysis:

Table 3.0. Confirmed ACMs

Asbestos Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
White duct wrapping on air handling equipment	Mechanical rooms on second and third floors	384 square feet	Good	Chrysotile	3.3

Asbestos Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
Off-white mudded joints and fittings	Around insulated piping under center stairwell, inside piping crawlspace, and mechanical rooms.	1,380 units	Good	Amosite	4.2
				Chrysotile	1.5

The following materials are assumed ACM until they can be tested:

Table 4.0. Assumed Asbestos-Containing Materials

Metal fire doors	Wood doors
Roofing components	Vent insulation
2 inch water piping insulation	4 inch water piping insulation

A summary of the classification, condition, and approximate quantity of identified ACM and a list of assumed ACM are presented Appendix A. A summary of the samples collected is presented in Appendix B. ACM location exhibits are included in Appendix C. The laboratory analytical report is included in Appendix D.

It should be reemphasized that, although reasonable efforts were made to physically survey and sample all suspect materials, some materials will need to be evaluated after the building is unoccupied. Additionally, suspect but unsampled materials could be located under existing building materials, in isolated areas, in pipe chases not accessed by Terracon during the survey, or in other concealed areas of the building. Therefore, if suspicious materials are encountered during renovation activities that do not appear to have been characterized as ACM or non-ACM, disturbance work should immediately stop, samples should be collected and analyzed prior to disturbing these materials or the materials can be assumed to contain asbestos and abated by a North Dakota licensed asbestos abatement firm.

5.2 Mold Survey

Table 5.0 contains an overview of findings from the physical survey. Significant findings are discussed in the section that follows.

Table 5.0. Physical Survey Findings

Inspection Parameter	Observation Comments
Year Constructed	1960
Type of Occupancy	Occupied dormitory
Major Renovations	None
Floors Above/Below Grade	3/0
Physical Examination (odors, housekeeping)	Evidence of mold was not noticed in the dormitories or common spaces. One area within the first floor storage locker room was observed to have historical moisture stains on the ceiling.
Type of Enclosure	Walls were a combination of gypsum wallboard and concrete masonry units (CMU). Ceilings were a combination of gypsum wallboard and concrete. Flooring appeared to be concrete throughout.
Types of Finishes	
■ Walls	■ White paint throughout. Some areas had laminate wall panels over the gypsum wallboards.
■ Ceilings	■ White orange peel textured gypsum wallboard ceilings and flat paint on concrete.
■ Floors	■ Carpeting/concrete
Discoloration/Water Staining	Concrete ceiling in first floor storage locker room – historical.
HVAC Type	Centralized units with air ducts. One per floor.

The interior spaces of the building showed evidence of moisture in only the first floor storage locker room. Microbial growth was not observed.

5.2.1 Mold Analytical Results and Recommendations

Total indoor fungal spore concentrations ranged from 2,210 to 10,340 counts per cubic meter (count/m^3). The outdoor total fungal concentration was 8,970 count/m^3. The total mold spore concentration in one indoor sample location exceeded the outdoor concentration (indicated in bold) and one sample was overloaded and could not be read. Table 6.0 shows the results of the samples collected on July 29 and 30, 2015. The samples were collected at a rate of 15 liters per minute and for 10 minutes, totaling sample volumes of 150 liters of air.

Table 6.0. Mold Sample Results

Sample Date	Sample	Lab ID	Sample location	Total Fungal Spores (count/m^3)
7/29/15	AOC – 1	351505112-001	Dorm room 211	4,707
7/29/15	AOC – 2	351505112-002	2nd floor lounge	5,230
7/29/15	AOC – 3	351505112-003	2nd floor mechanical room	4,390
7/29/15	AOC – 4	351505112-004	Dorm room 226	3,247
7/29/15	**AOC – 5**	**351505112-005**	**2nd floor hall near room 223**	**10,340**
7/29/15	AOC – 6	351505112-006	2nd floor hall near room 204	5,287
7/29/15	AOC – 7	351505112-007	3rd floor lounge	5,370
7/29/15	AOC – 8	351505112-008	3rd floor mechanical room	5,330
7/30/15	AOC – 9	351505112-009	3rd floor hall near room 306	2,997
7/30/15	AOC – 10	351505112-010	Dorm room 309	Present[1]
7/30/15	AOC – 11	351505112-011	Dorm room 320	3,140
7/30/15	AOC – 12	351505112-012	3rd floor hall near room 323	3,217
7/30/15	AOC – 13	351505112-013	1st floor hall near room 119	3,530
7/30/15	AOC – 14	351505112-014	Dorm room 120	3,147
7/30/15	AOC – 15	351505112-015	1st floor lounge	3,457
7/30/15	AOC – 16	351505112-016	1st floor laundry room	3,600
7/30/15	AOC – 17	351505112-017	1st floor mechanical room	5,697
7/30/15	AOC – 18	351505112-018	Foyer	4,210
7/30/15	AOC – 19	351505112-019	Kitchen	5,760
7/30/15	AOC – 20	351505112-020	1st floor hall near room 106	5,967
7/30/15	AOC – 21	351505112-021	Dorm room 106	2,210
7/30/15	AOC - 22	351505112-022	Outdoor sample	8,970

The total mold spore counts were generally elevated, although only one exceeded the outdoor concentration. The types of mold spores indoors were similar to those found outdoors and elevated concentrations indoors may be due to outside air making its way into the building by way of doors and windows. Terracon recommends additional investigation to determine if these mold spore concentrations are typical for this building.

[1] The sample was overloaded and the laboratory was unable to quantify mold spores.

5.3 Limited Lead-Based Paint Screening

Based on direct reading measurements conducted during the XRF survey, LBP, as defined by the USEPA, was identified on interior portions of the dormitory. It should be noted that the XRF indicates an inconclusive range of 0.6 – 1.1 mg/cm^2 and therefore all results greater than 0.6 mg/cm^2 are considered lead-containing.

The painting history of any given location in an older building often will vary from point to point due to factors including variability in paints used, paint film thickness, variable retention of older paint layers before repainting, demolition/installation of walls during renovations, and unknown historic non-homogenous painting schemes. As such, a given color and building component combination that is currently apparent often will not provide consistent testing results for lead.

Terracon attempts to perform lead paint testing in sufficient quantity to establish trends in lead content based on distinguishable characteristics such as color or building component, subject to time and budget constraints. Based on testing results in Appendix H, in Terracon's opinion the following components are known to contain LBP:

Table 7.0. Confirmed Lead-Based Paint Containing Materials

Location	Color	Substrate	Area (square feet)
First floor locker room, lower half	White	Smooth CMU	360
Laundry room ceiling	White	Concrete	280
Handrail, center stairwell	Brown	Metal	16

The above list is not intended to be an inclusive list of all locations where LBP is present throughout the building. Anyone completing work scheduled to disturb any of the above noted areas/materials should be notified of the presence of LBP so that necessary precautions can be taken to protect personnel from potential exposures as per the OSHA lead standard.

5.3.1 LBP Recommendations

Lead-based paint was identified during this screening.

Terracon recommends that the contractor(s) involved in the renovation be notified of the presence of LBP and lead-containing paint (lead concentrations less than USEPA's criteria) on building components. OSHA's lead standard for construction (29 CFR 1926.62) applies regardless of the concentration and contractor(s) will need to provide appropriate personal protective equipment and conduct personal exposure monitoring, at a minimum. Terracon recommends the contractor review the specified work tasks and methods involved in the remodeling process and prepare a detailed LBP management plan. The LBP management plan should identify the work procedures and health and safety measures to be used in the LBP material removal/stabilization.

Please Note: Terracon understands the building on the property is not currently considered target housing as defined by the USEPA and the project is not receiving federal assistance or Department of Housing and Urban Development (HUD) financing. These types of programs and level of assistance can require implementation of some or all provisions of the USEPA and/or HUD regulations.

6.0 LIMITATIONS/GENERAL COMMENTS

The survey was conducted utilizing limited destructive sampling techniques. Therefore, efforts were made to determine if multiple layers of materials were present (e.g., flooring), but the efforts were limited to the extent of allowable access with hand tools without affecting security, fire and life safety; the presence of safety hazards (electrical, slips, trips, and/or fall hazards); or unacceptable aesthetic or functional damage to building surfaces and materials, as per the judgment of the inspector at the time of the survey. Therefore, suspect ACM may be present in concealed spaces, cavities, and plenums of the building. Additional inspection by a licensed asbestos inspector is required by USEPA prior to demolition or renovation that would impact such materials not identified in the survey.

The services were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same locale following an approved scope of work. The results, findings, and conclusions expressed in this report are based on conditions observed during our survey of the building. The information contained in this report is relevant to the date on which this survey was conducted and areas accessed, and should not be relied upon to represent conditions at a later date. This report has been prepared on behalf of and exclusively for use by Leidos for specific application to their project as discussed. This report is not a bidding document. Contractors or consultants reviewing this report must draw their own conclusions regarding further investigation or remediation deemed necessary. Terracon does not warrant the work of regulatory agencies, laboratories, or other third parties supplying information that may have been used in the preparation of this report. No warranty, express or implied is made.

APPENDIX A

Asbestos Survey

Minot Air Force Base, North Dakota

CONFIRMED ASBESTOS-CONTAINING MATERIALS BY HOMOGENEOUS AREA (HA)

Confirmed-Containing Material	Location	Quantity	Condition	Asbestos Type	Concentration (% asbestos)
White duct wrapping on air handling equipment	Mechanical rooms on second and third floors	384 square feet	Good	Chrysotile	3.3
Off-white piping insulation, mudded joints and fittings	Around insulated piping under center stairwell, inside piping crawlspace, and mechanical rooms.	1,380 units	Good	Amosite	4.2
				Chrysotile	1.5

ASSUMED ASBESTOS-CONTAINING MATERIALS BY HA

Assumed Asbestos Containing Material	Location	Estimated Quantity	Condition
Metal fire doors	Stairwell entrance and building exits	17	Good
Wood room doors	Dorm rooms, restrooms, common rooms	166	Good
Roofing components	Pitched roof.	14,000 square feet[1]	Unknown
Vent insulation	Around air ducts above hallways with laterals to each room.	8,000 linear feet[1]	Unknown
2 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms. Two runs identified with laterals inside the piping crawlspace.	1,860 linear feet[1]	Damaged
4 inch water piping insulation	Around water lines beneath flooring and laterals into restrooms, laundry and kitchen. Four runs identified with laterals inside the piping crawlspace.	3,660 linear feet[1]	Damaged

[1] Quantities will need to be evaluated further once building is unoccupied.

APPENDIX A

Asbestos Survey
Minot Air Force Base, North Dakota

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[1] Quantities will need to be evaluated further once building is unoccupied.

APPENDIX B

ASBESTOS SURVEY SAMPLE LOCATION SUMMARY

HA MATERIAL LIST

HA No:	MATERIAL DESCRIPTION	HA No:	MATERIAL DESCRIPTION
F-1	9" x 9" floor tile and mastic	T-1	straight run pipe insulation
F-2	12" x 12" floor tile and mastic	T-2	mudded joints and fittings
F-3	vinyl sheet flooring	T-3	boiler insulation
F-4	mastic, only	T-4	flue insulation
F-5	carpet glue	T-5	storage tank insulation
F-6	wood vapor barrier	T-6	breeching insulation
F-7	Leveling Compound	T-7	boiler gaskets
F-8	2"x2" ceramic floor tile	T-8	duct insulation
F-9		T-9	boiler fire brick
		T-10	insulative mud
M-1	sheetrock and joint compound	T-11	fire stop
M-2	joint compound	T-12	vibration collar - brown
M-3	plaster	T-13	
M-4	cement asbestos panels	T-14	
M-5	2' x 4' lay-in ceiling panels	T-15	
M-6	2' x 2' lay-in ceiling panels		
M-7	12" x 12" ceiling tiles	R-1	built-up roof materials
M-8	12" x 12" ceiling tiles w/mastic	R-2	roof flashing
M-9	baseboard adhesive	R-3	roof shingles
M-10	window caulking	R-4	
M-11	building insulation	R-5	
M-12	flexible HVAC vibration collar		
M-13	Stage Light Cords	S-1	decorative/acoustical spray-on (knockdown)
M-14	Fire Door	S-2	decorative/acoustical troweled-on
M-15	Sink Coating	S-3	fire proofing spray-on
M-16	door caulking	S-4	fire proofing troweled-on
M-17	window glazing	S-5	
M-18	vinyl wall covering		
M-19	base ceramic tile 4"x6" beige		
M-20	4"x4" ceramic wall tile beige		
M-21	white tile grout		
M-22	random ceramic tile pattern - tan		
M-23	grey tile grout		
M-24	bathroom tile mortor, orange		

Terracon PN: M615 70 11 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
F-5 - 1 - A	Entrance Room 211	5698685 9/29/30
F-5 - 1 - B	3rd Floor central stairwell entrance	5698686
F-5 - 1 - C	West end of hall, 1st floor	5698687
F-4 - 1 - A	1st floor foyer entrance	5698688
F-4 - 1 - B	1st floor Stairwell, west end	5698689
F-4 - 1 - C	1st floor stairwell, east end	5698690
F-2 - 1 - A	1st floor kitchen	5698691
F-2 - 1 - B	2nd floor stairwell - West end	5698692
F-2 - 1 - C	3rd floor utility closet - East end	5698693
M-9 - 1 - A	Room 211, near entrance	5698694
M-9 - 1 - B	1st floor hall, near Room 115	5698695
M-9 - 1 - C	3rd floor hall, near Room 323	5698696
M-9 - 2 - A	1st floor, east utility closet	5698697
M-9 - 2 - B	2nd floor, east utility closet	5698698
M-9 - 2 - C	2nd floor, west utility closet	5698699
S-1 - 3 - A	Room 211, east wall	5698700
S-1 - 3 - B	1st floor south wall, near Room 125	5698701
S-1 - 3 - C	1st floor north wall, near Room 106	5698702
S-1 - 3 - D	3rd floor, hall ceiling, near Room 302	5698703
S-1 - 3 - E	3rd floor locker, east wall	5698704
S-1 - 3 - F	2nd floor, hall ceiling, near Room 207	5698705

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
S-1 - 3 - C	2nd floor, north wall, near Room 218	5698706 7/29/30
M-3 - 1 - A	2nd floor stairwell, east wall	5698707
M-3 - 1 - B	1st floor foyer, near NW corner	5698708
M-3 - 1 - C	1st floor ~~fo~~ building entrance, west wall	5698709
M-3 - 1 - D	land between 1st + 2nd floors, west wall	5698710
M-3 - 1 - E	3rd floor stairwell, near NW corner	5698711
M-18 - 1 - A	1st floor hall, west end	5698712
M-18 - 1 - B	2nd floor hall, east end	5698713
M-18 - 1 - C	Center stairwell	5698714
M-18 - 1 - D	3rd floor hall, west end	5698715
M-18 - 1 - E	Kitchen	5698716
M-6 - 1 - A	Room 129	5698717
M-6 - 1 - B	In Foyer, near stair	5698718
M-6 - 1 - C	In Foyer, near mail	5698719
S-1 - 2 - A	Room 129	5698720
S-1 - 2 - B	1st floor lounge, near south wall	5698721
S-1 - 2 - C	2nd floor lounge, near south wall	5698722
M22 - 1 - A	1st floor storage locker - East side	5698723
M22 - 1 - B	2nd floor storage locker - West side	5698724
M22 - 1 - C	3rd floor storage locker - East side	5698725
M23 - 1 - A	1st floor storage locker - East Side	5698726

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
M23 - 1 - B	2nd floor storage locker - West side	5698727 7/29/30
M23 - 1 - C	3rd Floor Storage locker - East side	5698728
F-4 - 3 - A	1st Floor Stair - West end	5698729
F-4 - 3 - B	2nd Floor Stairs - Center	5698730
F-4 - 3 - C	3rd floor Stairs - East	5698731
F-4 - 2 - A	2nd floor mech room, SW corner	5698732
F-4 - 2 - B	3rd floor mech room, SE corner	5698733
F-4 - 2 - C	2nd floor mech room, NE corner	5698734
M-15 - 1 - A	kitchen sink	5698735
M-15 - 1 - B	kitchen sink	5698736
M-15 - 1 - C	kitchen sink	5698737
M-21 - 1 - A	Room 211, west shower wall	5698738
M-21 - 1 - B	Room 211, west shower wall	5698739
M-21 - 1 - C	Room 211, west shower wall	5698740
M-20 - 1 - A	Room 211, west shower wall	5698741
M-20 - 1 - B	Room 211, west shower wall	5698742
M-20 - 1 - C	Room 211, west shower wall	5698743
F-8 - 1 - A	Room 211, under sink	5698744
F-8 - 1 - B	Room 211, under sink	5698745
F-8 - 1 - C	Room 211, under sink	5698746
start M-19 - 1 - A	Room 211, under sink	5698747

Terracon PN: M6157011 **Asbestos Sample Location Log** Page 4 of 5

Client Name: Terracon

Building Name: ~~[illegible]~~ Building 267 Minot AFB

Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date:
M-19 - 1 - B	Room 211, under sink	~~5698748~~ 7/29/30
M-19 - 1 - C	Room 211, under sink	~~5698749~~
M-24 - 1 - A	Room 211, under sink	5698750
M-24 - 1 - B	Room 211, under sink	5698751
M-24 - 1 - C	Room 211, under sink	5698752
M-1 - 1 - A	Room 211, east wall	5698753
M-1 - 1 - B	First floor lounge, north wall	5698754
M-1 - 1 - C	Kitchen, east wall	5698755
M-1 - 1 - D	2nd floor hall, west end outside room ~~20~~ 202	5698756
M-1 - 1 - E	3rd floor lounge, South west corner	5698757
M-1 - 1 - F	3rd floor hall, east end outside room 329	5698758
M-1 - 1 - G	~~2nd floor hall, west end outside room~~ Room 106, south wall	5698759
T-12 - 1 - A	2nd floor Mechanical Room	5698760
T-12 - 1 - B	2nd floor Mechanical Room	5698761
T-12 - 1 - C	3rd floor Mechanical Room	5698762
T-8 - 1 - A	2nd floor Mechanical Room	5698763
T-8 - 1 - B	3rd floor Mechanical Room	5698764
T-8 - 1 - C	3rd Floor Mechanical Room	5698765
T1 - 1 - A	Stairwell - Center - between 1st & 2nd floors	5698766
T1 - 1 - B	Under 1st floor stairs - center stairwell ~~1st flr~~	5698767
T1 - 1 - C	1st Floor, exterior mechanical room	5698768

Terracon PN: M6157011 **Asbestos Sample Location Log**

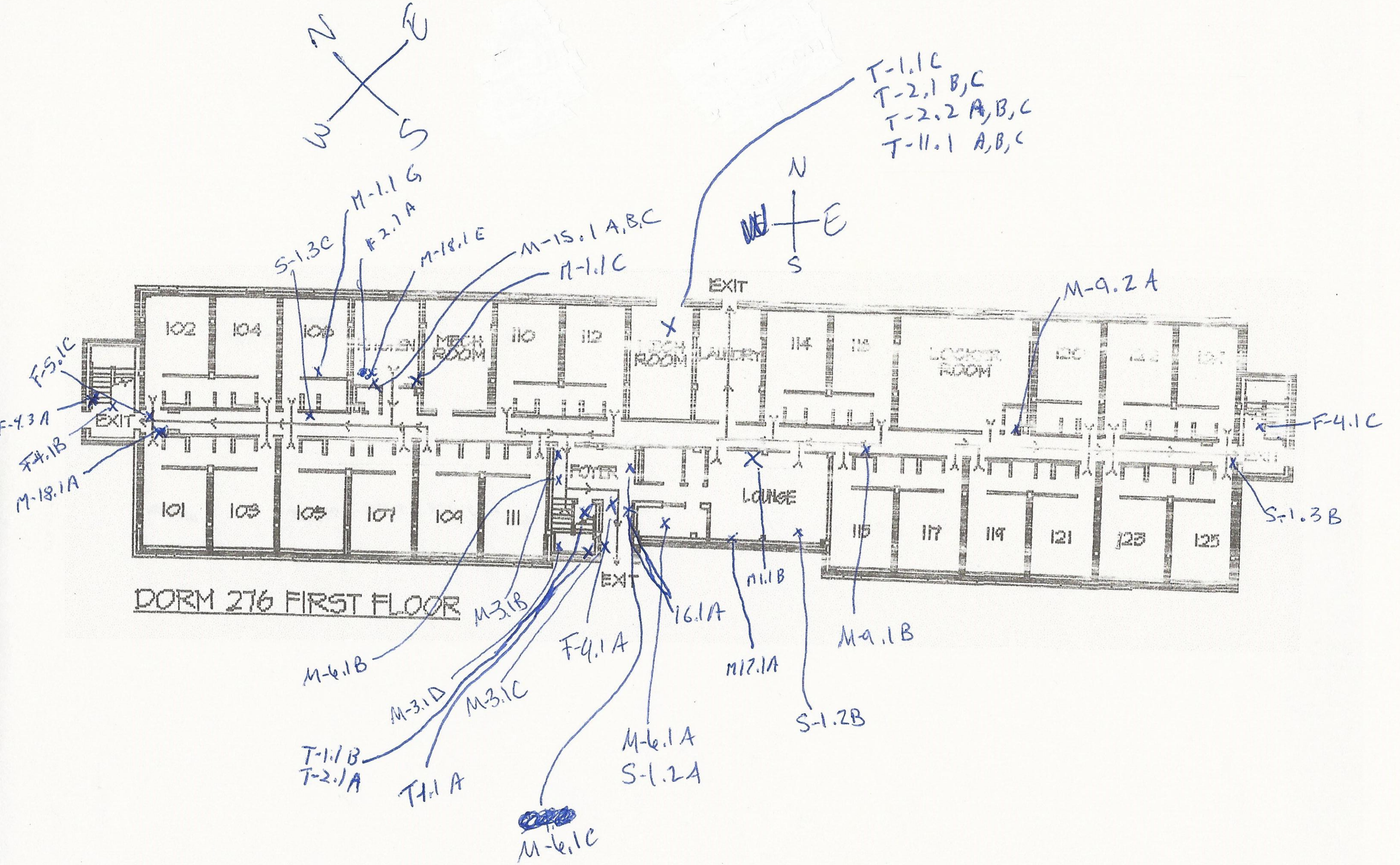
Client Name: Terracon
Building Name: Building 262 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
T-2 - 1 - A	Under 1st floor center stairwell	5698769 7/29/30
T-2 - 1 - B	1st floor exterior mechanical room	5698770
T-2 - 1 - C	1st floor exterior mechanical room	5698771
T-1 - 2 - A	1st floor exterior mechanical room	5698772
T-1 - 2 - B	1st floor exterior mechanical room	5698773
T-1 - 2 - C	1st floor exterior mechanical room	5698774
T-2 - 2 - A	1st floor exterior mechanical room	5698775
T-2 - 2 - B	1st floor exterior mechanical room	5698776
T-2 - 2 - C	1st floor exterior mechanical room	5698777
T-11 - 1 - A	1st floor exterior mechanical room	5698778
T-11 - 1 - B	1st floor exterior mechanical room	5698779
T-11 - 1 - C	1st floor exterior mechanical room	5698780
- -		
Additional Samples Labeled		
M-16 - 1 - A		5698781
- - B		5698782
- - C		5698783
M17 - 1 - A		5698784
- - B		5698785
- - C		5698786
- -		

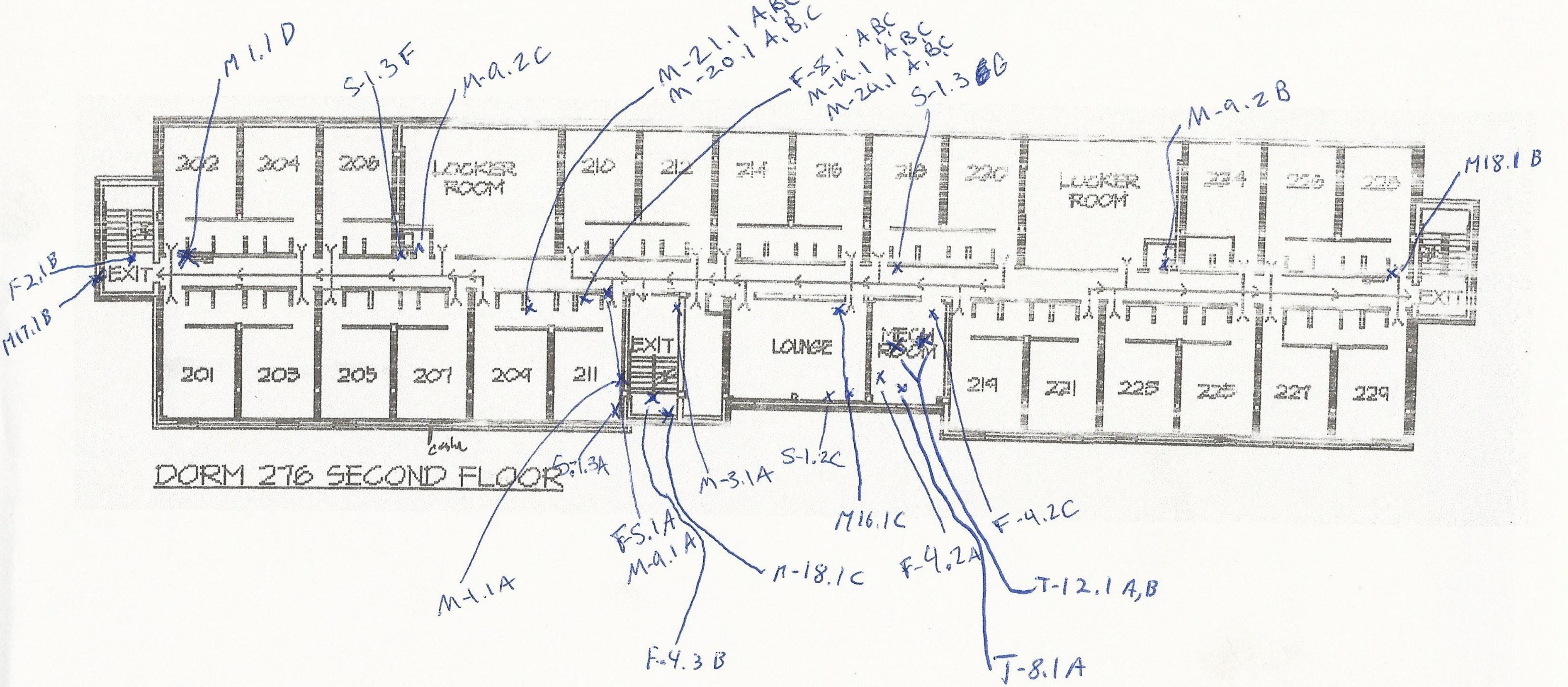
APPENDIX C

ASBESTOS SAMPLE LOCATION EXHIBITS

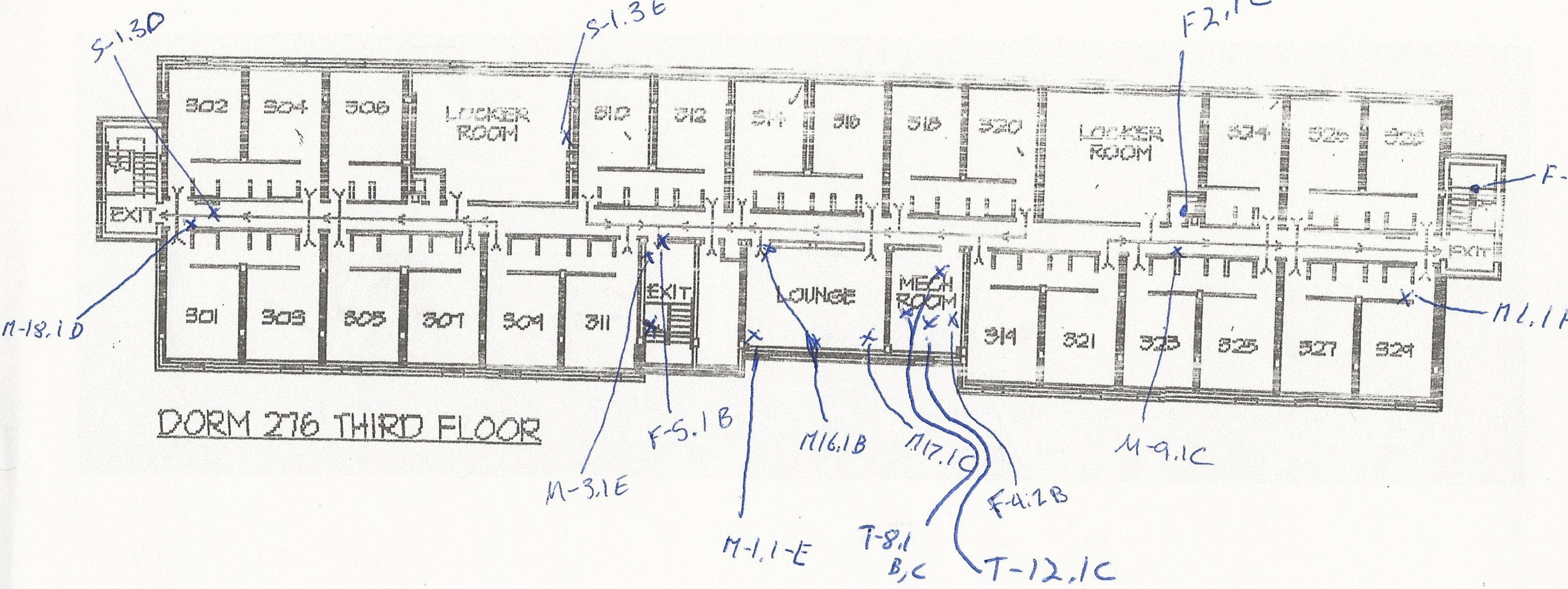
First Floor


N
E
W
S
T-1.1C
T-2.1 B,C
T-2.2 A,B,C
T-11.1 A,B,C
N
E
S
M-1.1 G
F2.1A
S-1.3C
M-18.1 E
M-15.1 A,B,C
M-1.1C
EXIT
M-9.2 A
F-5.1C
F-4.3A
F4.1B
M-18.1A
F-4.1C
S-1.3B
102
104
106
MECH ROOM
110
112
LAUNDRY
114
116
LOCKER ROOM
EXIT
101
103
105
107
109
111
FOYER
LOUNGE
115
117
119
121
123
125
EXIT
DORM 276 FIRST FLOOR
M-3.1B
16.1A
M1.1B
M-9.1B
M-6.1B
F-4.1A
M17.1A
M-3.1D
M-3.1C
S-1.2B
T-1.1B
T-2.1A
T1.1 A
M-6.1A
S-1.2A
M-6.1C

Second Floor



Third Floor



302
304
306
LOCKER ROOM
310
312
314
316
318
320
LOCKER ROOM
324
326
328
EXIT
EXIT
EXIT
301
303
305
307
309
311
LOUNGE
MECH ROOM
314
321
323
325
327
329
DORM 276 THIRD FLOOR
S-1.3D
S-1.3E
F2.1C
F-4.3.1C
M-18.1D
M1.1F
M-3.1E
F-5.1B
M-1.1-E
M16.1B
M17.1C
T-8.1 B,C
T-12.1C
F-4.2B
M-9.1C

APPENDIX D

ASBESTOS LABORATORY ANALYTICAL REPORT

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698685 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-A Entrance Room 211

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698686 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-B 3rd Floor Central Stairwell Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698687 **Description / Location:** Yellow/Tan Mastic
Client No.: F5-1-C West End Of Hall,1st Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698688 **Description / Location:** Off-White Mastic
Client No.: F4-1-A 1st Floor Foyer Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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This report shall not be reproduced except in full, without written approval of the laboratory.

Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello **Approved By:**

Date: 8/6/2015

Frank E. Ehrenfeld, III
Laboratory Director

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698689 **Description / Location:** Off-White Mastic
Client No.: F4-1-B 1st Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698690 **Description / Location:** Off-White Mastic
Client No.: F4-1-C 1st Floor Stairwell,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL International Asbestos Testing Laboratories

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698691 **Description / Location:** Tan Floor Tile
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698691 **Description / Location:** Yellow Mastic **Layer No.: 2**
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698691 **Description / Location:** Grey Leveling Compound **Layer No.: 3**
Client No.: F2-1-A 1st Floor Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

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Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698692 **Description / Location:** Tan Floor Tile
Client No.: F2-1-B 2nd Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698692 **Description / Location:** Yellow/Black Mastic **Layer No.: 2**
Client No.: F2-1-B 2nd Floor Stairwell,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698693 **Description / Location:** Tan Floor Tile
Client No.: F2-1-C 3rd Floor Utility Closet,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698693 **Description / Location:** Yellow/Black Mastic **Layer No.: 2**
Client No.: F2-1-C 3rd Floor Utility Closet,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698694 **Description / Location:** Yellow Mastic
Client No.: M9-1-A Room 211, Near Entrance

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698695 **Description / Location:** Yellow Mastic
Client No.: M9-1-B 1st Floor Hall,Near Room 115

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698696 **Description / Location:** Yellow Mastic
Client No.: M9-1-C 3rd Floor Hall,Near Room 323

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698697 **Description / Location:** White/Black Paint
Client No.: M9-2-A 1st Floor,East Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698698 **Description / Location:** White/Black Paint
Client No.: M9-2-B 2nd Floor,East Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698699 **Description / Location:** White/Black Paint
Client No.: M9-2-C 2nd Floor,West Utility Closet

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698700 **Description / Location:** White Texture
Client No.: S1-3-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698701 **Description / Location:** White Texture
Client No.: S1-3-B 1st Floor South Wall,Near Room 125

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698702 **Description / Location:** White Texture
Client No.: S1-3-C 1st Floor North Wall,Near Room 106

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698703 **Description / Location:** White Texture
Client No.: S1-3-D 3rd Floor,Hall Ceiling,Near Room 302

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698704 **Description / Location:** White Texture
Client No.: S1-3-E 3rd Floor Locker,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698705 **Description / Location:** White Texture
Client No.: S1-3-F 2nd Floor,Hall Ceiling,Near Room 207

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698706 **Description / Location:** White Texture
Client No.: S1-3-G 2nd Floor,North Wall,Near Room 218

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698707 **Description / Location:** White Texture
Client No.: M3-1-A 2nd Floor Stairwell,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698708 **Description / Location:** White Texture
Client No.: M3-1-B 1st Floor Foyer,Near NW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698709 **Description / Location:** White Texture
Client No.: M3-1-C 1st Floor Building Entrace,West Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: L. Solebello

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698710 **Description / Location:** White Texture
Client No.: M3-1-D Land Between 1st&2nd Floors,West Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698711 **Description / Location:** White Texture
Client No.: M3-1-E 3rd Floor Stairwell,Near NW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698712 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-A 1st Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698712 **Description / Location:** Off-White Mastic **Layer No.: 2**
Client No.: M18-1-A 1st Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698713 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-B 2nd Floor Hall,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698713 **Description / Location:** Off-White Mastic **Layer No.:** **2**
Client No.: M18-1-B 2nd Floor Hall,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698713 **Description / Location:** White Joint Compound **Layer No.:** **3**
Client No.: M18-1-B 2nd Floor Hall,East End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698714 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698714 **Description / Location:** Off-White Mastic **Layer No.:** 2
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698714 **Description / Location:** White Joint Compound **Layer No.:** 3
Client No.: M18-1-C Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698715 **Description / Location:** White Vinyl Wall Covering
Client No.: M18-1-D 3rd Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698715 **Description / Location:** Clear Mastic **Layer No.:** 2
Client No.: M18-1-D 3rd Floor Hall,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698716 **Description / Location:** Off - White Vinyl Wall Covering
Client No.: M18-1-E Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698716 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M18-1-E Kitchen

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: L. Solebello

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698717 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-A Room 129

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698718 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-B In Foyer,Near Stair

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698719 **Description / Location:** Silver/Grey Ceiling Tile
Client No.: M6-1-C In Foyer,Near Mail

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	5	Cellulose	35
		60	Mineral Wool	

Lab No.: 5698720 **Description / Location:** Off-White Texture
Client No.: S1-2-A Room 129

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698721 **Description / Location:** Off-White Texture
Client No.: S1-2-B 1st Floor Lounge,Near South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Lab No.: 5698722 **Description / Location:** Off-White Texture
Client No.: S1-2-C 2nd Floor Lounge,Near South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	None Detected

Lab No.: 5698723 **Description / Location:** Tan Ceramic Tile
Client No.: M22-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698723 **Description / Location:** Grey Mortar **Layer No.: 2**
Client No.: M22-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698724 **Description / Location:** Tan Ceramic Tile
Client No.: M22-1-B 2nd Floor Storage Locker,West Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698725 **Description / Location:** Grey Grout
Client No.: M22-1-C 3rd Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698726 **Description / Location:** Tan Ceramic Tile
Client No.: M23-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698726 **Description / Location:** Grey Grout **Layer No.: 2**
Client No.: M23-1-A 1st Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698727 **Description / Location:** Grey Grout
Client No.: M23-1-B 2nd Floor Storage Locker,West Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698728 **Description / Location:** Tan Ceramic Tile
Client No.: M23-1-C 3rd Floor Storage Locker,East Side

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698729 **Description / Location:** Off-White/Grey Mastic/Leveling Comp
Client No.: F4-3-A 1st Floor Stair,West End

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698730 **Description / Location:** Off-White Mastic
Client No.: F4-3-B 2nd Floor Stairs,Center

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698730 **Description / Location:** Brown Mastic **Layer No.: 2**
Client No.: F4-3-B 2nd Floor Stairs,Center

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698731 **Description / Location:** Off-White Mastic
Client No.: F4-3-C 3rd Floor Stairs,East

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698732 **Description / Location:** Black Mastic
Client No.: F4-2-A 2nd Floor Mech. Room,SW Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: V. Smith

Date: 8/6/2015

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698733 **Description / Location:** Black Mastic
Client No.: F4-2-B 3rd Floor Mech. Room,SE Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698734 **Description / Location:** Black Mastic
Client No.: F4-2-C 2nd Floor Mech. Room,NE Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698735 **Description / Location:** Black Insulation
Client No.: M15-1-A Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	1	Cellulose	99

Lab No.: 5698736 **Description / Location:** Black Insulation
Client No.: M15-1-B Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	2	Cellulose	98

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: V. Smith

Date: 8/6/2015

IATL International Asbestos Testing Laboratories

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698737 **Description / Location:** Black Insulation
Client No.: M15-1-C Kitchen Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	2	Cellulose	98

Lab No.: 5698738 **Description / Location:** White Grout
Client No.: M21-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698739 **Description / Location:** White Grout
Client No.: M21-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698740 **Description / Location:** White Grout
Client No.: M21-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698741 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698741 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M20-1-A Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698742 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698742 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M20-1-B Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698743 **Description / Location:** Tan Ceramic Tile
Client No.: M20-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698743 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M20-1-C Room 211,West Shower Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698744 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698745 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698746 **Description / Location:** Beige Ceramic Tile
Client No.: F8-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698747 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698747 **Description / Location:** Tan Mastic **Layer No.: 2**
Client No.: M19-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698748 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698748 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M19-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698749 **Description / Location:** Tan/White Ceramic Tile
Client No.: M19-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698749 **Description / Location:** Tan Mastic **Layer No.:** 2
Client No.: M19-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698750 **Description / Location:** Tan Mastic
Client No.: M24-1-A Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698751 **Description / Location:** Tan Mastic
Client No.: M24-1-B Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698752 **Description / Location:** Tan Mastic
Client No.: M24-1-C Room 211,Under Sink

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698753 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698753 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-A Room 211,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698754 **Description / Location:** Grey/Tan Sheetrock
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	40	Cellulose	60

Lab No.: 5698754 **Description / Location:** White/Tan Sheetrock **Layer No.: 2**
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75
		Trace	Fibrous Glass	

Lab No.: 5698754 **Description / Location:** White Joint Compound **Layer No.: 3**
Client No.: M1-1-B 1st Floor Lounge,North Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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CERTIFICATE OF ANALYSIS

Client: Terracon Consultants, Inc.
6701 4th Street SW
Minot ND 58701

Report Date: 8/6/2015
Report No.: 370048
Project: Minot AFB Dorm Survey
Project No.: M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698755 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-C Kitchen,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698755 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M1-1-C Kitchen,East Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698756 **Description / Location:** White/Tan Sheetrock
Client No.: M1-1-D 2nd Floor Hall,West End Outside Rm 202

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75

Lab No.: 5698756 **Description / Location:** White Joint Compound **Layer No.:** 2
Client No.: M1-1-D 2nd Floor Hall,West End Outside Rm 202

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698757 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-E 3rd Floor Lounge,South West Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698757 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-E 3rd Floor Lounge,South West Corner

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698758 **Description / Location:** White/Tan Sheetrock
Client No.: M1-1-F 3rd Floor Hall,Est End Outside Rm 329

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	20	Cellulose	80
		Trace	Fibrous Glass	

Lab No.: 5698758 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-F 3rd Floor Hall,Est End Outside Rm 329

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698759 **Description / Location:** Off-White/Tan Sheetrock
Client No.: M1-1-G Room 106,South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	25	Cellulose	75
		Trace	Fibrous Glass	

Lab No.: 5698759 **Description / Location:** White Joint Compound **Layer No.: 2**
Client No.: M1-1-G Room 106,South Wall

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698760 **Description / Location:** Black/White Fibrous Material
Client No.: T12-1-A 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	50	Fibrous Glass	50

Lab No.: 5698761 **Description / Location:** Black/White Fibrous Material
Client No.: T12-1-B 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	60	Fibrous Glass	40

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analytical Method: US EPA 600/R-93/116 by Polarized Light Microscopy, (ELAP 198.1 where applicable)

Comments: Quantification at <0.25% by volume is possible with this method. (PC) Indicates Stratified Point Count Method performed. (PC-Trace) means that asbestos was detected but is not quantifiable under the Point Counting regimen. Analysis includes all distinct separable layers in accordance with EPA 600 Method. If not reported or otherwise noted, layer is either not present or the client has specifically requested that it not be analyzed (ex. analyze until positive instructions). Small asbestos fibers may be missed by PLM due to resolution limitations of the optical microscope. Therefore, PLM is not consistently reliable in detecting asbestos in non-friable organically bound (NOB) materials. Quantitative transmission electron microscopy (TEM) is currently the only method that can pronounce materials as non-asbestos containing.

Analysis Performed By: B. Hargrove

Date: 8/6/2015

IATL **International Asbestos Testing Laboratories**

9000 Commerce Parkway Suite B Mt. Laurel, NJ 08054
Telephone: 856-231-9449 Fax: 856-231-9818

CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698762
Client No.: T12-1-C
Description / Location: Black/White Fibrous Material, 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	60	Fibrous Glass	40

Lab No.: 5698763
Client No.: T8-1-A
Description / Location: Yellow Insulation, 2nd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698764
Client No.: T8-1-B
Description / Location: Yellow Insulation, 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698764
Client No.: T8-1-B
Description / Location: White/Silver Wrap, 3rd Floor Mechanical Room
Layer No.: 2

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
PC 3.3	Chrysotile	40	Cellulose	PC 51.7
		5	Fibrous Glass	

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Analysis Performed By: B. Hargrove

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698765 **Description / Location:** Yellow Insulation
Client No.: T8-1-C 3rd Floor Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698766 **Description / Location:** Yellow Insulation
Client No.: T1-1-A Stairwell Center Between 1st & 2nd Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698766 **Description / Location:** White/Silver Wrap **Layer No.: 2**
Client No.: T1-1-A Stairwell Center Between 1st & 2nd Floor

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	50	Cellulose	45
		5	Fibrous Glass	

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698767 **Description / Location:** Tan Insulation
Client No.: T1-1-B Under 1st Floor Stairs,Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698767 **Description / Location:** Tan/Off-White Wrap **Layer No.: 2**
Client No.: T1-1-B Under 1st Floor Stairs,Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	80	Cellulose	20

Lab No.: 5698768 **Description / Location:** Tan Insulation
Client No.: T1-1-C 1st Floor,Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698768 **Description / Location:** Tan/Off-White Wrap **Layer No.: 2**
Client No.: T1-1-C 1st Floor,Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	75	Cellulose	25

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698769
Client No.: T2-1-A
Description / Location: Off-White Insulation
Under 1st Floor Center Stairwell

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
PC 4.2	Amosite	35	Fibrous Glass	PC 54.3
PC 1.5	Chrysotile	5	Cellulose	

Lab No.: 5698770
Client No.: T2-1-B
Description / Location: Sample Not Analzyed

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
	Sample Not Analyzed		Sample Not Analyzed	

Lab No.: 5698771
Client No.: T2-1-C
Description / Location: Sample Not Analzyed

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
	Sample Not Analyzed		Sample Not Analyzed	

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698772 **Description / Location:** Tan Insulation
Client No.: T1-2-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698772 **Description / Location:** Grey/Silver Wrap **Layer No.: 2**
Client No.: T1-2-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	45	Cellulose	45
		10	Fibrous Glass	

Lab No.: 5698773 **Description / Location:** Tan Insulation
Client No.: T1-2-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	98	Fibrous Glass	2

Lab No.: 5698773 **Description / Location:** Grey/Tan Wrap **Layer No.: 2**
Client No.: T1-2-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	75	Cellulose	25

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client: Terracon Consultants, Inc.
6701 4th Street SW
Minot ND 58701

Report Date: 8/6/2015
Report No.: 370048
Project: Minot AFB Dorm Survey
Project No.: M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698774 **Description / Location:** Tan Insulation
Client No.: T1-2-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	95	Fibrous Glass	5

Lab No.: 5698774 **Description / Location:** Off-White/Grey Wrap **Layer No.: 2**
Client No.: T1-2-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	85	Cellulose	15

Lab No.: 5698775 **Description / Location:** White/Grey Wrap
Client No.: T2-2A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698776 **Description / Location:** White/Brown Wrap
Client No.: T2-2B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

Client:	Terracon Consultants, Inc.	**Report Date:**	8/6/2015
	6701 4th Street SW	**Report No.:**	370048
	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698777 **Description / Location:** Off-White Wrap
Client No.: T2-2C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698778 **Description / Location:** Red Caulk
Client No.: T11-1-A 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	10	Synthetic	90

Lab No.: 5698779 **Description / Location:** Red Caulk
Client No.: T11-1-B 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	10	Synthetic	90

Lab No.: 5698780 **Description / Location:** Red Caulk
Client No.: T11-1-C 1st Floor Exterior Mechanical Room

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698781 **Description / Location:** White Caulk
Client No.: M16-1-A

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698782 **Description / Location:** White Caulk
Client No.: M16-1-B

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698783 **Description / Location:** Off-White Caulk
Client No.: M16-1-C

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698784 **Description / Location:** Off-White Caulk
Client No.: M17-1-A

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Date: 8/6/2015

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CERTIFICATE OF ANALYSIS

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	Minot ND 58701	**Project:**	Minot AFB Dorm Survey
		Project No.:	M6157011

BULK SAMPLE ANALYSIS SUMMARY

Lab No.: 5698785 **Description / Location:** Off-White Caulk
Client No.: M17-1-B

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Lab No.: 5698786 **Description / Location:** Off-White Caulk
Client No.: M17-1-C

% Asbestos	Type	% Non-Asbestos Fibrous Material	Type	% Non-Fibrous Material
None Detected	None Detected	None Detected	None Detected	100

Accreditations: **NIST-NVLAP No. 101165-0** **NY-DOH No. 11021** **AIHA-LAP, LLC No. 100188**

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Analysis Performed By: B. Hargrove

Date: 8/6/2015

iATL INTERNATIONAL
Asbestos Testing Laboratories

9000 Commerce Parkway, Suite B • Mount Laurel, NJ 08054
Phone: 877-428-4285/856-231-9449 • Fax: 856-231-9818

Chain of Custody

–Bulk Asbestos –

Contact Information

Client Company:	Terracon Consultants, Inc	**Project Number:**	M6157011
Office Address:	6701 4th Street SW	**Project Name:**	Minot AFB Dorm Survey
City, State, Zip:	Minot, ND 58701	**Primary Contact:**	Steve Maliszeski
Fax Number:	701-772-2633	**Office Phone:**	701-792-2615
Email Address:	steve.maliszeski@terracon.com	**Cell Phone:**	440-665-4840

PLM Instructions:

- [x] PLM: Bulk Asbestos Building Materials EPA 600 R-93/116, 1993
- [ ] PLM: Bulk Asbestos Building Materials EPA 600 M-4/82-020, 1982
- [ ] PLM: Bulk Asbestos Building Materials NIOSH 9002, 1985
- [ ] PLM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.1, 2002
- [ ] PLM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.6, 2010
- [ ] TEM: Bulk Asbestos Building Materials NYSDOH-ELAP 198.4, 2009

E-MAILED
Prelim 8/6/15 NS

- [x] PLM: Point Counting
  - [ ] PC: via ELAP 198.1
  - [ ] PC: 400 Points
  - [ ] PC: 800 Points *
  - [ ] PC: 1600 Points *
- [x] PLM: Instructions for Multi-Layered Samples
  - [x] Analyze and Report All Separable Layers per EPA 600
  - [x] Report Composite for Drywall Systems per NESHAP
  - [ ] Report All Layers and Composite Where Applicable
  - [ ] Only Analyze and Report Specifically Noted Layer

- [x] PLM: Analyze Until Positive (Positive Stop)
  - [x] AUP: by Homogenous Area as Noted
  - [ ] AUP: by Material Type as Noted
- [ ] PLM: NOB via 198.6
  - [ ] PLM: Friable via EPA 600 2.3
  - [ ] If <1% by PLM, to TEM via 198.4 *
  - [ ] If <1% by PLM, Hold for Instructions
- [ ] PLM: Non-Building Material** (Dust, Wipe, Tape)
  - [ ] Soil or Vermiculite Analysis*
  - [ ] CARB 435

E-MAILED
8-7-15 DL

Special Instructions: Analyze per Terracon standard, please submit with .pdf and database file for use with Terracon ARMS system. Please call with questions. Point count <10% per Terracon standard.

** Additional charge and turnaround may be required* *** Alternative Method (ex: EPA 600/R-04/004) may be recommended by Laboratory*

Turnaround Time

Preliminary Results Requested Date: ______ (Specific date / time) [ ] Verbal [x] Email [ ] Fax

96

[ ] 10 Day [ ] 5 Day [x] 3 Day [ ] 2 Day [ ] 1 Day* [ ] 12 Hour** [ ] 6 Hour** [ ] RUSH**

* End of next business day unless otherwise specified. ** Matrix Dependent. *****Please notify the lab before shipping*****

Chain of Custody

Relinquished (Name/Organization):	Steve Maliszeski/Terracon	Date: 7/30/15	Time: 1700
Received (Name / iATL):		Date:	Time:
Sample Login (Name / iATL):		Date: 8/3/15	Time:
Analysis(Name(s) / iATL):	BM	Date: 8-6-15	Time:
QA/QC Review (Name / iATL):	PBC 8/7/15	Date:	Time:
Archived / Released: ______ QA/QC InterLAB Use: ______		Date:	Time:

RECEIVED
AUG - 3 2015
iATL - By

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
F-5 - 1 - A	Entrance Room 211	5698685 7/29/30
F-5 - 1 - B	3rd Floor central stairwell entrance	5698686
F-5 - 1 - C	West end of hall, 1st floor	5698687
F-4 - 1 - A	1st floor foyer entrance	5698688
F-4 - 1 - B	1st floor Stairwell, west end	5698689
F-4 - 1 - C	1st floor stairwell, east end	5698690
F-2 - 1 - A	1st floor kitchen	5698691
F-2 - 1 - B	2nd floor stairwell - West end	5698692
F-2 - 1 - C	3rd floor utility closet - East end	5698693
M-9 - 1 - A	Room 211, near entrance	5698694
M-9 - 1 - B	1st floor hall, near Room 115	5698695
M-9 - 1 - C	3rd floor hall, near Room 323	5698696
M-9 - 2 - A	1st floor, east utility closet	5698697
M-9 - 2 - B	2nd floor, east utility closet	5698698
M-9 - 2 - C	2nd floor, west utility closet	5698699
S-1 - 3 - A	Room 211, east wall	5698700
S-1 - 3 - B	1st floor south wall, near Room 125	5698701
S-1 - 3 - C	1st floor north wall, near Room 106	5698702
S-1 - 3 - D	3rd floor, hall ceiling, near Room 302	5698703
S-1 - 3 - E	3rd floor locker, east wall	5698704
S-1 - 3 - F	2nd floor, hall ceiling, near Room 207	5698705

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
S-1 - 3 - G	2nd floor, north wall, near Room 218	5698706 7/29/30
M-3 - 1 - A	2nd floor stairwell, east wall	5698707
M-3 - 1 - B	1st floor foyer, near NW corner	5698708
M-3 - 1 - C	1st floor ~~fo~~ building entrance, west wall	5698709
M-3 - 1 - D	land between 1st + 2nd floors, west wall	5698710
M-3 - 1 - E	3rd floor stairwell, near NW corner	5698711
M-18 - 1 - A	1st floor hall, west end	5698712
M-18 - 1 - B	2nd floor hall, east end	5698713
M-18 - 1 - C	Center stairwell	5698714
M-18 - 1 - D	3rd floor hall, west end	5698715
M-18 - 1 - E	Kitchen	5698716
M-6 - 1 - A	Room 129	5698717
M-6 - 1 - B	In Foyer, near stair	5698718
M-6 - 1 - C	In Foyer, near mail	5698719
S-1 - 2 - A	Room 129	5698720
S-1 - 2 - B	1st floor lounge, near south wall	5698721
S-1 - 2 - C	2nd floor lounge, near south wall	5698722
M22 - 1 - A	1st floor storage locker - East side	5698723
M22 - 1 - B	2nd floor Storage locker - West side	5698724
M22 - 1 - C	3rd floor Storage locker - East side	5698725
M23 - 1 - A	1st floor storage locker - East Side	5698726

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
M23 - 1 - B	2nd floor storage locker - West side	5698727 7/29/30
M23 - 1 - C	3rd Floor Storage locker - East side	5698728
F-4 - 3 - A	1st Floor Stair - West end	5698729
F-4 - 3 - B	2nd Floor Stairs - Center	5698730
F-4 - 3 - C	3rd floor Stairs - East	5698731
F-4 - 2 - A	2nd floor mech room, SW corner	5698732
F-4 - 2 - B	3rd floor mech room, SE corner	5698733
F-4 - 2 - C	2nd floor mech room, NE corner	5698734
M-15 - 1 - A	kitchen sink	5698735
M-15 - 1 - B	kitchen sink	5698736
M-15 - 1 - C	kitchen sink	5698737
M-21 - 1 - A	Room 211, west shower wall	5698738
M-21 - 1 - B	Room 211, west shower wall	5698739
M-21 - 1 - C	Room 211, west shower wall	5698740
M-20 - 1 - A	Room 211, west shower wall	5698741
M-20 - 1 - B	Room 211, west shower wall	5698742
M-20 - 1 - C	Room 211, west shower wall	5698743
F-8 - 1 - A	Room 211, under sink	5698744
F-8 - 1 - B	Room 211, under sink	5698745
F-8 - 1 - C	Room 211, under sink	5698746
start M-19 - 1 - A	Room 211, under sink	5698747

Terracon PN: M6157011 **Asbestos Sample Location Log**

Client Name: Terracon
Building Name: ~~[illegible]~~ Building 267 Minot AFB
Inspector: STM/TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date:
M-19 - 1 - B	Room 211, under sink	~~5698748~~ 7/29/30
M-19 - 1 - C	Room 211, under sink	~~5698749~~
M-24 - 1 - A	Room 211, under sink	5698750
M-24 - 1 - B	Room 211, under sink	5698751
M-24 - 1 - C	Room 211, under sink	5698752
M-1 - 1 - A	Room 211, east wall	5698753
M-1 - 1 - B	First floor lounge, north wall	5698754
M-1 - 1 - C	Kitchen, east wall	5698755
M-1 - 1 - D	2nd floor hall, west end outside room ~~[illegible]~~ 202	5698756
M-1 - 1 - E	3rd floor lounge, Southwest corner	5698757
M-1 - 1 - F	3rd floor hall, east end outside room 329	5698758
M-1 - 1 - G	~~2nd floor hall, west end outside room~~ Room 106, south wall	5698759
T-12 - 1 - A	2nd floor Mechanical Room	5698760
T-12 - 1 - B	2nd floor Mechanical Room	5698761
T-12 - 1 - C	3rd floor Mechanical Room	5698762
T-8 - 1 - A	2nd floor Mechanical Room	5698763
T-8 - 1 - B	3rd floor Mechanical Room	5698764
T-8 - 1 - C	3rd floor Mechanical Room	5698765
T1 - 1 - A	Stairwell - Center - between 1st & 2nd floors	5698766
T1 - 1 - B	Under 1st floor stairs - center stairwell ~~1st flr~~	5698767
T1 - 1 - C	1st Floor, exterior mechanical room	5698768

Terracon PN: M6157011 **Asbestos Sample Location Log** Page 5 of 5

Client Name: Terracon
Building Name: Building 262 Minot AFB
Inspector: STM / TLF

Sample No: (HA, BS Code, Sample No.)	Written location where bulk sample is collected.	Collection Date
T-2 - 1 - A	Under 1st floor center stairwell	5698769 7/29/20
T-2 - 1 - B	1st floor exterior mechanical room	5698770
T-2 - 1 - C	1st floor exterior mechanical room	5698771
T-1 - 2 - A	1st floor exterior mechanical room	5698772
T-1 - 2 - B	1st floor exterior mechanical room	5698773
T-1 - 2 - C	1st floor exterior mechanical room	5698774
T-2 - 2 - A	1st floor exterior mechanical room	5698775
T-2 - 2 - B	1st floor exterior mechanical room	5698776
T-2 - 2 - C	1st floor exterior mechanical room	5698777
T-11 - 1 - A	1st floor exterior mechanical room	5698778
T-11 - 1 - B	1st floor exterior mechanical room	5698779
T-11 - 1 - C	1st floor exterior mechanical room	5698780
- -		
Additional Samples Labeled		
M-16 - 1 - A		5698781
- - B		5698782
- - C		5698783
M17 - 1 - A		5698784
- - B		5698785
- - C		5698786
- -		

APPENDIX E

MOLD SURVEY SAMPLE LOCATION EXHIBITS

~~Note~~ Notes

- * No observable mold
- No obvious signs of water intrusion
- Peeling paint observed in several utility closets & lockers
- No observable odor, except for exterior mech room
- DID NOT CHECK EVERY DORM ROOM, as some were occupied.

Note: All thermo switches in dorm rooms contain mercury.

Dorm 276 1st Floor

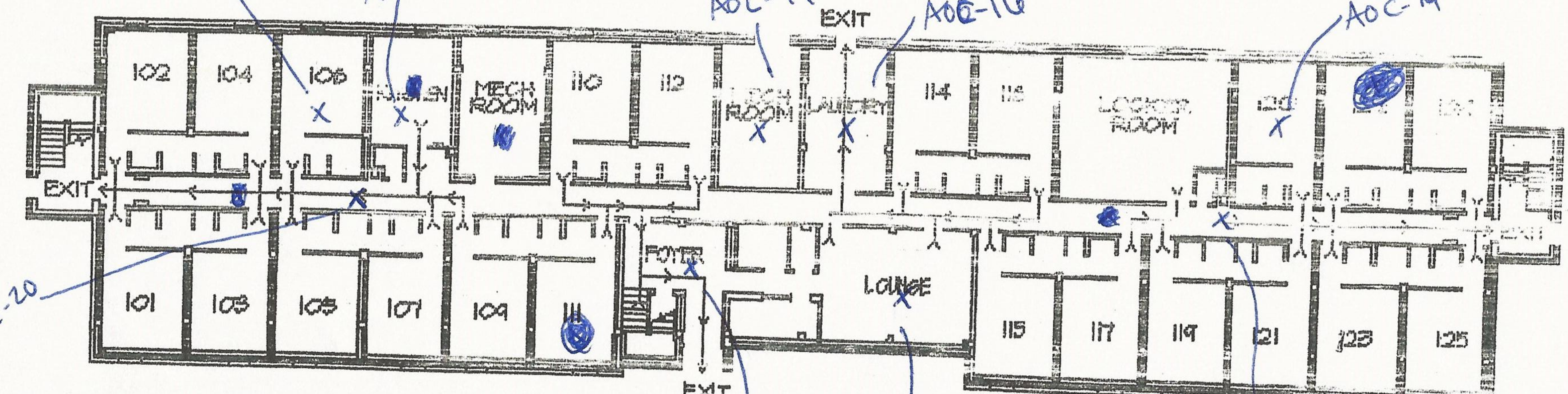
Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.
2. If there is a fire in your room and you cannot safely extinguish it:
   - Evacuate the area, close all doors as you leave, and take your [illegible]
   - Activate the fire alarm in the corridor.
3. If there is a fire outside your room:
   - Feel the door.
   - If it's hot, do not open it.
   - Seal the bottom of the door with wet towels to keep the smoke out. [illegible]
   - If the door is not hot, and no danger appears through the peep hole, open cautiously, [illegible] behind the door.
   - Be prepared to close your door fast, if necessary.
4. If you are able to exit your room safely, walk to the nearest stairwell [illegible]. If smoke is present in the hallway.

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 FIRST FLOOR

AOC-22 (outdoor sample)

~~* one unoccupied room from each wing~~

S
E W
N

Dorm 276 2nd Floor

Outdoor sample

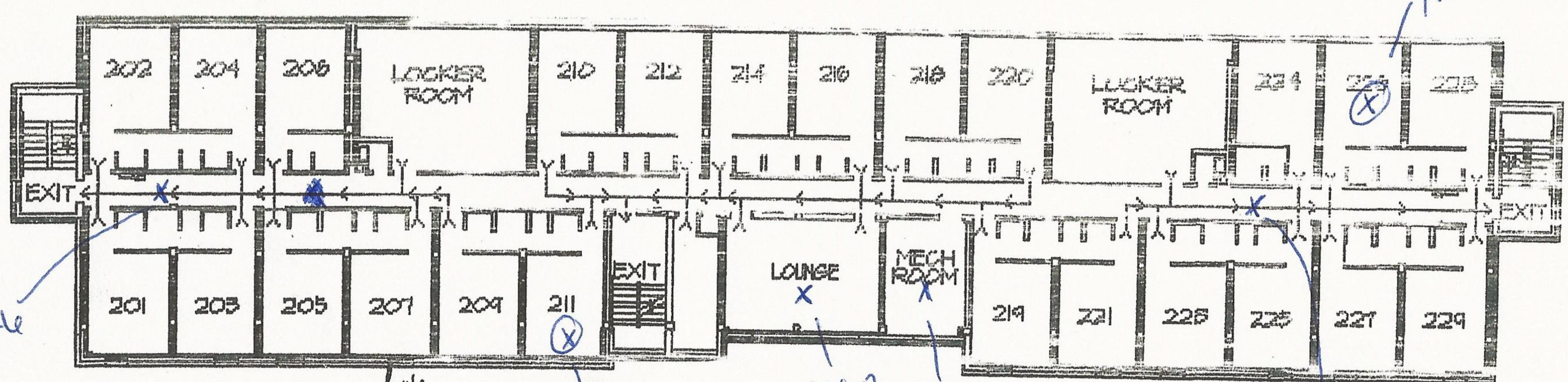
Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.
2. If there is a fire in your room and you cannot safely extinguish it:
   -Evacuate the area, close all doors as you leave, and follow your [illegible]
   -Activate the fire alarm in the corridor.
3. If there is a fire outside your room:
   -Feel the door.
   -If it is hot, do not open it.
   -Seal the bottom of the door with wet towels to keep the smoke out. [illegible] for further assistance.
   -If the door is not hot, and no danger appears through the peep hole, open cautiously standing behind the door.
   -Be prepared to close your door fast, if necessary.
4. If you are able to exit your room safely, walk to the nearest stairwell [illegible] if smoke is present in the hallway.

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 SECOND FLOOR

~~one unoccupied room from each wing~~

Dorm 276 3rd Floor

Welcome to Dorm # 276, Minot AFB,

EMERGENCY EXIT PLAN

IN CASE OF FIRE/ FIRE ALARM ACTIVATION:

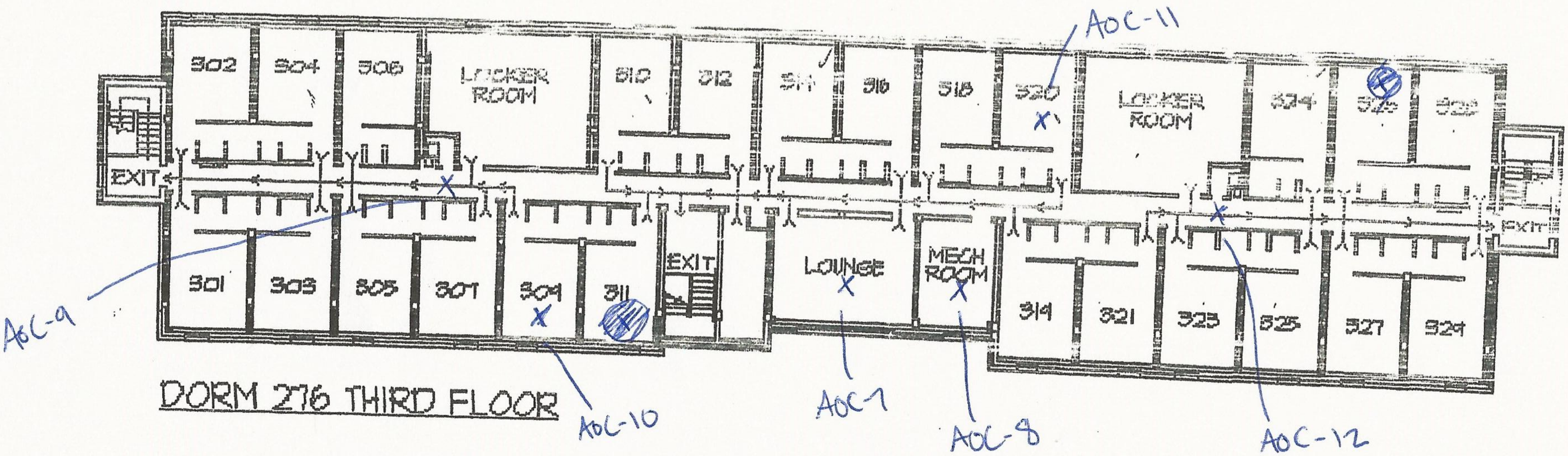
1. If you detect smoke or fire, immediately call 911. Give the exact location and what is burning.

2. If there is a fire in your room and you cannot safely extinguish it:
   -Evacuate the area, close all doors as you exit, [illegible] your room key.
   -Activate the fire alarm in the corridor.

3. If there is a fire outside your room:
   -Feel the door.
   -If it is hot, do not open it.
   -Seal the bottom of the door with wet towels to keep the smoke out. Wait for further assistance.
   -If the door is not hot, and no danger appears through the peep hole, open cautiously standing behind the door.
   -Be prepared to close your door fast, if necessary.

4. If you are able to exit your room safely walk to the nearest stairwell (crawl, if smoke is present in the hallway).

ABOVE ALL, DO NOT PANIC. WALK DOWN THE STAIRWELL.



DORM 276 THIRD FLOOR

~~one unoccupied room from each wing~~

APPENDIX F

MOLD LABORATORY ANALYTICAL REPORT

OrderID: 351505112

EMSL ANALYTICAL, INC.
LABORATORY•PRODUCTS•TRAINING

Microbiology Chain of Custody

EMSL Order Number *(Lab Use Only)*:

5112

EMSL ANALYTICAL INC.
14375 23RD AVE NORTH
MINNEAPOLIS, MN 55447
763-449-4922

Company : Terracon	**EMSL-Bill to:** ☐ Same ☒ Different **If Bill to is Different please note in Comments**** *Third Party Billing requires written authorization from third party*
Street: 6701 4th Street SW	
City: Minot / **State/Province: ND**	**Zip/Postal Code: 58701** / **Country: USA**
Report To (Name): Steve Maliszeski	**Fax #: 701-772-2633**
Telephone #: 701-792-2615	**E-mail Address: steve.maliszeski@terracon.com**
Project Name/ Number: Minot AFB Dorm Renovation	
Please Provide Results: ☐ Fax ☒ E-mail / **PO# M6157011**	**State Samples Taken: ND**

Turnaround Time (TAT) Options* - Please Check

☐ 3 Hours | ☐ 6 Hours | ☐ 24 Hours | ☐ 48 Hours | ☒ 3 Days | ☐ 4 Days | ☐ 5 Days | ☐ 10 Days | ☐ 2 Weeks

**Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide. TATs are subject to methodology requirements*

Non Culturable Air Samples (Spore Traps)

• **M001** Air-O-Cell	• **M173** Allegro M2	• **M004** Allergenco	• **M032** Allergenco-D	• **M172** Versa Trap
• **M049** BioSIS	• **M003** Burkard	• **M043** Cyclex	• **M002** Cyclex-d	
• **M030** Micro 5	• **M174** MoldSnap	• **M176** Relle Smart	• **M130** Via-Cell	

Other Microbiology Test Codes

• **M041** Fungal Direct Examination	• **M014** Endotoxin Analysis	• **M029** *Enterococci*
• **M005** Viable Fungi ID and Count	• **M015** Heterotrophic Plate Count	• **M019** Fecal Coliform
• **M006** Viable Fungi ID and Count (Speciation)	• **M180** Real Time Q-PCR-ERMI 36 Panel	• **M133** MRSA Analysis
• **M007** Culturable Fungi	• **M018** Total Coliform (Membrane Filtration)	• **M028** *Cryptococcus neoformans* Detection
• **M008** Culturable Fungi (Speciation)	• **M020** Fecal *Streptococcus* (Membrane Filtration)	• **M120** *Histoplasma capsulatum* Detection
• **M009** Gram Stain Culturable Bacteria	• **M210-215** *Legionella* Detection	• **M033-39** Allergen Testing
• **M010** Bacterial Count and ID – 3 Most Prominent	• **M026** Recreational Water Screen	• **M044** Group Allergen (Cat, Dog, Cockroach, Dustmites)
• **M011** Bacterial Count and ID – 5 Most Prominent	• **M027** Mycotoxin Analysis	• **Other** See Analytical Price Guide
• **M013** Sewage Contamination in Buildings		

Preservation Method (Water):

Name of Sampler: Steve Maliszeski **Signature of Sampler:** [signature]

Sample #	Sample Location	Sample Type	Test Code	Volume/Area	Date/Time Collected
	See Attached Forms				

Client Sample # (s):	-	**Total # of Samples:**	22
Relinquished (Client): Steve Maliszeski [signature]	**Date: 7/30/15**	**Time: 1700**	
Received (Client): Mclaypool FE	**Date:** 8/3/15	**Time:** 9:05	

Comments: Invoice: A.P., 1555 N. 42nd Street Unit B, Grand Forks, ND 58203 7810 7/66 3853

5112

CHAIN OF CUSTODY
IAQ SAMPLES

5

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-1	Room 211	Air M001 150 L	4:15 pm	79.5° / 38.6%	July 29 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-2	2nd Floor Lounge		4:27 pm	77.7° / 39.1%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-3	2nd Floor mech. room		4:39 pm	77.9° / 38.5%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-4	Room 226		4:52 pm	78.4° / 41.5%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-5	2nd Floor, west hall, near room 223		5:03 pm	77.9° / 38.6%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Page 2 of 6

OrderID: 351505112

Sheet 1 of 5

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND. 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-6	2nd Floor, east hall near Room 204	Air, M001, 150 L	5:15 pm	78° / 40.2%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-7	3rd Floor Lounge		5:28 p.m.	71.2° / 48%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-8	3rd Floor Mech Rm		5:41 p.m.	74.6° / 43.2%	July 29, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-9	3rd Floor, east hall near room 306		8:36 a.m.	75.5° / 45.7%	July 30, 2015	150	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-10	Room 309		8:49 a.m.	78.6° / 41.2%	July 30, 2015	150	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 2 of 5

Page 3 Of 6

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220

FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-11	Room 320	Air, M001, 150 L	9:03 a.m.	76.6° / 43.4%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-12	3rd Floor, west hall, near room 323		9:15 a.m.	77.0° / 41.1%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-13	1st Floor, west hall, near room 119		9:30 a.m.	76.4° / 46.5%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-14	Room 120		9:42 a.m.	76.6° / 46.9%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-15	1st Floor Lounge		9:54 a.m.	78.2° / 44.8%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by:
		Steve Maliszeski	5 of 22 total	Total samples
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 3 of 5

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

PHONE: (701) 852-5220

FAX: (701) 772-2633

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-16	1st Floor Laundry	Air, M001, 150 L	10:06 a.m.	77.1° / 47.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-17	1st Floor, Exterior Mech Room		10:18 a.m.	81.5° / 42.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-18	Foyer		10:30 a.m.	75.9° / 50%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-19	Kitchen		10:42 a.m.	74.3° / 49.7%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-20	First Floor, East hall, near room 106		10:54 a.m.	75.9° / 49.2%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	5 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Page 5 Of 6

OrderID: 351505112

5112

CHAIN OF CUSTODY
IAQ SAMPLES

Client Name: Terracon

Project Address: Building 267

City, State, Zip: Minot AFB, ND 58705

Project Name: MAFB Dorm Renovation

TERRACON
6701 4th Street SW
Minot, ND 58701

Project No. M6157011

Date Collected: 7/30/15

Turn Around Time: Normal (5 days)

Collected By: STM / TLF

PHONE: (701) 852-5220 FAX: (701) 772-2633

Sample Identification	Sample Description and Location	Remarks	Time	Temp /RH	Date Collected	Sample Volume	Analysis Required
AOC-21	Room 106	Air, MOD1, 150 L	11:06 a.m.	76.2° / 47.8%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
AOC-22	Outdoor Sample	⊥	11:18 a.m.	76.1° / 45.5%	July 30, 2015	150 L	AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**
							AIR SAMPLES **Air-O-Cell Cassette only**

Date	Time	Relinquished by:	Total samples	Received by: Total samples
7/30/15	1700	Steve Maliszeski [signature]	2 of 22 total	
Date	Time	Relinquished by:	Total samples	Received by: Total samples

Sheet 5 of 5

EMSL Analytical, Inc.
14375 23rd Avenue North Minneapolis, Mn 55447
Phone/Fax: (763) 449-4922 / (763) 449-4924
http://www.EMSL.com / minneapolislab@emsl.com

Order ID: 351505112
Customer ID: TCND42
Customer PO:
Project ID:

Attn: Steve Maliszeski
Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone: (701) 792-2615
Fax:
Collected: 07/29/2015
Received: 08/03/2015
Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0001			351505112-0002			351505112-0003		
Client Sample ID:	AOC-1			AOC-2			AOC-3		
Volume (L):	150			150			150		
Sample Location:	Room 211			2nd Floor Lounge			2nd Floor Mech. Room		
Spore Types	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total
Alternaria	9	200	4.2	1	20	0.4	11	230	5.2
Ascospores	27	570	12.1	42	890	17	25	530	12.1
Aspergillus/Penicillium	5	100	2.1	-	-	-	-	-	-
Basidiospores	35	740	15.7	95	2000	38.2	40	840	19.1
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	135	2850	60.5	107	2260	43.2	112	2360	53.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	-	-	-	2	40	0.9
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	3	60	1.3	2	40	0.8	1	20	0.5
Myxomycetes++	7	100	2.1	-	-	-	11	230	5.2
Pithomyces	1	20	0.4	-	-	-	-	-	-
Rust	-	-	-	-	-	-	5	100	2.3
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	1	20	0.4	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	3	60	1.3	-	-	-	1	20	0.5
Nigrospora	1*	7*	0.1	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	1	20	0.5
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**226**	**4707**	**100**	**248**	**5230**	**100**	**209**	**4390**	**100**
Hyphal Fragment	21	440	-	8	200	-	21	440	-
Insect Fragment	1*	7*	-	-	-	-	1*	7*	-
Pollen	1	20	-	-	-	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	4	-	-	1	-	-	2	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

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14375 23rd Avenue North Minneapolis, Mn 55447
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http://www.EMSL.com / minneapolislab@emsl.com

Order ID: 351505112
Customer ID: TCND42
Customer PO:
Project ID:

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Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone: (701) 792-2615
Fax:
Collected: 07/29/2015
Received: 08/03/2015
Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0004			351505112-0005			351505112-0006		
Client Sample ID:	AOC-4			AOC-5			AOC-6		
Volume (L):	150			150			150		
Sample Location:	Room 226			2nd Floor West Hall, Near Room 223			2nd Floor, East Hall, Near Room 204		
Spore Types	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total
Alternaria	5	100	3.1	8	200	1.9	13	270	5.1
Ascospores	32	680	20.9	36	760	7.4	28	590	11.2
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	54	1100	33.9	189	3990	38.6	54	1100	20.8
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	1*	7*	0.1
Cladosporium	57	1200	37	247	5210	50.4	140	2950	55.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.6	-	-	-	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	2	40	1.2	4	80	0.8	7	100	1.9
Myxomycetes++	4	80	2.5	7	100	1	11	230	4.4
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	-	-	-	-	-	-	2	40	0.8
Nigrospora	1*	7*	0.2	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	1	20	0.6	-	-	-	-	-	-
Total Fungi	**157**	**3247**	**100**	**491**	**10340**	**100**	**256**	**5287**	**100**
Hyphal Fragment	4	80	-	24	510	-	15	320	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	1	20	-	-	-	-	1	20	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	2	-	-	2	-	-	4	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Initial report from: 08/05/2015 16:22:36

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Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0007			351505112-0008			351505112-0009		
Client Sample ID:	AOC-7			AOC-8			AOC-9		
Volume (L):	150			150			150		
Sample Location:	3rd Floor Lounge			3rd Floor Mech. Rm			3rd Floor, East Hall Near Room 306		
Spore Types	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total	Raw Count	Count/m³	% of Total
Alternaria	2	40	0.7	10	210	3.9	5	100	3.3
Ascospores	25	530	9.9	12	250	4.7	31	650	21.7
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	92	1900	35.4	39	820	15.4	16	340	11.3
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	131	2760	51.4	180	3800	71.3	83	1800	60.1
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	1	20	0.4	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	4	80	1.5	-	-	-	-	-	-
Myxomycetes++	2	40	0.7	11	230	4.3	6	100	3.3
Pithomyces	-	-	-	-	-	-	1*	7*	0.2
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	1	20	0.4	-	-	-	-	-	-
Cercospora	-	-	-	-	-	-	-	-	-
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**257**	**5370**	**100**	**253**	**5330**	**100**	**142**	**2997**	**100**
Hyphal Fragment	5	100	-	15	320	-	12	250	-
Insect Fragment	-	-	-	2	40	-	1	20	-
Pollen	3*	20*	-	1	20	-	1	20	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	3	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	4	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Phone:	(701) 792-2615
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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0010**			**351505112-0011**			**351505112-0012**		
Client Sample ID:	**AOC-10**			**AOC-11**			**AOC-12**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**Room 309**			**Room 320**			**3rd Floor, West Hall, Near Room 323**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	Present	Present	-	2	40	1.3	23	490	15.2
Ascospores	Present	Present	-	76	1600	51	32	680	21.1
Aspergillus/Penicillium	-	-	-	-	-	-	2	40	1.2
Basidiospores	-	-	-	40	840	26.8	22	460	14.3
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	Present	Present	-	23	490	15.6	57	1200	37.3
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	Present	Present	-	1	20	0.6	1	20	0.6
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	-	-	-	1	20	0.6
Myxomycetes++	Present	Present	-	6	100	3.2	13	270	8.4
Pithomyces	-	-	-	-	-	-	2*	10*	0.3
Rust	Present	Present	-	2*	10*	0.3	1*	7*	0.2
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	1	20	0.6	-	-	-
Cercospora	-	-	-	1	20	0.6	-	-	-
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	1	20	0.6
Total Fungi	**-**	**-**	**-**	**152**	**3140**	**100**	**155**	**3217**	**100**
Hyphal Fragment	Present	Present	-	2	40	-	15	320	-
Insect Fragment	-	-	-	-	-	-	-	-	-
Pollen	-	-	-	-	-	-	3	60	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	5	-	-	1	-	-	2	-

Sample Comments: 351505112-0010 Overloaded

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0013			351505112-0014			351505112-0015		
Client Sample ID:	AOC-13			AOC-14			AOC-15		
Volume (L):	150			150			150		
Sample Location:	1st Floor, West Hall, Near Room 119			Room 120			1st Floor Lounge		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	9	200	5.7	3	60	1.9	2*	10*	0.3
Ascospores	79	1700	48.2	51	1100	35	91	1900	55
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	29	610	17.3	22	460	14.6	41	870	25.2
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	39	820	23.2	65	1400	44.5	25	530	15.3
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.6	-	-	-	1*	7*	0.2
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	-	-	-	1	20	0.6
Myxomycetes++	5	100	2.8	4	80	2.5	5	100	2.9
Pithomyces	1	20	0.6	1*	7*	0.2	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	1	20	0.6	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	2	40	1.1	2	40	1.3	1	20	0.6
Nigrospora	-	-	-	-	-	-	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**166**	**3530**	**100**	**148**	**3147**	**100**	**167**	**3457**	**100**
Hyphal Fragment	9	200	-	8	200	-	2	40	-
Insect Fragment	-	-	-	-	-	-	1	20	-
Pollen	1	20	-	1	20	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	1	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

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Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0016**			**351505112-0017**			**351505112-0018**		
Client Sample ID:	**AOC-16**			**AOC-17**			**AOC-18**		
Volume (L):	**150**			**150**			**150**		
Sample Location:	**1st Floor Laundry**			**1st Floor, Exterior Mech Room**			**Foyer**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	-	-	-	23	490	8.6	1	20	0.5
Ascospores	66	1400	38.9	35	740	13	70	1500	35.6
Aspergillus/Penicillium	-	-	-	2	40	0.7	2	40	1
Basidiospores	80	1700	47.2	36	760	13.3	93	2000	47.5
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	21	440	12.2	160	3380	59.3	29	610	14.5
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	-	-	-	5	100	1.8	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	1	20	0.6	1	20	0.4	1	20	0.5
Myxomycetes++	1	20	0.6	7	100	1.8	1	20	0.5
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	1	20	0.4	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	1	20	0.6	2	40	0.7	-	-	-
Nigrospora	-	-	-	1*	7*	0.1	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	-	-	-	-	-	-	-	-	-
Total Fungi	**170**	**3600**	**100**	**273**	**5697**	**100**	**197**	**4210**	**100**
Hyphal Fragment	2	40	-	21	440	-	2	40	-
Insect Fragment	-	-	-	4	80	-	-	-	-
Pollen	1*	7*	-	4	80	-	-	-	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	-	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	1	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

EMSL Analytical, Inc.

14375 23rd Avenue North Minneapolis, Mn 55447
Phone/Fax: (763) 449-4922 / (763) 449-4924
http://www.EMSL.com / minneapolislab@emsl.com

Order ID: 351505112
Customer ID: TCND42
Customer PO:
Project ID:

Attn: Steve Maliszeski
Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone: (701) 792-2615
Fax:
Collected: 07/29/2015
Received: 08/03/2015
Analyzed: 08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	351505112-0019			351505112-0020			351505112-0021		
Client Sample ID:	AOC-19			AOC-20			AOC-21		
Volume (L):	150			150			150		
Sample Location:	Kitchen			First Floor, East Hall, Near Room 106			Room 106		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	1	20	0.3	4	80	1.3	4	80	3.6
Ascospores	76	1600	27.8	73	1500	25.1	17	360	16.3
Aspergillus/Penicillium	-	-	-	-	-	-	-	-	-
Basidiospores	143	3020	52.4	113	2380	39.9	29	610	27.6
Bipolaris++	-	-	-	-	-	-	-	-	-
Chaetomium	-	-	-	-	-	-	-	-	-
Cladosporium	49	1000	17.4	89	1900	31.8	54	1100	49.8
Curvularia	-	-	-	-	-	-	-	-	-
Epicoccum	1	20	0.3	1	20	0.3	-	-	-
Fusarium	-	-	-	-	-	-	-	-	-
Ganoderma	-	-	-	2	40	0.7	-	-	-
Myxomycetes++	3	60	1	2	40	0.7	3	60	2.7
Pithomyces	-	-	-	-	-	-	-	-	-
Rust	-	-	-	-	-	-	-	-	-
Scopulariopsis	-	-	-	-	-	-	-	-	-
Stachybotrys	-	-	-	-	-	-	-	-	-
Torula	-	-	-	-	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-	-	-	-	-
Cercospora	1	20	0.3	-	-	-	-	-	-
Nigrospora	-	-	-	1*	7*	0.1	-	-	-
Oidium	-	-	-	-	-	-	-	-	-
Stemphylium	1	20	0.3	-	-	-	-	-	-
Total Fungi	**275**	**5760**	**100**	**285**	**5967**	**100**	**107**	**2210**	**100**
Hyphal Fragment	2	40	-	11	230	-	8	200	-
Insect Fragment	-	-	-	-	-	-	1	20	-
Pollen	1	20	-	5	100	-	3*	20*	-
Analyt. Sensitivity 600x	-	21	-	-	21	-	-	21	-
Analyt. Sensitivity 300x	-	7*	-	-	7*	-	-	7*	-
Skin Fragments (1-4)	-	1	-	-	1	-	-	1	-
Fibrous Particulate (1-4)	-	1	-	-	1	-	-	1	-
Background (1-5)	-	1	-	-	2	-	-	2	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

EMSL

EMSL Analytical, Inc.

14375 23rd Avenue North Minneapolis, Mn 55447
Phone/Fax: (763) 449-4922 / (763) 449-4924
http://www.EMSL.com / minneapolislab@emsl.com

Order ID:	351505112
Customer ID:	TCND42
Customer PO:	
Project ID:	

Attn: Steve Maliszeski
Terracon Consultants, Inc.
6701 4th Street SW
Minot, ND 58701

Phone:	(701) 792-2615
Fax:	
Collected:	07/29/2015
Received:	08/03/2015
Analyzed:	08/05/2015

Proj: M6157011 / MAFB Dorm Renovation

Test Report: Air-O-Cell(™) Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	**351505112-0022**		
Client Sample ID:	**AOC-22**		
Volume (L):	**150**		
Sample Location:	**Outdoor Sample**		
Spore Types	**Raw Count**	**Count/m³**	**% of Total**
Alternaria	2	40	0.4
Ascospores	94	2000	22.3
Aspergillus/Penicillium	-	-	-
Basidiospores	228	4810	53.6
Bipolaris++	-	-	-
Chaetomium	-	-	-
Cladosporium	95	2000	22.3
Curvularia	-	-	-
Epicoccum	1	20	0.2
Fusarium	-	-	-
Ganoderma	2	40	0.4
Myxomycetes++	-	-	-
Pithomyces	1	20	0.2
Rust	-	-	-
Scopulariopsis	-	-	-
Stachybotrys	-	-	-
Torula	-	-	-
Unidentifiable Spores	-	-	-
Cercospora	1	20	0.2
Nigrospora	-	-	-
Oidium	1	20	0.2
Stemphylium	-	-	-
Total Fungi	**425**	**8970**	**100**
Hyphal Fragment	11	230	-
Insect Fragment	-	-	-
Pollen	3	60	-
Analyt. Sensitivity 600x	-	21	-
Analyt. Sensitivity 300x	-	7*	-
Skin Fragments (1-4)	-	-	-
Fibrous Particulate (1-4)	-	1	-
Background (1-5)	-	1	-

Bipolaris++ = Bipolaris/Drechslera/Exserohilum
Myxomycetes++ = Myxomycetes/Periconia/Smut

No discernable field blank was submitted with this group of samples.

Jodie Bourgerie, Laboratory Manager
or Other Approved Signatory

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 5 indicate an overloading of background particulates, prohibiting accurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungal spore, structure, pollen, fiber particle or insect fragment. "*" Denotes particles found at 300X. "-" Denotes not detected. Due to method stopping rules, raw counts in excess of 100 are extrapolated based on the percentage analyzed. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Minneapolis, Mn AIHA-LAP, LLC EMLAP 163162

Initial report from: 08/05/2015 16:22:36

For Information on the fungi listed in this report please visit the Resources section at www.emsl.com

APPENDIX G

IDENTIFIED LEAD-BASED LBP LOCATIONS
Minot Air Force Base, North Dakota

Confirmed Lead-Based Paint Containing Materials			
Location	**Color**	**Substrate**	**Area (square feet)**
First floor locker room, lower half	White	Smooth CMU	360
Laundry room ceiling	White	Concrete	280
Handrail, center stairwell	Brown	Metal	16

APPENDIX H

LBP TESTING DATA SHEETS

Building 276 - First Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Dorm Room	111	North	White	Drywall	Orange Peel	Negative	
Dorm Room	111	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	111		White	Metal		Negative	Radiator
Dorm Room	111		White	Wood		Negative	Window
Dorm Room	111		Brown	Metal		Negative	Restroom door
Dorm Room	117	West	White	Drywall	Orange Peel	Negative	
Dorm Room	117	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	117		White	Metal		Negative	West wing
Dorm Room	117		White	Wood		Negative	Window
Dorm Room	117		Brown	Metal		Negative	Restroom door
Hallway - West	117	North	White	Laminate		Negative	
Hallway - West	117	North	White	Drywall	Orange Peel	Negative	
Hallway - West	117	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	117	North	Brown	Metal		Negative	
Hallway - East	103	North	White	Laminate	Orange Peel	Negative	East wing
Hallway - East	103	North	White	Drywall	Orange Peel	Negative	
Hallway - East	103	North	Brown	Metal		Negative	Door frame
Hallway - East		Ceiling	White	Drywall	Orange Peel	Negative	
Utility Closet		South	White	CMU		Negative	East wing
Utility Closet		Ceiling	White	concrete	Orange Peel	Negative	
Utility Closet		South	White	CMU		Negative	West wing
Utility Closet		Ceiling	White	concrete		Negative	
Locker Room		West	White	CMU		Positive	Lower section of wall
Locker Room		West	White	CMU		Negative	Upper wall rough texture cmu
Locker Room		Ceiling	White	concrete		Negative	
Locker Room		North	White	Drywall	Orange Peel	Negative	West wing
Locker Room			White	Metal		Negative	West wing
Locker Room			Brown	Wood		Negative	Window

Building 276 - First Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Lounge		South	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Concrete	Popcorn	Negative	
Lounge			White	Metal		Negative	Radiator
Lounge		North	White	Wood		Negative	Window
Storage		Ceiling	White	concrete	Popcorn	Negative	
Storage			White	Wood		Negative	North room next to lounge
Lounge		West	White	Drywall	Orange Peel	Negative	Restroom
Lounge		Ceiling	White	Drywall		Negative	Restroom
Mechanical			Blue	Metal		Negative	Exterior entry mechanical
Mechanical			Brown	Metal		Negative	Exterior entry mechanical room
Kitchen		East	White	Laminate		Negative	
Kitchen		West	White	Drywall	Orange Peel	Negative	
Kitchen		Ceiling	White	Drywall	Orange Peel	Negative	
Kitchen			White	Wood		Negative	window
Kitchen			White	Metal		Negative	Radiator
Laundry		East	White	CMU		Negative	
Laundry		East	White	Drywall		Negative	
Laundry		Ceiling	White	concrete		Positive	
Laundry			Brown	Metal		Negative	Door
Foyer		East	White	CMU		Negative	
Foyer		North	White	Drywall	Orange Peel	Negative	
Foyer		West	White	Drywall	Orange Peel	Negative	
Foyer		Ceiling	White	Drywall		Negative	
Foyer		Ceiling	White	concrete		Negative	
Storage - Foyer		West	Blue	Drywall		Negative	Storage closet
Entry		West	White	Drywall	Orange Peel	Negative	

Building 276 -Second Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Stair - West		East	White	CMU		Negative	
Stair - West			White	Metal		Negative	Stair supports
Stair - West			Black	Metal		Negative	Handrail
Stair - West			Brown	Metal		Negative	Door
Stair - West			Brown	Wood		Negative	Window
Stair - East		North	White	CMU		Negative	
Stair - East			White	Metal		Negative	Stair supports
Stair - East			Brown	Metal		Negative	Door
Stair - East			Brown	Wood		Negative	Window
Dorm Room	205	West	White	Drywall	Orange Peel	Negative	
Dorm Room	205	Ceiling	White	Drywall	Orange Peel	Negative	East wing
Dorm Room	205		White	Metal		Negative	Radiator
Dorm Room	205		White	Wood		Negative	Window
Dorm Room	205		Brown	Metal		Negative	Restroom door
Dorm Room	325	West	White	Drywall	Orange Peel	Negative	East wing
Dorm Room	223	North	White	Drywall	Orange Peel	Negative	
Dorm Room	223	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	223	North	White	Wood	Orange Peel	Negative	
Dorm Room	223	North	White	Wood		Negative	Window
Dorm Room	223	North	White	Metal		Negative	Radiator
Dorm Room	223		Brown	Metal		Negative	Restroom door
Hallway - West	219	North	White	Drywall	Orange Peel	Negative	
Hallway - West	219	North	White	Laminate		Negative	
Hallway - West	219	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	219	North	Brown	Metal		Negative	Doorframe
Hallway - East	207	North	White	Drywall	Orange Peel	Negative	
Hallway - East	207	North	White	Laminate		Negative	
Hallway - East		Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - East	207	North	Brown	Metal		Negative	Doorframe

Building 276 -Second Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Utility Closet		South	White	CMU		Negative	Visible green paint
Utility Closet		Ceiling	White	concrete		Negative	
Utility Closet		West	White	CMU		Negative	West wing
Utility Closet		Ceiling	White	concrete		Negative	
Locker Room		East	White	CMU		Negative	East wing
Locker Room		East	White	CMU	Orange Peel	Negative	East wing
Locker Room			White	Metal		Negative	Radiator
Locker Room			Brown	Wood		Negative	Window
Locker Room		Ceiling	White	concrete		Negative	
Lounge		East	White	Drywall	Orange Peel	Negative	Western
Lounge			White	Metal	Orange Peel	Negative	Radiator
Lounge			White	Wood		Negative	Window
Lounge		Ceiling	White	Drywall		Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Dorm Room	309	North	White	Drywall	Orange Peel	Negative	
Dorm Room	309	North	White	Drywall	Orange Peel	Negative	
Dorm Room	309	Ceiling	White	Wood		Negative	Vent
Dorm Room	309	North	Brown	Wood		Negative	Window
Dorm Room	309		Brown	Metal		Negative	Rest Room
Dorm Room	309	North	Brown	Wood		Negative	Window
Dorm Room	320	Ceiling	White	Drywall	Orange Peel	Negative	
Dorm Room	320	South	Brown	Wood		Negative	Window
Dorm Room	320	South	White	Metal		Negative	Radiator
Dorm Room	320		Brown	Metal		Negative	Rest Room Door
Dorm Room	320	West	White	Drywall	Orange Peel	Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Hallway - West	325	Ceiling	White	Drywall	Orange Peel	Negative	
Hallway - West	325	North	Brown	Metal		Negative	Doorframe
Hallway - West			White	Piping insulation		Negative	Vent insulation
Hallway - East	325	South	White	Drywall	Orange Peel	Negative	
Hallway - East	325	South	White	Drywall	Orange Peel	Negative	
Hallway - East	305	North	White	Drywall	Orange Peel	Negative	
Hallway - East	305	North	White	Drywall	Orange Peel	Negative	
Hallway - East	305	South	White	Laminate		Negative	
Utility Closet		South	White	Drywall		Negative	East Ceiling
Utility Closet		South	Brown	Metal		Negative	Hallway - East Door Frame
Utility Closet		South	White	CMU		Negative	Hallway - East
Utility Closet		South	White	CMU		Negative	Hallway - East
Utility Closet		South	White	CMU		Negative	Hallway - West
Utility Closet		Ceiling	White	Drywall		Negative	West Hallway
Locker Room		West	White	CMU		Negative	West hallway
Locker Room				Metal		Negative	Silver on cages
Locker Room			White	Metal		Negative	Radiator
Locker Room		South	White	CMU		Negative	East wing
Locker Room		South	Brown	Wood		Negative	Window
Locker Room		West	White	Drywall	Orange Peel	Negative	East wing
Locker Room		Ceiling	White	concrete		Negative	
Locker Room			White	Metal		Negative	Radiator
Locker Room		Ceiling	White	concrete		Negative	East Wing
Lounge			White	Metal	Orange Peel	Negative	Radiator
Lounge		South	White	Drywall	Orange Peel	Negative	
Lounge		Ceiling	White	Drywall		Negative	
Lounge		North	White	Wood		Negative	

Building 276 -Third Floor Lead-Based Paint Results

Room Type	Room #	Direction	Color	Substrate	Surfacing	Pass Fail	Notes
Mechanical		West	White	CMU		Negative	
Mechanical			White	Piping insulation		Negative	Yellow on straight pipe insulation
Mechanical		Ceiling	White	concrete		Negative	
Mechanical				Metal		Negative	Gray paint on door frame
stair - Center		East	White	concrete	Orange Peel	Negative	
stair - Center		Ceiling	White	concrete		Negative	
stair - Center			Brown	Metal		Negative	Emergency ladder
stair - Center			Brown	Metal		Negative	Railing
stair - Center			Brown	Metal		Positive	Green paint visable
stair - Center			Brown	Metal		Negative	Door
Stair - East	311	Ceiling	White	Drywall	Orange Peel	Negative	

APPENDIX I

LICENSES AND CERTIFICATIONS

NORTH DAKOTA
DEPARTMENT *of* HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov

July 22, 2015

Terracon Consultants, Inc.
2281 S. Plaza Drive, Unit 16
Rapid City, SD 57702

Ladies and Gentlemen:

Enclosed you will find an asbestos certification card issued by the North Dakota Department of Health for Terri Fields.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of one year from the date of completion of the last training course. Individuals who intend to continue performing asbestos work must be recertified prior to that time. To be recertified, an individual must have attended an EPA approved refresher course in the specific discipline for which they are applying for recertification within the previous 12-month period.

If you have any questions concerning the certification or certification process, please feel free to contact me at (701)328-5188.

Sincerely,

Sandi Washek
For Justin L. Otto
Environmental Scientist
Asbestos Control Program

JLO:csc
Enc:

North Dakota Department of Health
Certificate
of No. 5781
Asbestos Abatement

This is to certify that Terri Lynn Fields **has met the requirements of Chapter 33-15-13 of the North Dakota Air Pollution Control Rules for certification in the following asbestos abatement discipline(s):**

Supervisor
Worker
x Inspector Exp: 3/6/2016
Management Planner
Project Designer
Project Monitor

Sandi Washek
Asbestos Control Program

March 13, 2015

Terracon Consultants, Inc.
6701 – 4th St SW
Minot, ND 58701

Ladies and Gentlemen:

Enclosed you will find an asbestos certification card issued by the North Dakota Department of Health for Stephen Maliszeski.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of one year from the date of completion of the last training course. Individuals who intend to continue performing asbestos work must be recertified prior to that time. To be recertified, an individual must have attended an EPA approved refresher course in the specific discipline for which they are applying for recertification within the previous 12-month period.

If you have any questions concerning the certification or certification process, please feel free to contact me at (701)328-5188.

Sincerely,

Justin L. Otto
Environmental Scientist
Asbestos Control Program

JLO:csc
Enc:

North Dakota Department of Health
Certificate
of
No. 5680
Asbestos Abatement

This is to certify that Steve T. Maliszeski has met the requirements of Chapter 33-15-13 of the North Dakota Air Pollution Control Rules for certification in the following asbestos abatement discipline(s):

Supervisor
Worker
x Inspector
Management Planner
Project Designer
Project Monitor

Exp: 3/28/2016

Asbestos Control Program

Environmental Health Section Chief's Office	Division of Air Quality	Division of Municipal Facilities	Division of Waste Management	Division of Water Quality
701.328.5150	701.328.5188	701.328.5211	701.328.5166	701.328.5210

Printed on recycled paper.

February 17, 2015

Terracon
6701 Fourth St SW
Minot, ND 58701

Ladies and Gentlemen:

Enclosed you will find a lead-based paint certification card issued by the North Dakota Department of Health for Stephen Maliszeski.

This card identifies the discipline for which the individual is certified. The State of North Dakota grants certification following proof of successful completion of an EPA or Department approved course. Individuals are allowed to perform only those duties in which they are certified and proof of certification must be available at the work site. Certification is for a period of three years from the date of completion of the last training course. Individuals who intend to continue performing lead-based paint work must be recertified prior to that time. To be recertified, an individual must have attended an EPA or State approved refresher course in the specific discipline for which they are applying for recertification within the previous three year period.

If you have any questions concerning the certification, please feel free to contact me at 701-328-5188.

Sincerely,

Sandi Washek
Environmental Scientist
Lead-Based Paint Program

SW:csc
Enc:

North Dakota Department of Health
Certificate
of
Lead-Based Paint Abatement

GREAT SEAL STATE OF NORTH DAKOTA

No. 315

This is to certify that Stephen T. Maliszeski has met the requirements of Chapter 33-15-24 of the North Dakota Air Pollution Control Rules for certification in the following lead-based paint abatement discipline(s):

Supervisor
Worker
Inspector
x Risk Assessor
Project Designer

Exp: 1/23/2018

LBP Control Program

Environmental Health Section Chief's Office	Division of Air Quality	Division of Municipal Facilities	Division of Waste Management	Division of Water Quality
701.328.5150	701.328.5188	701.328.5211	701.328.5166	701.328.5210

Printed on recycled paper.

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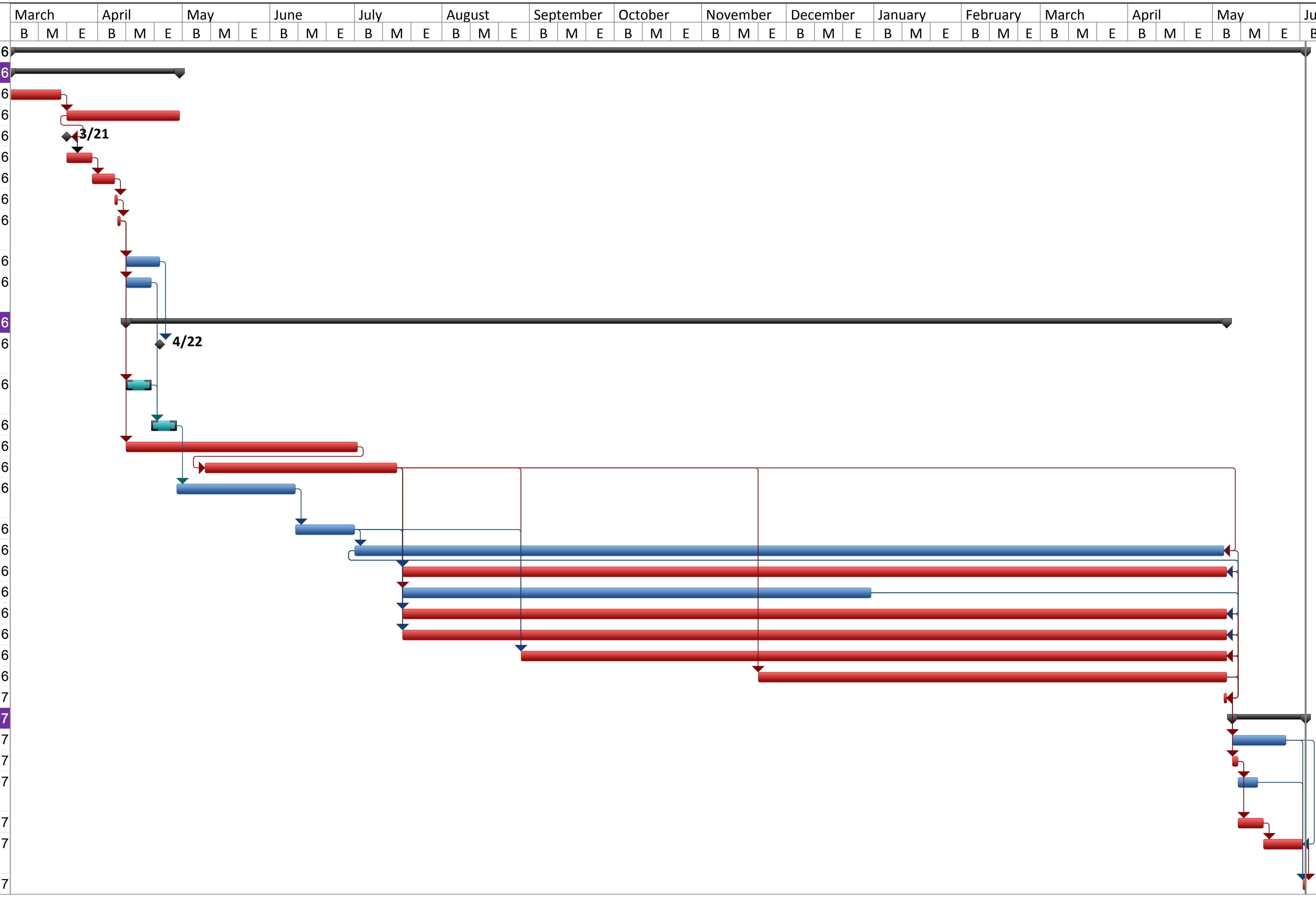
APPENDIX E – CONSTRUCTION SCHEDULE

leidos

RENOVATE DORM 276 - PRELIMINARY COST CONSTRUCTION SCHEDULE

ID		Task Name	Duration	Start
1		OVERALL PROJECT	329 days	Tue 3/1/16
2		Pre-Construction	44 days	Tue 3/1/16
3		Advertise for bids	14 days	Tue 3/1/16
4		Bid documents available to bidders	30 days	Mon 3/21/16
5		Receive Bids	0 days	Mon 3/21/16
6		Bid Evaluation	7 days	Mon 3/21/16
7		Award negation and clarifications	6 days	Wed 3/30/16
8		Contract Award	1 day	Thu 4/7/16
9		START: Government issues Construction Notice to Proceed	1 day	Fri 4/8/16
10		Contractor Mobilization	10 days	Mon 4/11/16
11		Initial Project Schedule Submission (7 days after NTP)	7 days	Mon 4/11/16
12		Construction to close out	280 days	Mon 4/11/16
13		Contractor takes possession of project site.	0 days	Fri 4/22/16
14		Hazardous Material Abatement Submittal Preparation	7 days	Mon 4/11/16
15		Government Review & Approval	7 days	Wed 4/20/16
16		Other Submittals Perpetration	60 days	Mon 4/11/16
17		Government Review & Approval	50 days	Mon 5/9/16
18		Hazardous Material Abatement W/Partial Demo of Access	30 days	Fri 4/29/16
19		Balance of Demolition	15 days	Fri 6/10/16
20		Architectural Finishes Build out	220 days	Fri 7/1/16
21		Plumbing Construction	210 days	Mon 7/18/16
22		Geothermal Well Field	120 days	Mon 7/18/16
23		HVAC Construction	210 days	Mon 7/18/16
24		Electrical Constructions	210 days	Mon 7/18/16
25		Communication System Indoors	180 days	Mon 8/29/16
26		Communications System Outdoors	120 days	Mon 11/21/16
27		Substantial Completion	1 day	Fri 5/5/17
28		Close out	20 days	Mon 5/8/17
29		Start-up & Commissioning.	15 days	Mon 5/8/17
30		Contractor's pre-final inspection.	2 days	Mon 5/8/17
31		Correction of punch list from Contractor's pre-final inspection.	5 days	Wed 5/10/17
32		Government's pre-final inspection.	7 days	Wed 5/10/17
33		Correction of punch list from Government's pre-final inspection.	10 days	Fri 5/19/17
34		Final inspection & acceptance.	1 day	Fri 6/2/17



Project: **Minot AFB**
DMP - Renovate Dorm 276
Date: November 12, 2015

Task, Split, Milestone, Summary, Project Summary, External Tasks, External Milestone, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, Deadline, Critical, Critical Split, Progress