REVIEWED

By Thomas Meyers CBO at 10:42 am, Oct 18, 2014

Electrical sections of manual not approved

SURE HOUSE

a new direction for coastal housing

NOT APPROVED

Tom Meyers has indicated that you are on the cusp between yellow and green for approval of this submission from the perspective of building code compliance. Please review his comments and submit a revised document.

Stevens Institute of Technology Design Development

Project Manual

Sustainable Resilient

SURE HOUSE

a new direction for coastal housing

U.S Department Of Energy Solar Decathlon 2015

Stevens Institute of Technology

Project Manual

Design Development Submission
October 8 2014

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INTRODUCTORY NARRATIVE

SUSTAINABILITY AND RESILIENCY ON THE JERSEY SHORE

The mission of the Stevens team is to design and build a sustainable, resilient, solar-powered home for vulnerable coastal communities. SUREhouse, Stevens' entry to the 2015 U.S. Department of Energy Solar Decathlon, will broaden the impact of the Solar Decathlon event to not only address education and innovation related to sustainable solar-powered house design, but also to embrace the compelling contemporary issue of designing and building resilient housing for vulnerable areas, especially areas where such resilience is a vital aspect of any truly sustainable development. SUREhouse will become an integral part of a broader research and development enterprise at Stevens in partnership with major stakeholders in the New York Metropolitan region to address the development of resilient urban coastal communities.

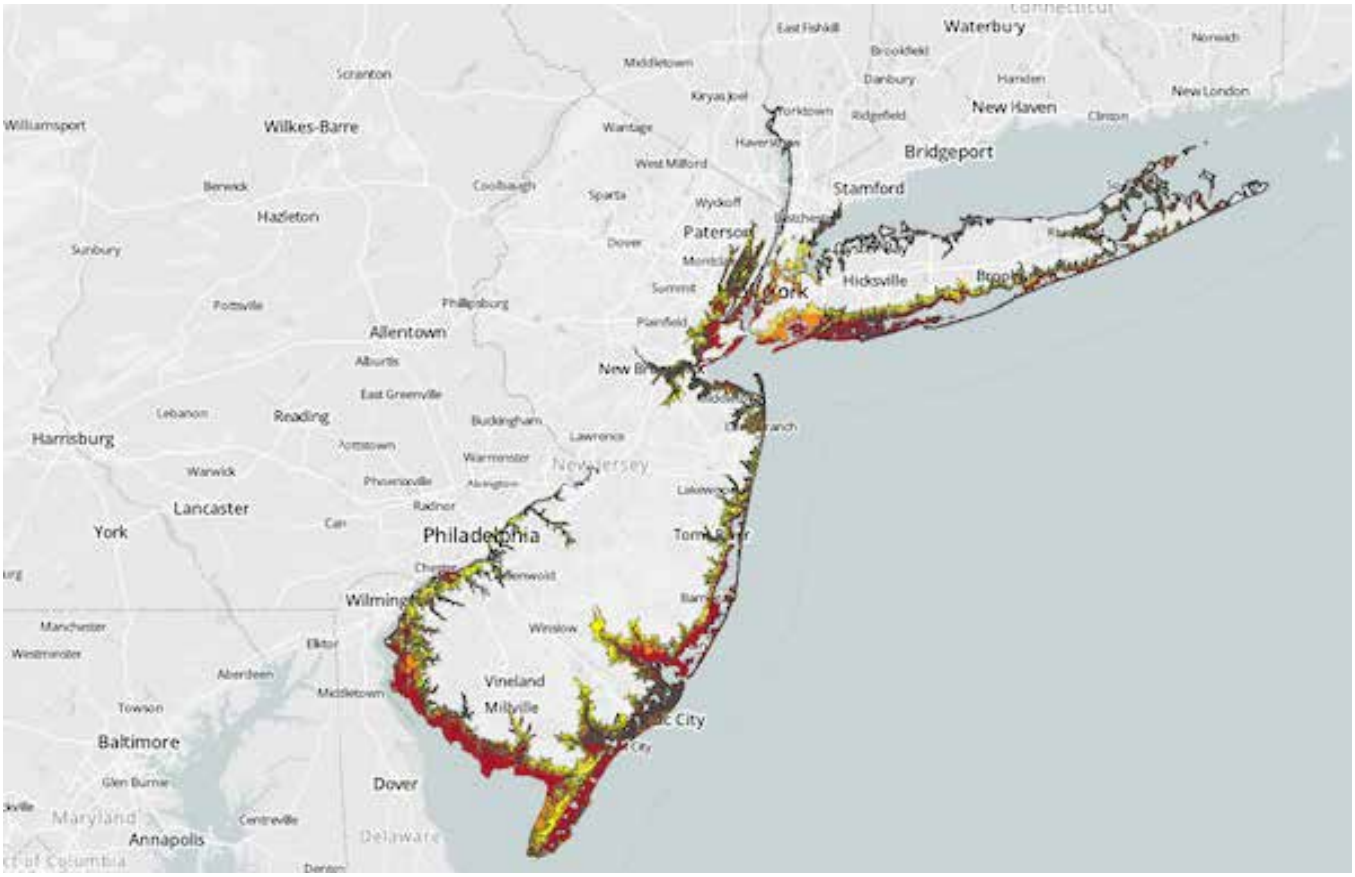


Fig 0.1 Map of New York / New Jersey Coastline Affected by Hurricane Sandy.

INTRODUCTORY NARRATIVE

ARCHITECTURE NARRATIVE

The architectural design of the SUREhouse will utilize several strategies in order to achieve our target point value in the Architecture contest. Most important, the SUREhouse will be designed using a simple, clear and compelling concept: a solar-powered, storm-resilient home for vulnerable coastal communities. All architectural elements, from the smallest details to the overall house form, will be assessed for consistency and applicability to this core concept. The idea of the “shore-home” will drive the exciting, innovative yet comfortable architectural design that highlights indoor/outdoor spaces, open views, and smart material choices. The exterior decks will be an especially important element of the architectural design, speaking to the importance of outdoor space in the lifestyle of the coastal communities found throughout the mid-Atlantic region.

Through smart design the SUREhouse will effectively double its useable space in the warm summer months by opening up to these large outdoor spaces. Exterior elements such as outdoor kitchens, exterior showers and built-in garden planters will enliven the outdoor spaces while evoking a desirable coastal lifestyle. This outdoor space will complement a simple, contemporary interior that will rely on ample natural daylight and functional, flexible living space to create a warm and inviting family home.

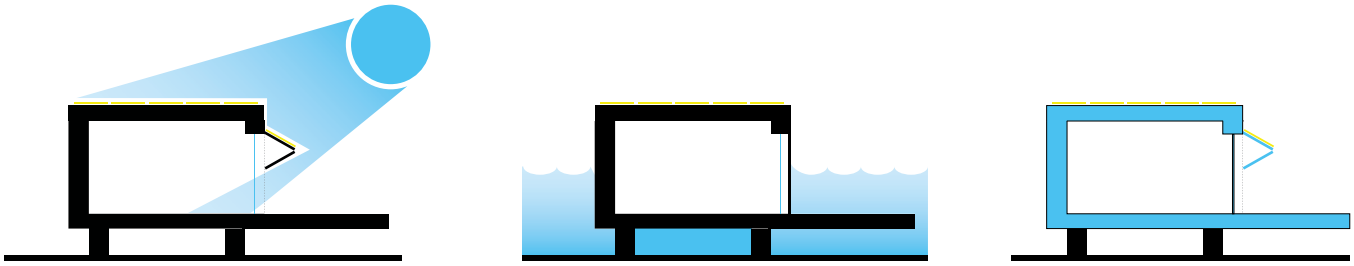


Fig 0.2 Conceptual Basis of Design

The patterns of life typical of coastal communities inform all aspects of the SUREhouse. Large decks for informal outdoor living, durable materials which can resist the intense shore environment, and open flexible spaces allow for the residents to live comfortably and with all of the amenities people expect from a shore home. The New York/New Jersey shore neighborhoods have several unique conditions which have also informed the design of the SUREhouse. Because these neighborhoods have tight, semi-urban streets and little space between neighboring homes, SUREhouse is designed to prioritize broad ocean views through the use of expansive glass on the south face while shielding the residents from exposure to their neighbors along the sides through the use of solid walls, providing a sense of both openness and privacy.

INTRODUCTORY NARRATIVE

ARCHITECTURE NARRATIVE

Fig 0.3 Possible Location Proximities to Major Cities

The New York and New Jersey shore communities have an incredibly rich and varied building culture. From the blue-collar bungalows of Breezy Point and the historic homes of Ocean Grove to the exuberance of Asbury Park and Coney Island, the communities that make up the Mid-Atlantic coastline have one common denominator: a love of the coastal landscape. This shore lifestyle, which prioritizes outdoor living, casual spaces and openness, is the inspiration for the SURE house.

The SURE house, composed of a roughly square volume of approximately 1,000sf, will include 2 bedrooms, 2 baths and a large kitchen-living-dining area with built-in cabinetry and furniture, helping the spaces to function well without needing to be overly large. In summer, thanks to the large expanse of south-facing sliding doors, the home will open itself to the coastal climate and double its use-able space as the living, kitchen and dining areas spill out onto the large deck. The deck features an enclosed garden space, outdoor eating and cooking equipment, and relaxed open-air living areas. The outdoor deck is ringed by a movable screen that controls sunlight, rain, noise, views and access to the space through intelligent, automated operation. Drawing material inspiration from the neighborhoods along the shore, the home both inside and out is built from durable materials evoking a relaxed beach-front character. While the large open deck and south-facing glass open to the coastal environment, the more closed east and west sides successfully screen the home from its neighbors providing privacy and in the process addressing a common issue in the tight semi-urban neighborhoods along the coast.

INTRODUCTORY NARRATIVE

ARCHITECTURE NARRATIVE

The SURE house is designed with a middle-class family as the target market. The two bedrooms and flexible living spaces allow for a family to live comfortably in a relatively compact home while still offering plenty of private space. The integration of a variety of built-in furniture elements will maximize the compact interior spaces without sacrificing functionality.

The patterns of life typical of coastal communities inform all aspects of the SURE house. Large decks for informal outdoor living, durable materials which can resist the intense shore environment, and open flexible spaces allow for the residents to live comfortably and with all of the amenities people expect from a shore home.

The New York/New Jersey shore neighborhoods have several unique conditions which have also informed the design of the SURE house. Because these neighborhoods have tight, semi-urban streets and little space between neighboring homes, SURE house is designed to prioritize broad ocean views through the use of expansive glass facing the water and solid walls oriented toward neighbors, providing a sense of both openness and privacy.

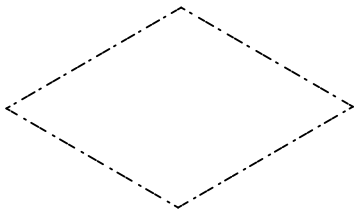


Fig 0.4 The site is prepared and readied for installation.

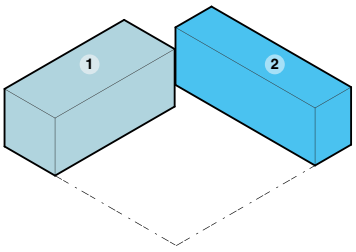


Fig 0.5 Two modules are added.
(1) A living module (2) A service module
These blocks include kitchen, bathroom and mechanical room.

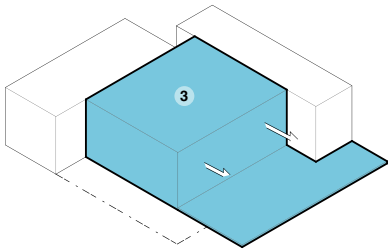


Fig 0.6 The rest of the house area is 'stretched' between the blocks using innovtive construction techniques and materials.

Prefabrication and off-site assembly of homes and home components is an extremely effective construction technique particularly suited to the New York/New Jersey shore neighborhoods. The tight, semi-urban spaces, the lack of staging areas for workmen, and the sensitivity of the coastal environment make any on-site construction extremely difficult. The unique hybrid approach to the prefabrication of SURE house utilizes several system-intensive pre-fab "blocks" which are manufactured off-site and then connected on-site using typical construction materials and processes. This approach allows for the off-site construction of complex, systems-intensive elements like the bathrooms, kitchens, furniture and mechanical spaces while preserving the flexibility of typical home construction techniques. These high-performance "blocks" will exploit the latest material and fabrication technologies such as glass fiber composites to ensure water-proof, durable and strong building assemblies.

INTRODUCTORY NARRATIVE

SITE LOCATIONS

Like many coastal regions, the New York and New Jersey shore communities saw a steady increase in the cost of homes and land even before Hurricane Sandy. Post-Sandy, the cost of repairs as well as FEMA policy and its new Flood Insurance Program regulations have driven up the costs of homeownership in these shore towns dramatically. These cost increases are rapidly changing the character of these areas as lower-income residents get priced out and wealthy buyers increasingly purchase property along the shore.

Fig 0.7 Image New Jersey shore town of flooding after Hurricane Sandy.

The SURE house seeks to make affordable coastal living possible for middle-class families and support the neighborhoods which have thrived here for generations.

Median sf home prices along the New Jersey shore can range anywhere from $110/sf for some inland areas such as Toms River to more than $500/sf along the barrier islands. The SURE house has a target construction cost of $350/sf which will put it squarely within the average price range for this area. At 1,000 sf this means the SURE house has a target total cost of $350,000.

The team will use cost analysis metrics to evaluate every aspect of the home's design and assess design-decision impacts on the overall energy performance and competition contests. Net Present Value Annuity analysis and Price/saved-kWh calculations will be used to assess overall design-decision cost-effectiveness and deliver the maximum performance for the best price.

INTRODUCTORY NARRATIVE

SITE CRITERA

Lot Sizing

The selected blocks were analyzed by their local vernacular. Typically locations were selected where the SURE House can be accomodated without disrupting the streetscape. A typical Solar Decathlon lot is 60' x 78'. Therefore, this dimension was considered a limitation in the consideration of where to site the SURE House permanenetly in New Jersey.

Birds Eye Views

Keeping in mind that SURE House is part of a larger network of the community, it is important for us to take into account not just the house, or the adjacent homes, but the entire urban fabric in order to create a home for the community.

Beach Views

These collection of images relate to a view down a typical block looking towards the beach. A central design element of the SURE House is that it be situated with access to beach views.

Sandy Damage

Keeping in mind damage from hurricanes and superstorms, such as Hurricane Sandy, it is important for us to remember who we are designing for, and our responsibility toward resiliency.

FEMA Flood Zones

The selected FEMA Flood zones analyzed are AE +7 and +8. An AE flood zone is a zone where water builds up without wave action. This means the affected areas have the potential to flood +7 or +8 feet from sea level. This criteria was selected as a base for how much water SURE House would be able to resist in a coastal community.

INTRODUCTORY NARRATIVE

SITE CRITERA

Demographics

These core demographic attributes were selected in order to compare certain criteria of shore communities which dictate whether the community is more for tourists, residents, children, or blue collar working class families.

Street Elevation

The SURE house is intended to fit into elevations which relate to it in size and height.

Cross Sections

These cross sections show a relationship between the house and the street. Finding existing neighborhoods with this relationship is key to implementing the SURE house design because the house has a strong relationship to its street and community.

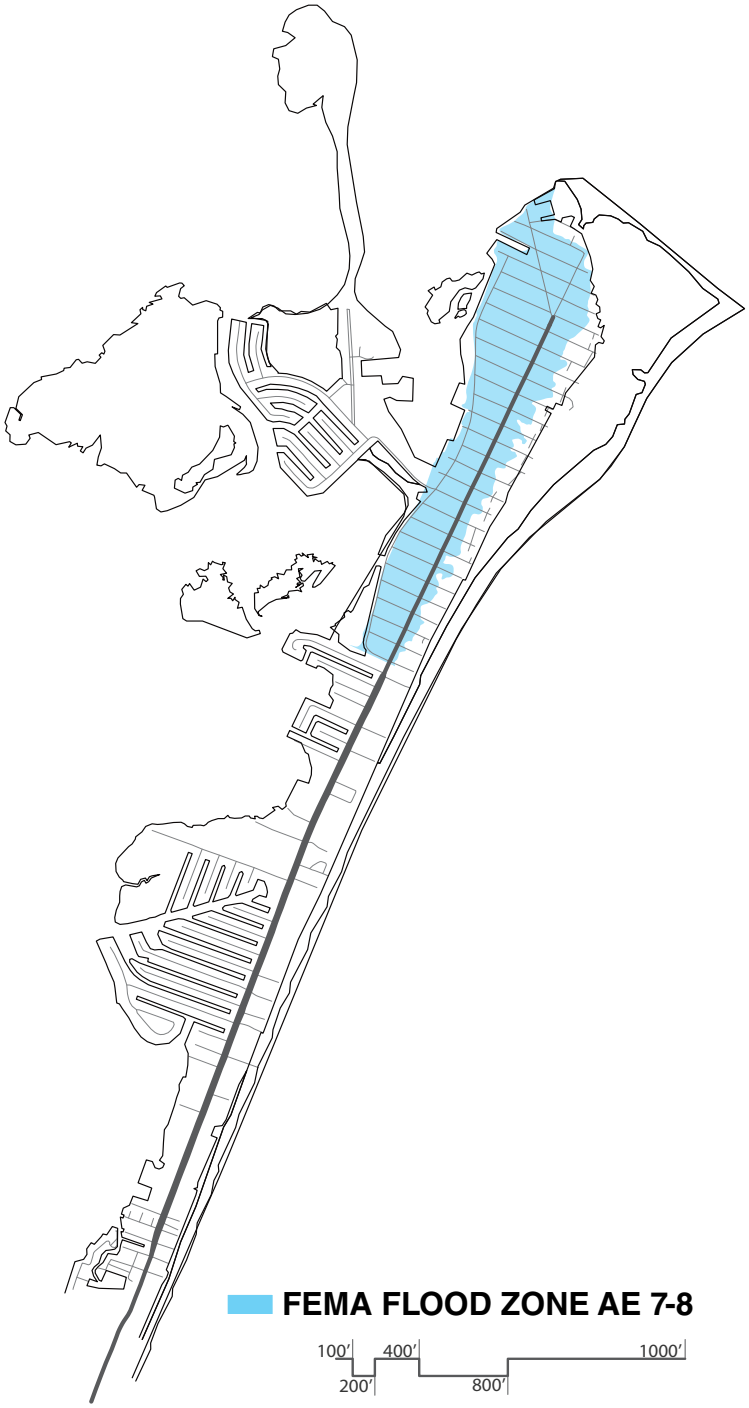
Parking Conditions

Parking conditions are an important part of the coastal community, especially in flood prone areas. As a new category in the Solar Decathlon, parking becomes an important condition in terms of energy and carbon footprint as well.

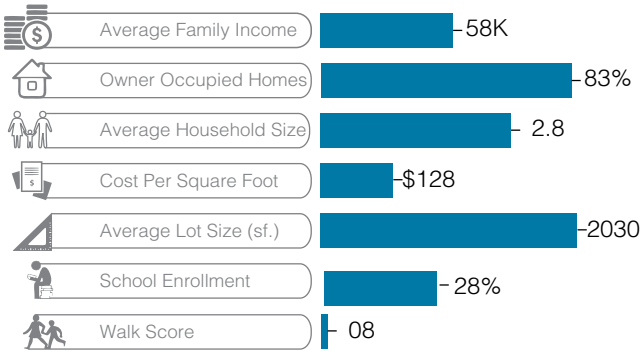
INTRODUCTORY NARRATIVE

SITE LOCATIONS

BARNEGAT LIGHT



DEMOGRAPHICS



SANDY DAMAGE

BIRDS EYE VIEW

STREET PERSPECTIVE

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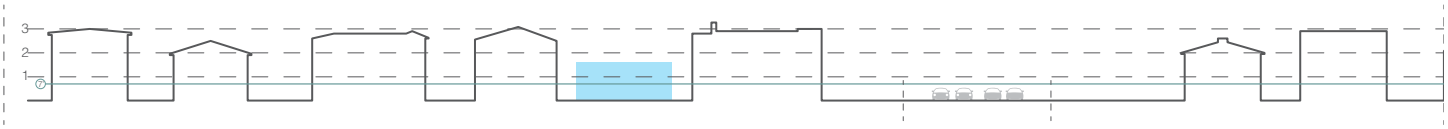
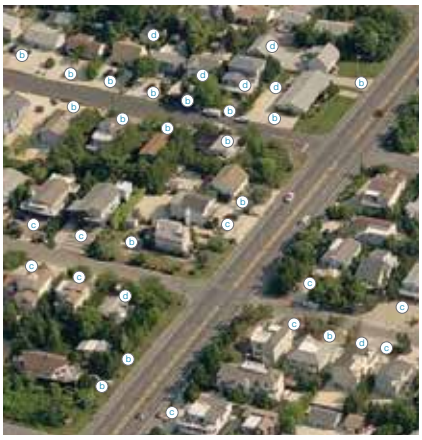
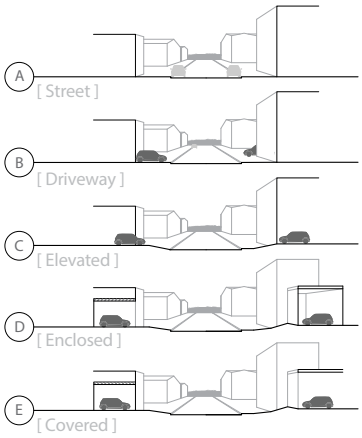
SITE LOCATIONS

BARNEGAT LIGHT

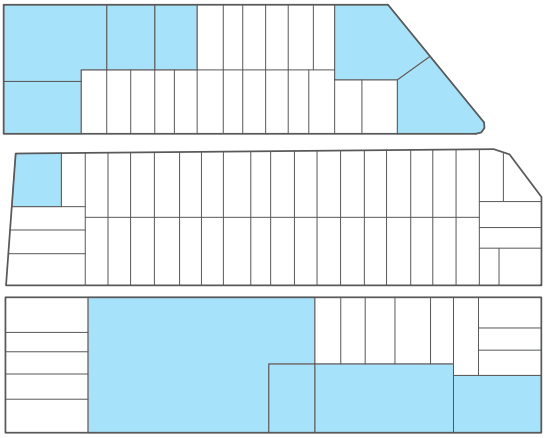


STREETSCAPE CONTEXT



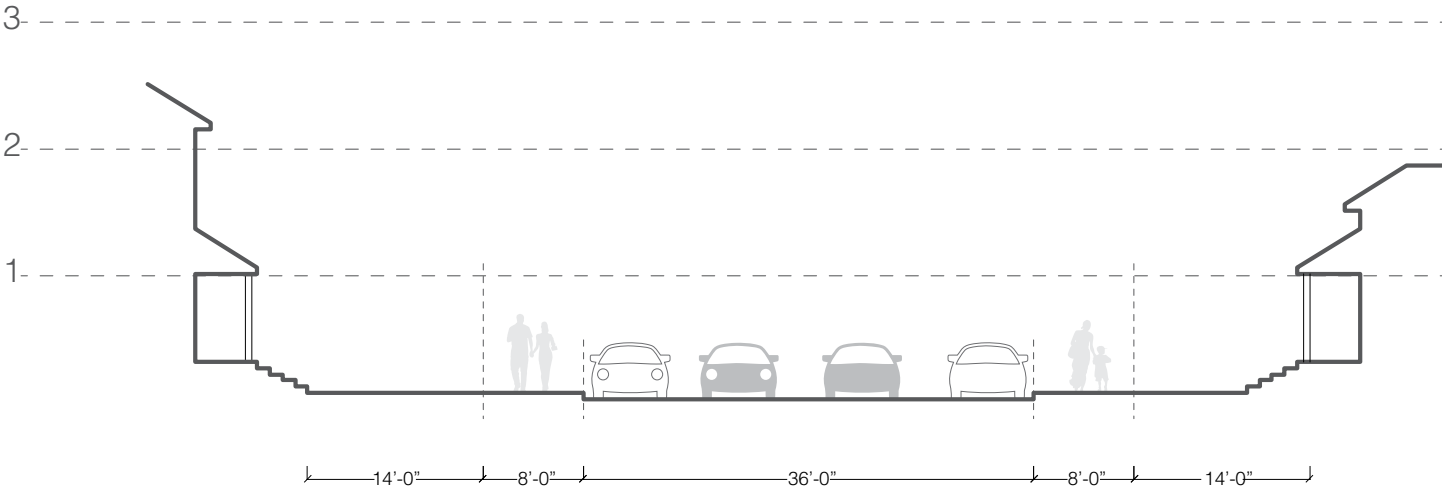


PARKING CONDITIONS



LOT SIZING

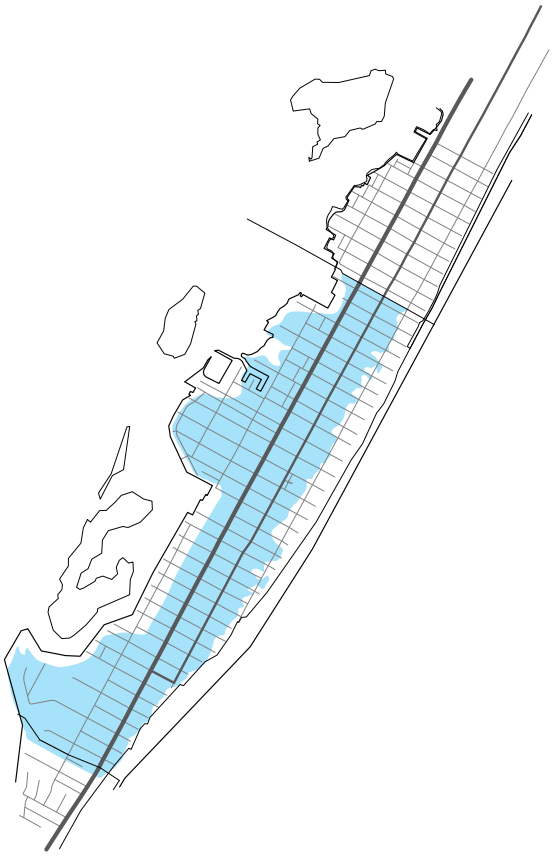
SECTIONAL CONDITION



INTRODUCTORY NARRATIVE

SITE LOCATIONS

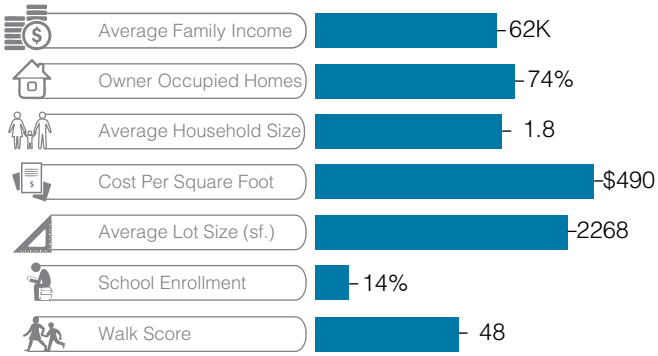
BEACH HAVEN



FEMA FLOOD ZONE AE 7-8

100′ 200′ 400′ 800′ 1000′

DEMOGRAPHICS



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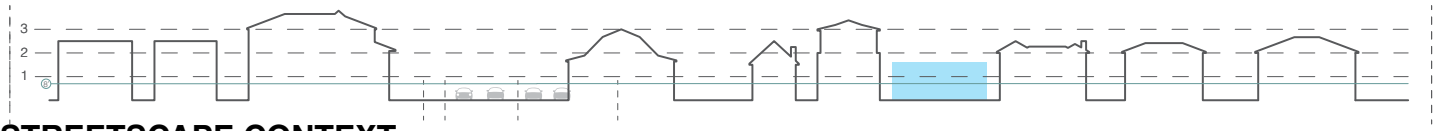
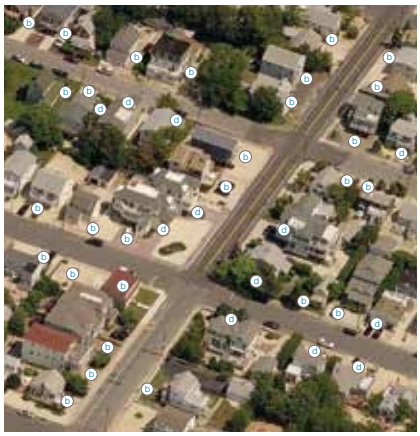
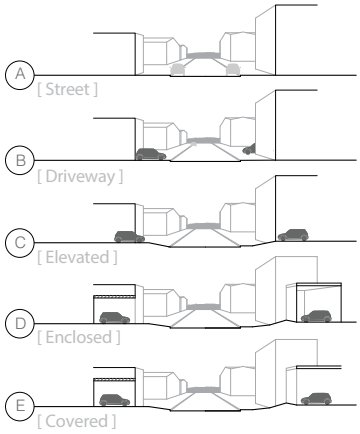


STREETSCAPE CONTEXT





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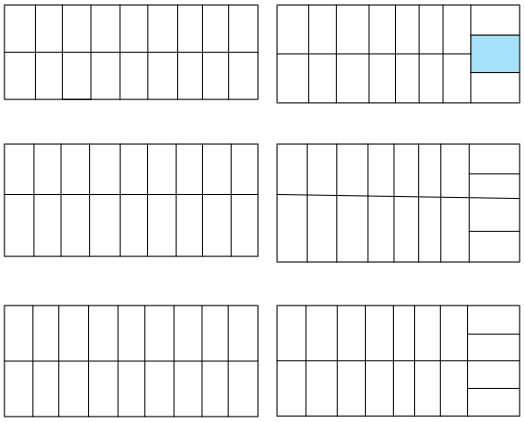

LOT SIZING

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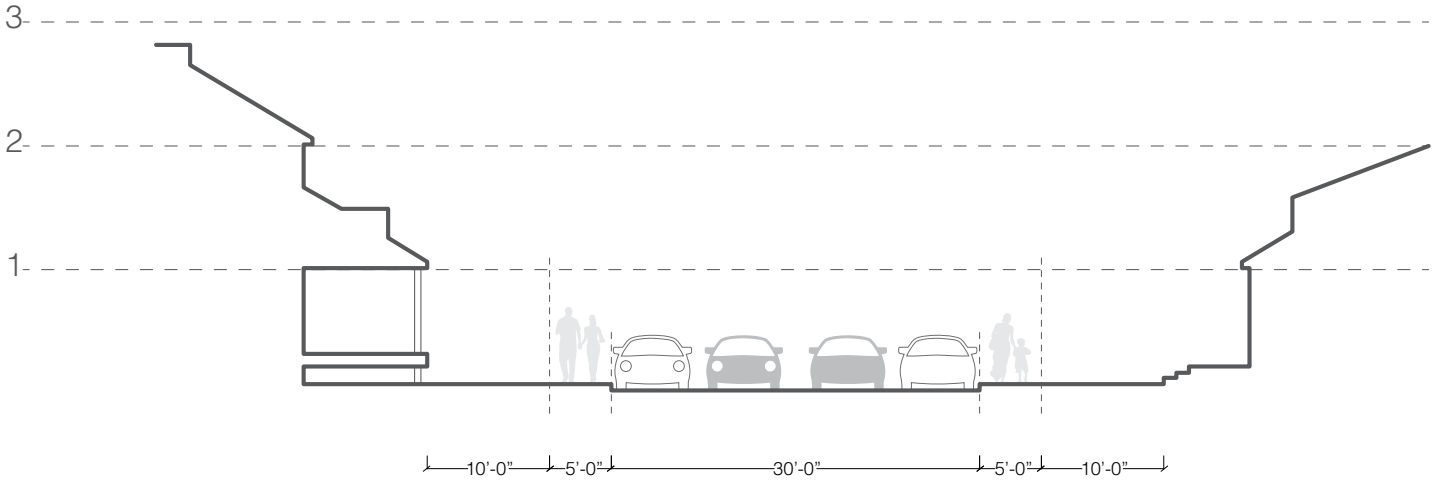
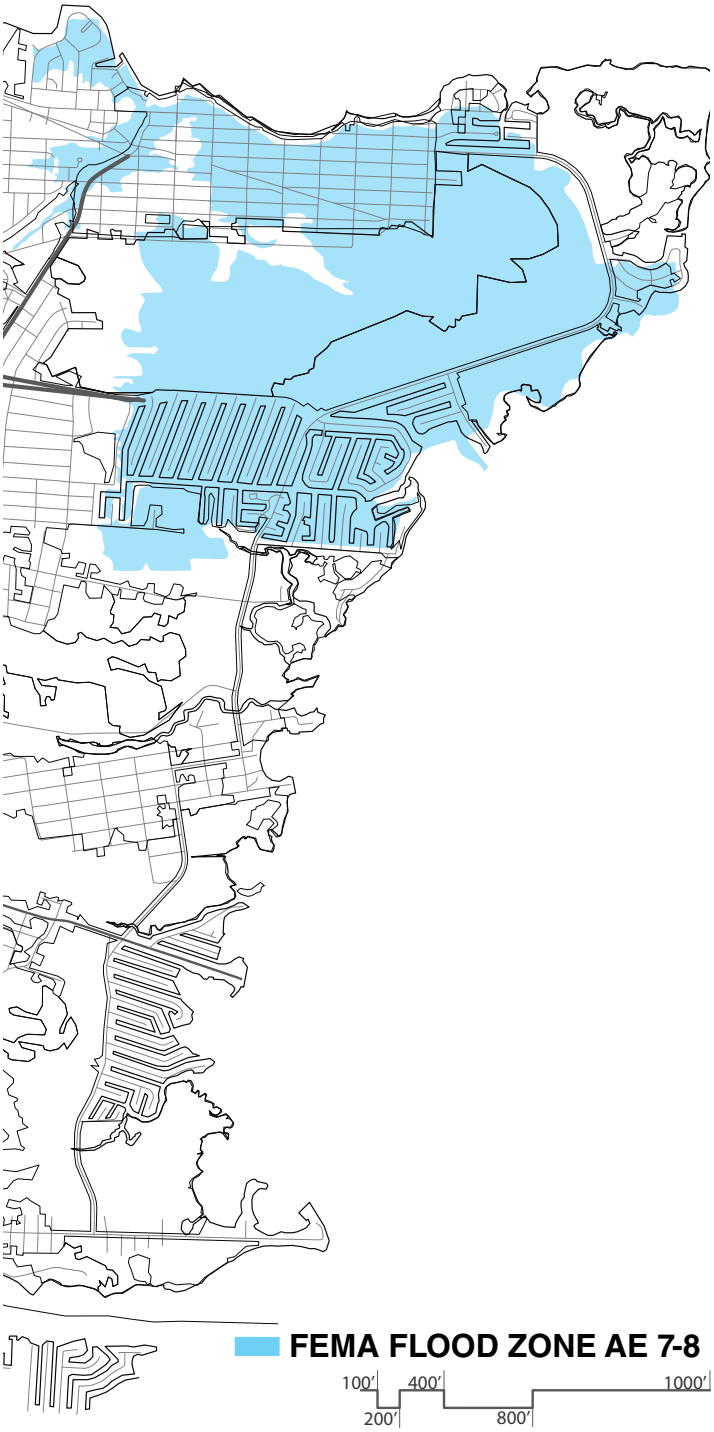


INTRODUCTORY NARRATIVE

SITE LOCATIONS

BAYVILLE



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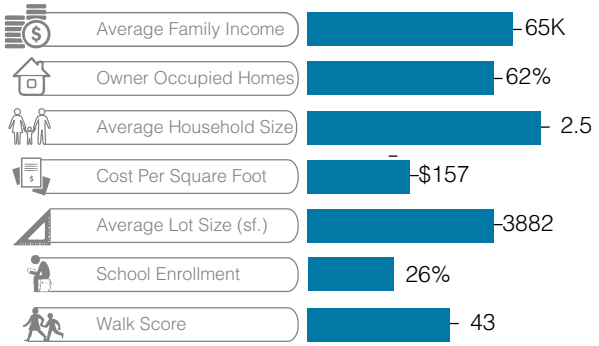

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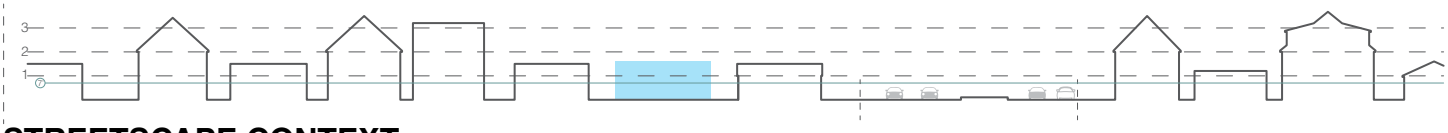

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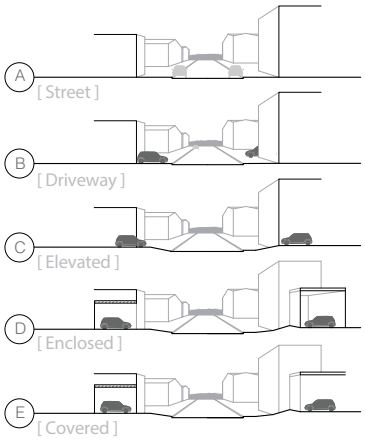

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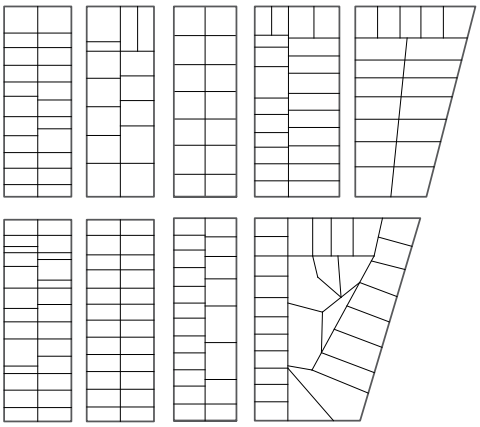

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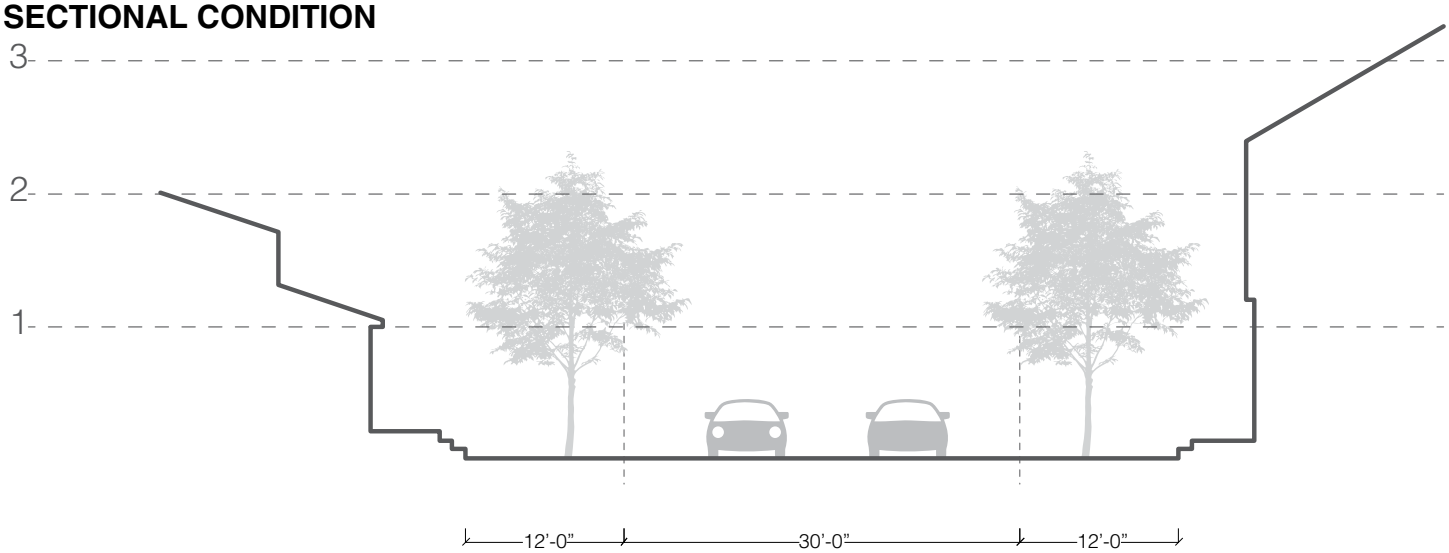
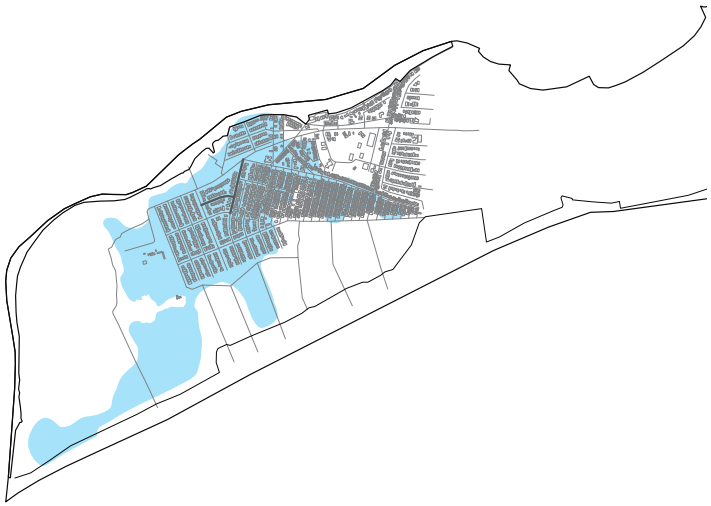


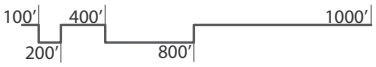
INTRODUCTORY NARRATIVE

SITE LOCATIONS

BREEZE POINT



FEMA FLOOD ZONE AE 7-8



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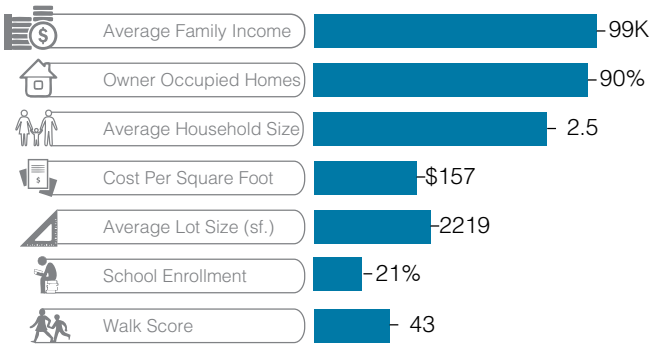

SANDY DAMAGE

BIRDS EYE VIEW

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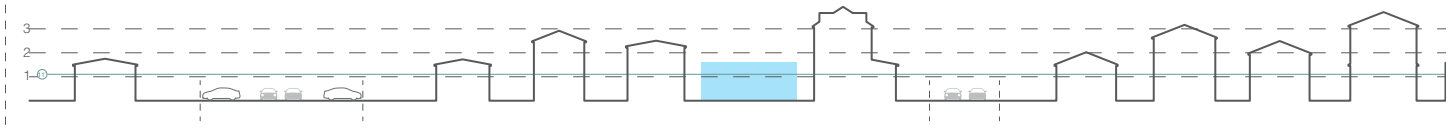
BREEZY POINT



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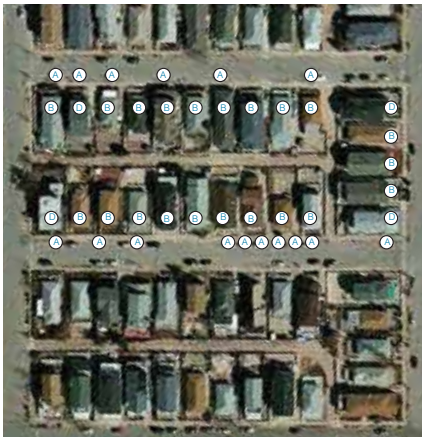

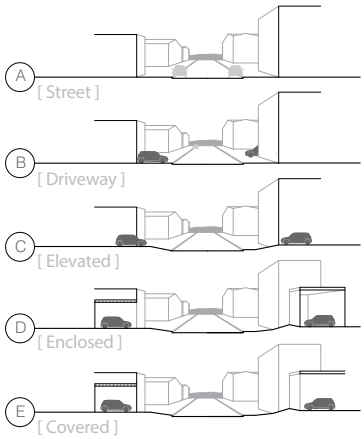

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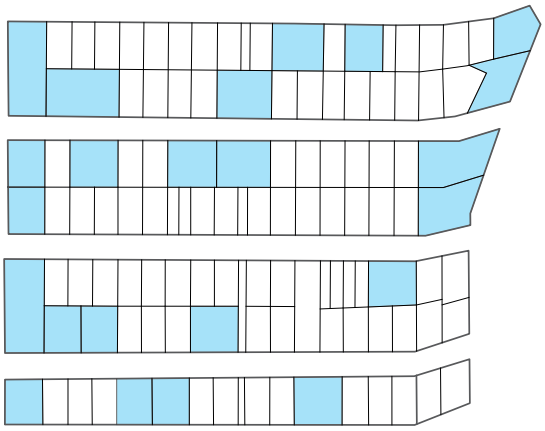
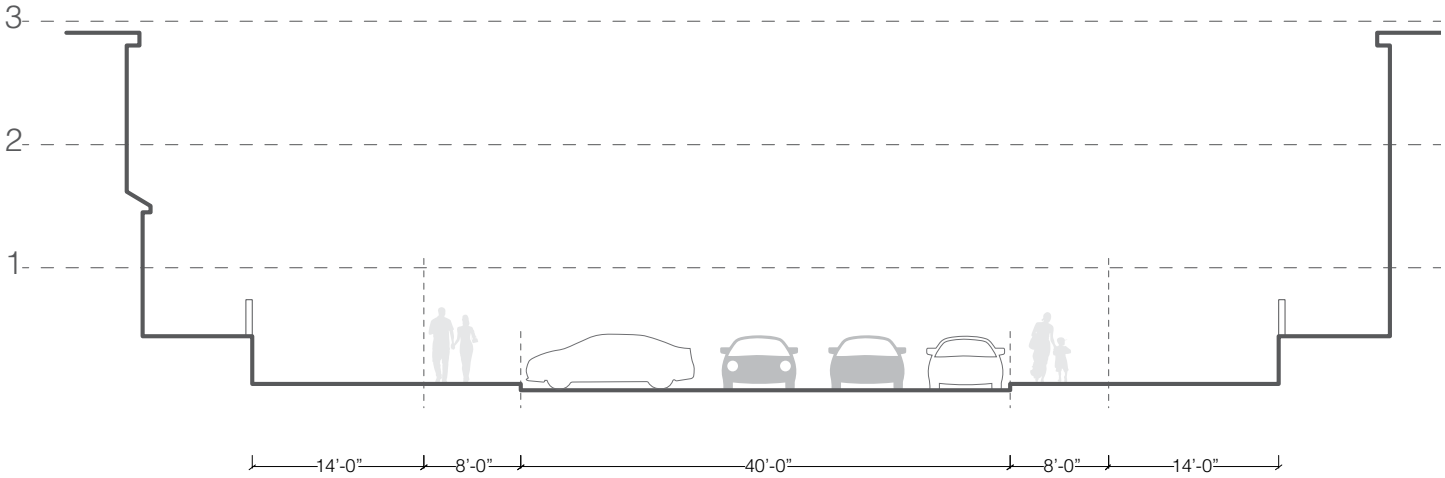


LOT SIZING

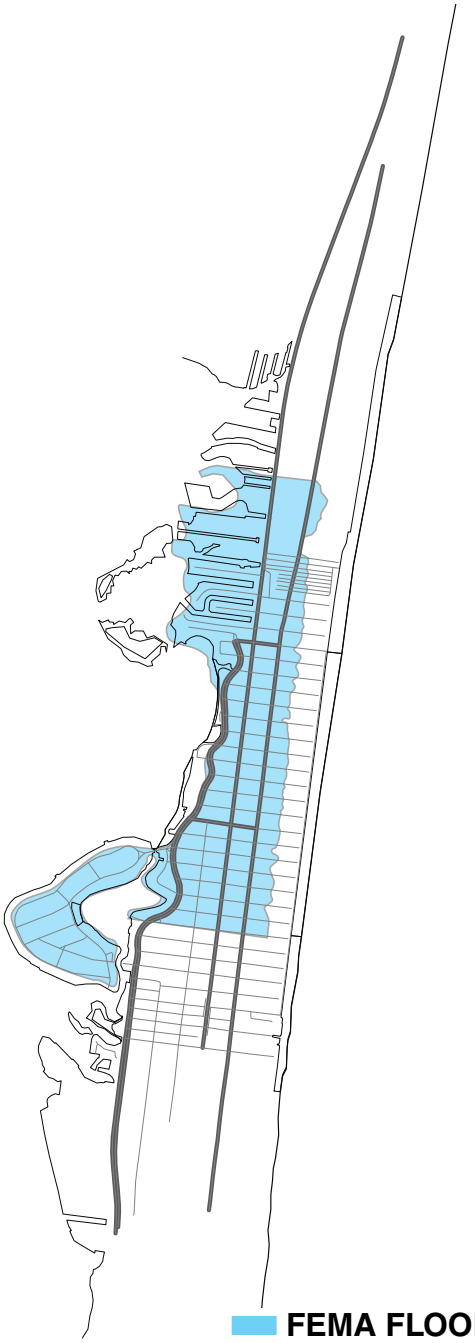
SECTIONAL CONDITION



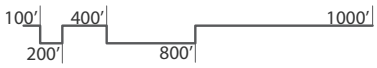
INTRODUCTORY NARRATIVE

SITE LOCATIONS

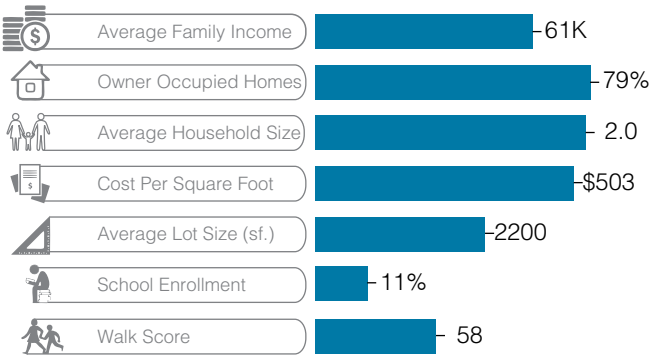
LAVALLETTE



FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



SANDY DAMAGE

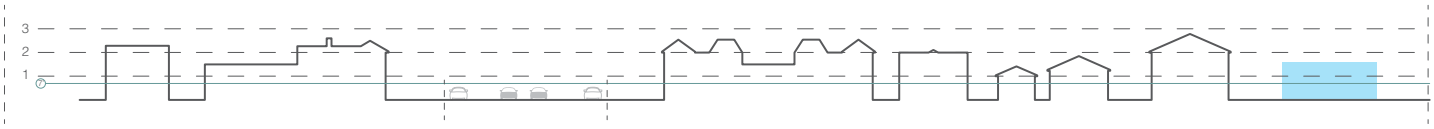
BIRDS EYE VIEW

STREET PERSPECTIVE

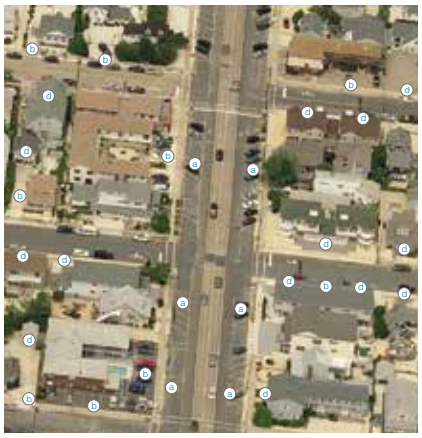
INTRODUCTORY NARRATIVE

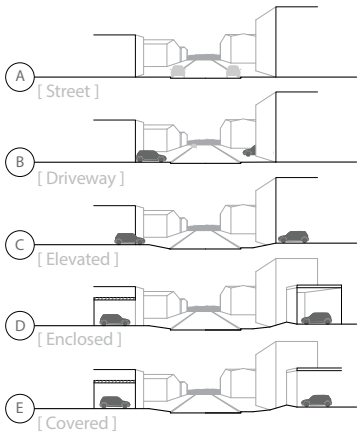
SITE LOCATIONS

LAVALLETTE

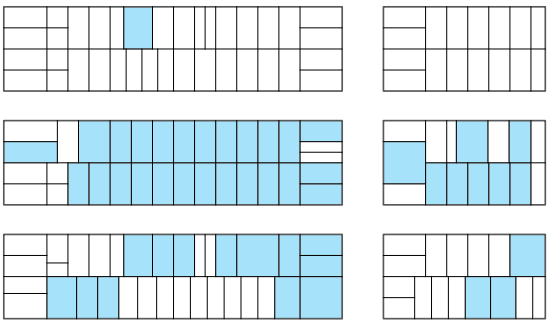


STREETSCAPE CONTEXT



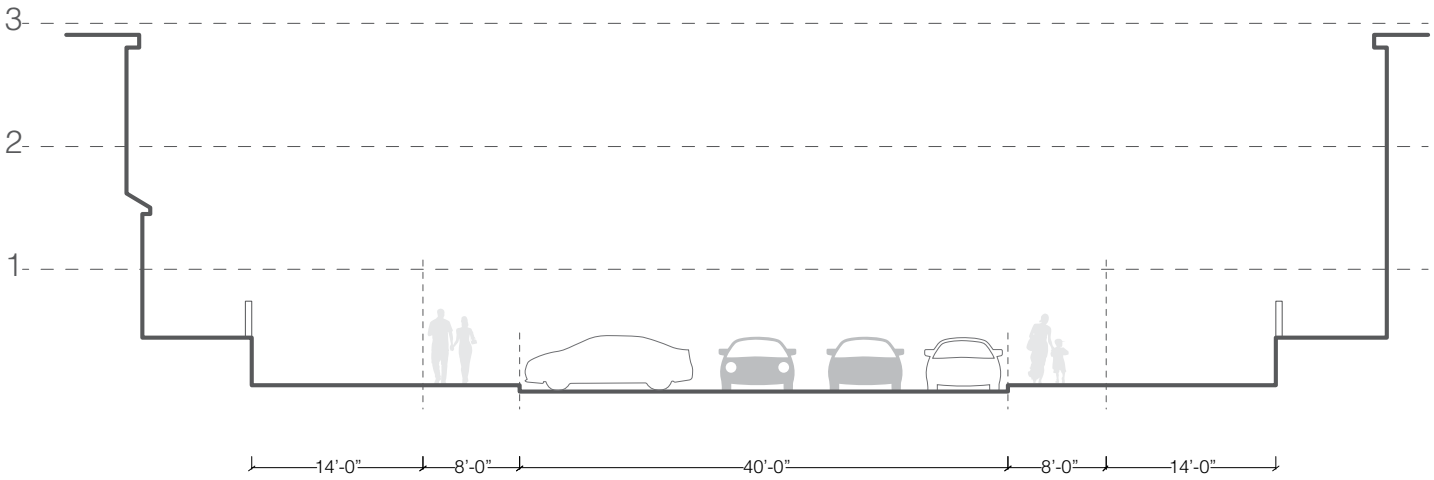


PARKING CONDITIONS



LOT SIZING

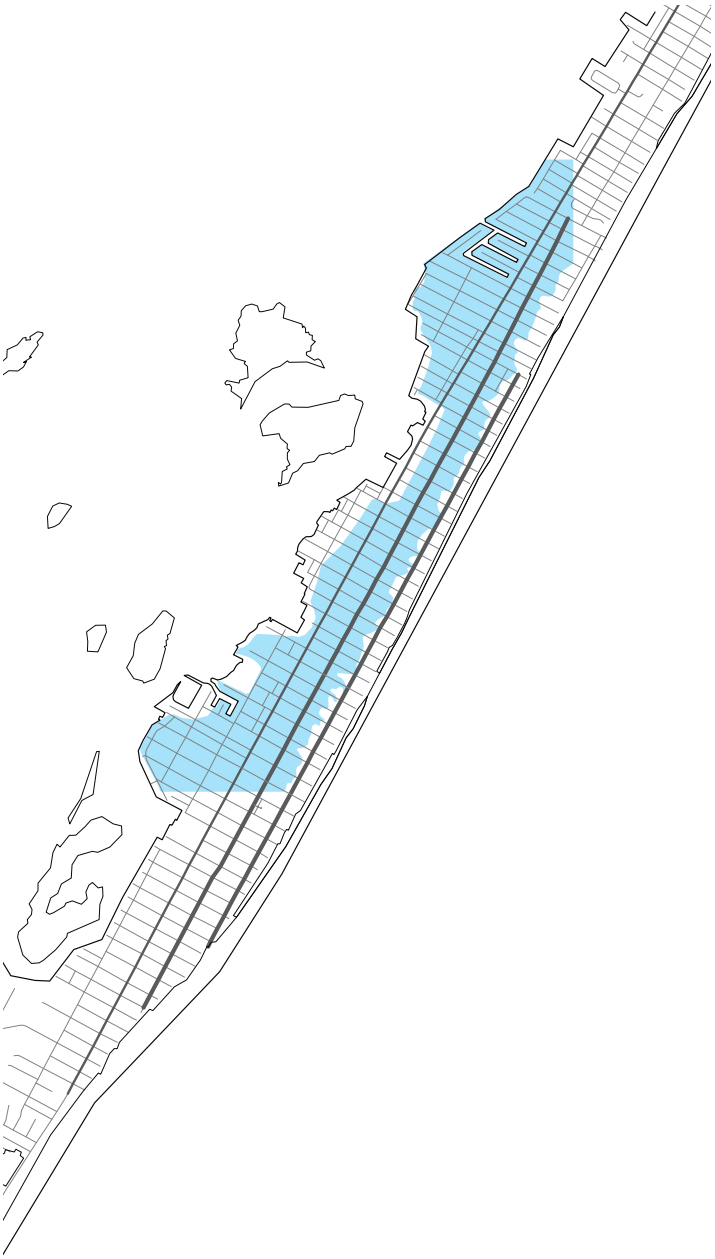
SECTIONAL CONDITION



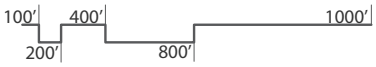
INTRODUCTORY NARRATIVE

SITE LOCATIONS

LONG BEACH



FEMA FLOOD ZONE AE 7-8



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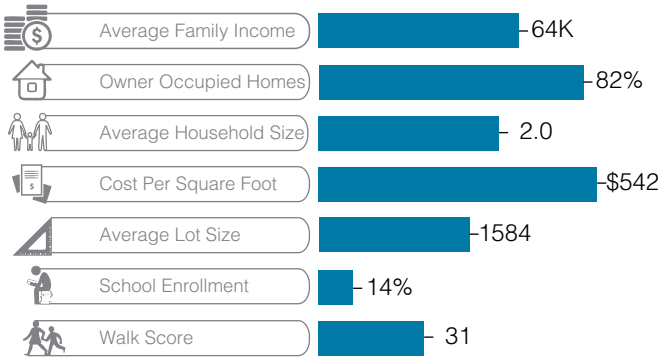


SANDY DAMAGE

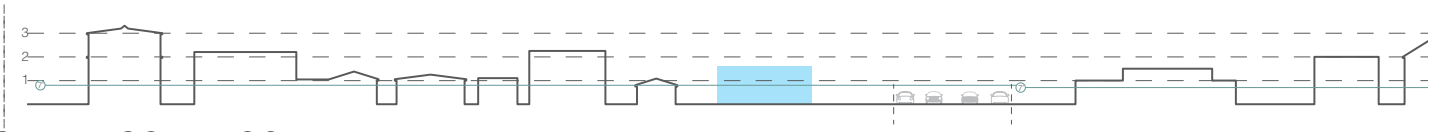
BIRDS EYE VIEW

STREET PERSPECTIVE

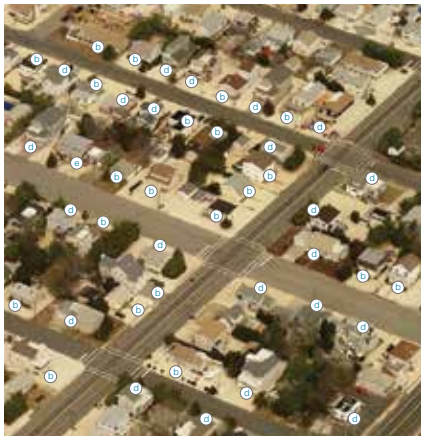
INTRODUCTORY NARRATIVE

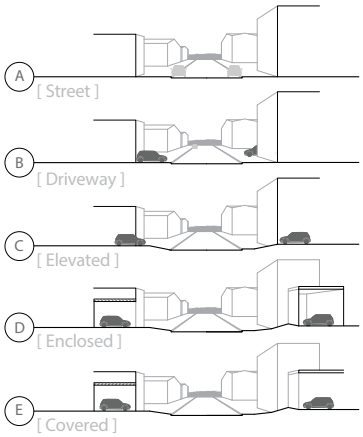
SITE LOCATIONS

LONG BEACH

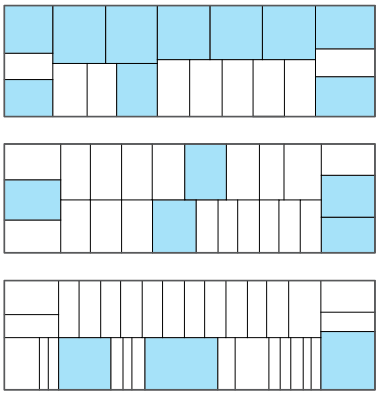


STREETSCAPE CONTEXT



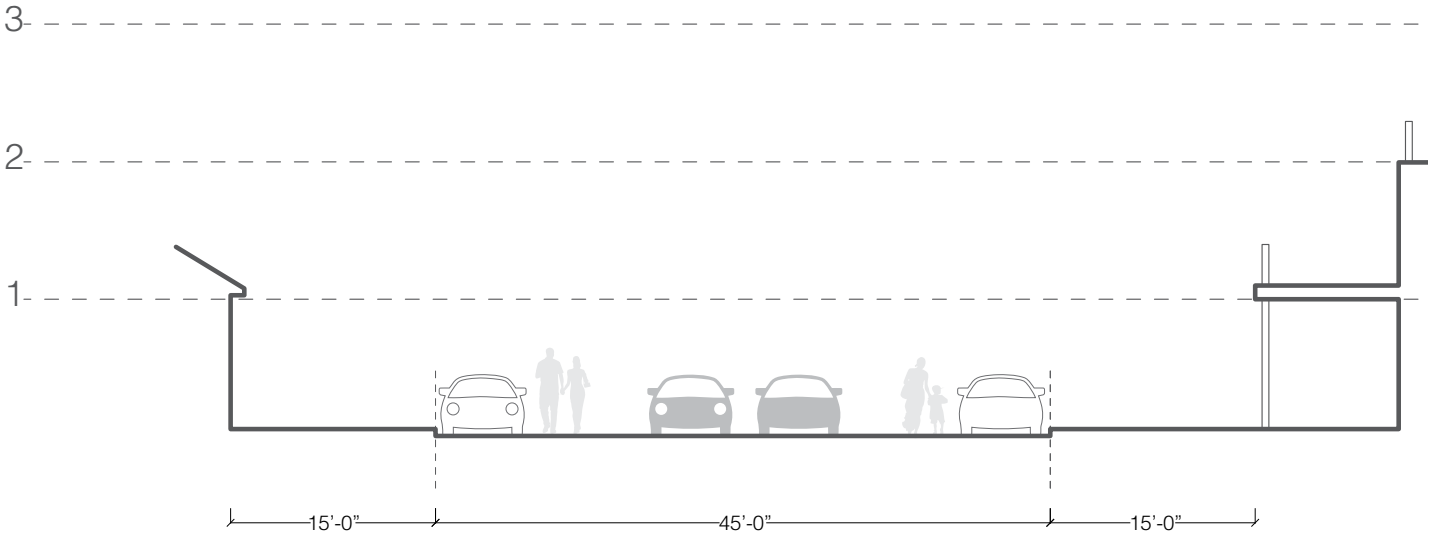


PARKING CONDITIONS



LOT SIZING

SECTIONAL CONDITION



INTRODUCTORY NARRATIVE

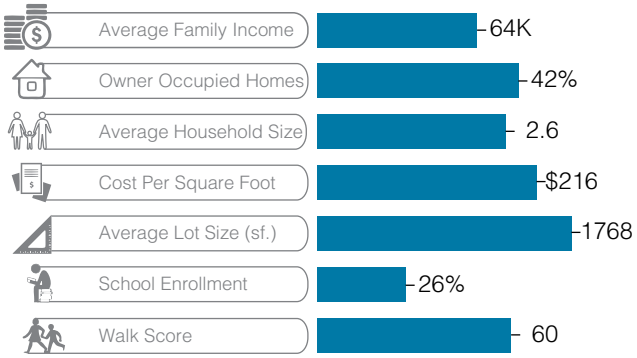
SITE LOCATIONS

LONG BRANCH

FEMA FLOOD ZONE AE 7-8

100' 200' 400' 800' 1000'

DEMOGRAPHICS



SANDY DAMAGE

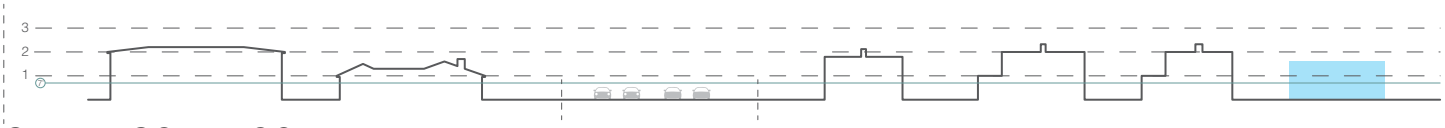
BIRDS EYE VIEW

STREET PERSPECTIVE

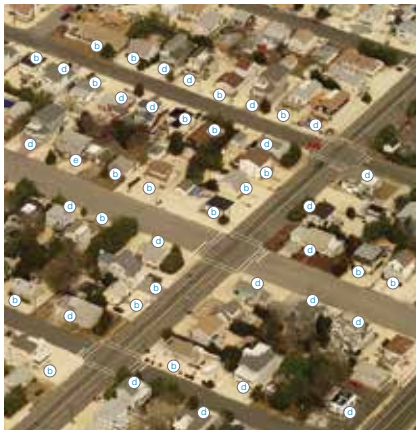
INTRODUCTORY NARRATIVE

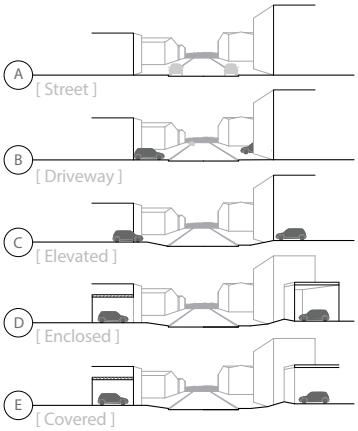
SITE LOCATIONS

LONG BRANCH

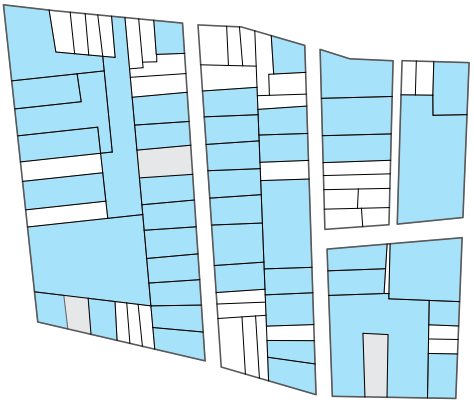


STREETSCAPE CONTEXT



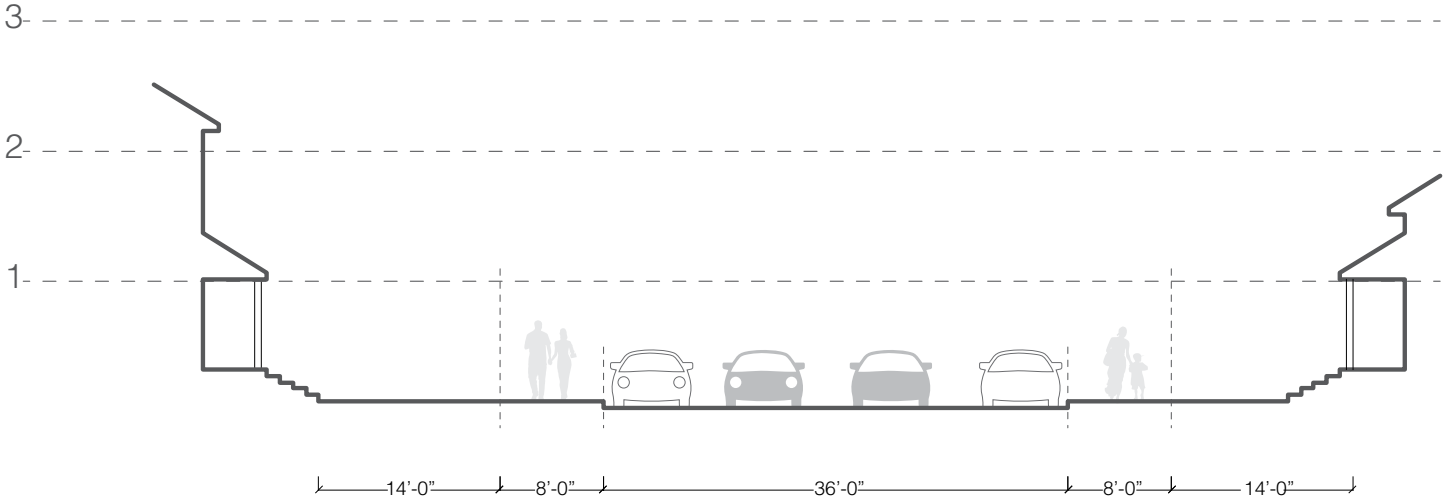


PARKING CONDITIONS



LOT SIZING

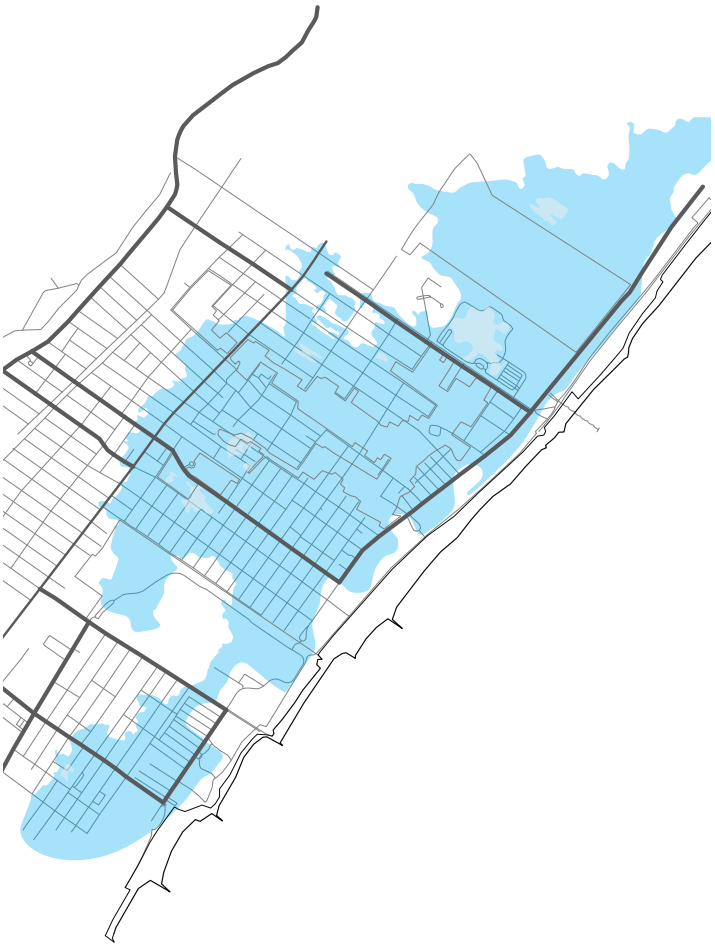
SECTIONAL CONDITION



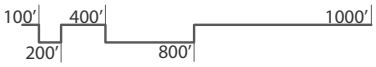
INTRODUCTORY NARRATIVE

SITE LOCATIONS

MIDLAND BEACH



FEMA FLOOD ZONE AE 7-8



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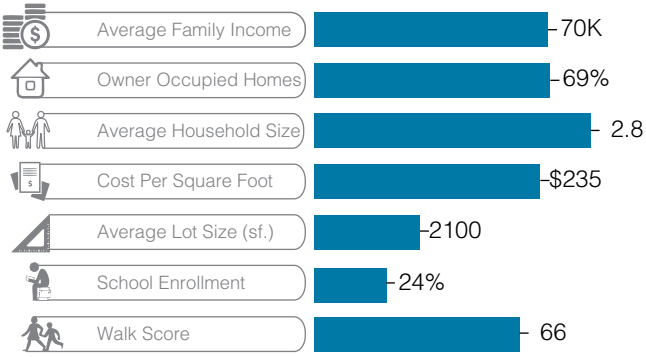


SANDY DAMAGE

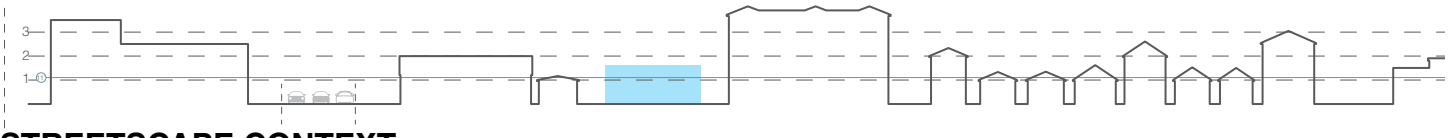
BIRDS EYE VIEW

STREET PERSPECTIVE

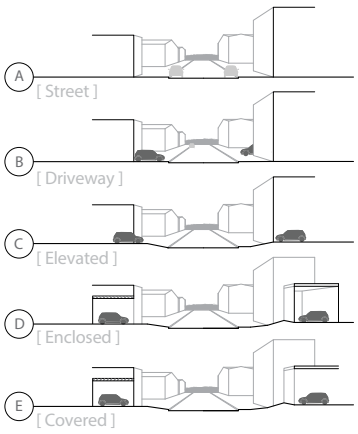
INTRODUCTORY NARRATIVE

SITE LOCATIONS

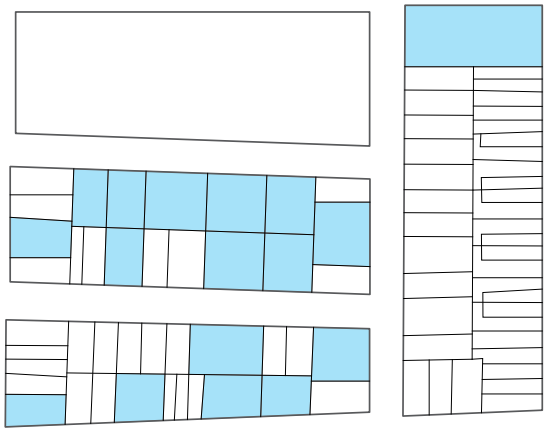
MIDLAND BEACH



STREETSCAPE CONTEXT

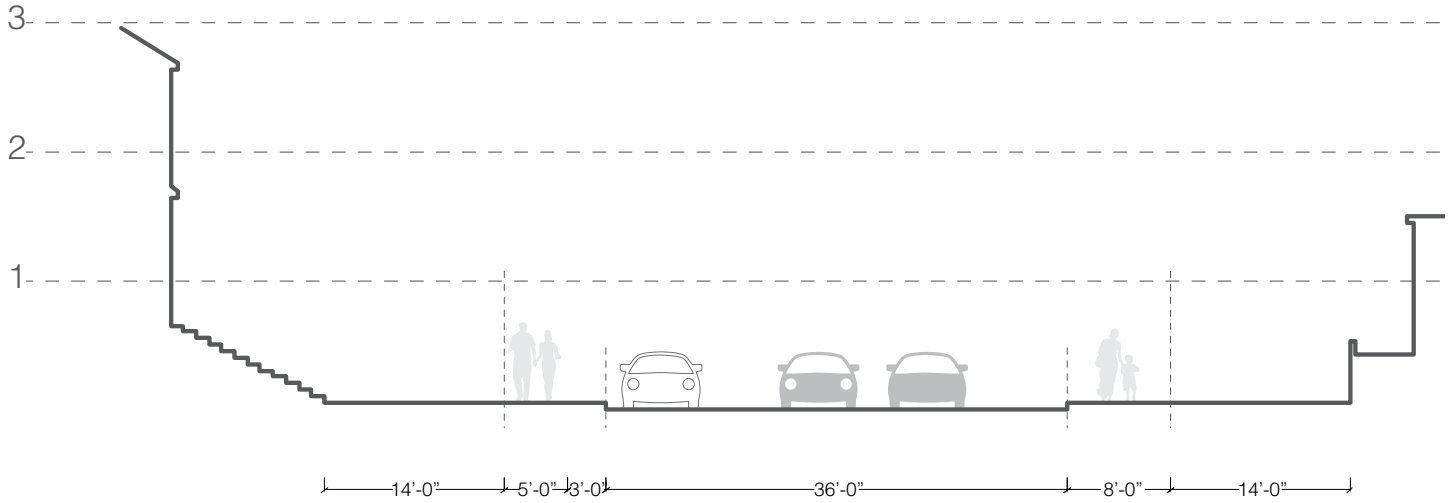


PARKING CONDITIONS



LOT SIZING

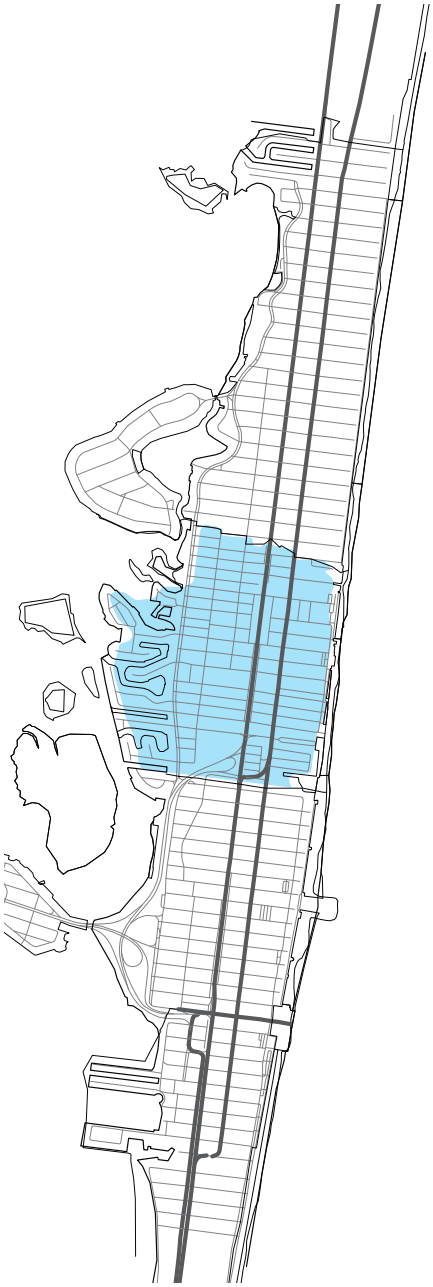
SECTIONAL CONDITION



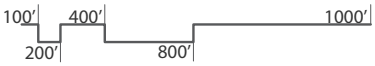
INTRODUCTORY NARRATIVE

SITE LOCATIONS

ORTLEY BEACH



FEMA FLOOD ZONE AE 7-8



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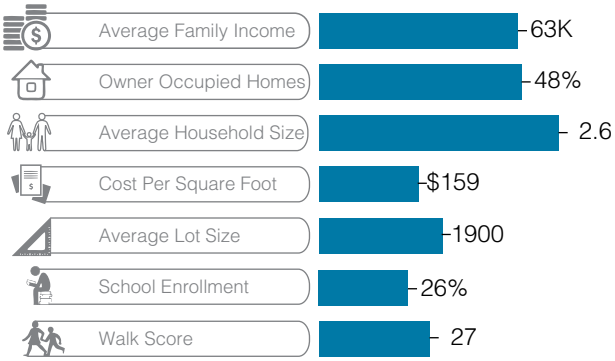


SANDY DAMAGE

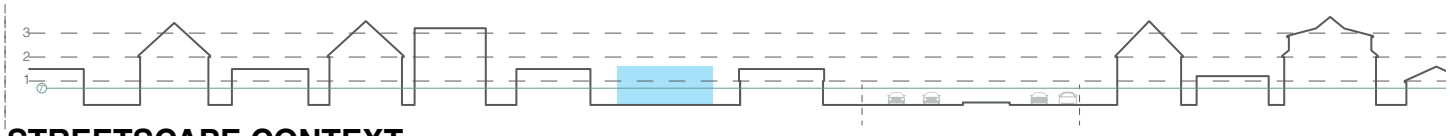
BIRDS EYE VIEW

STREET PERSPECTIVE

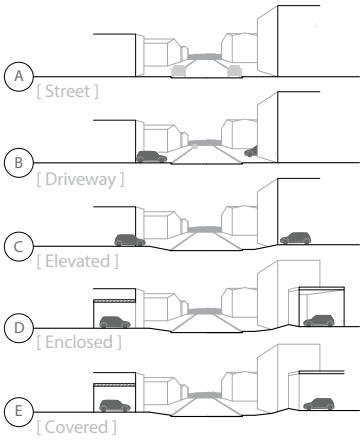
INTRODUCTORY NARRATIVE

SITE LOCATIONS

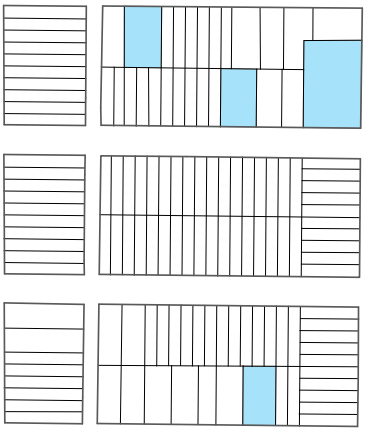
ORTLEY BEACH



STREETSCAPE CONTEXT

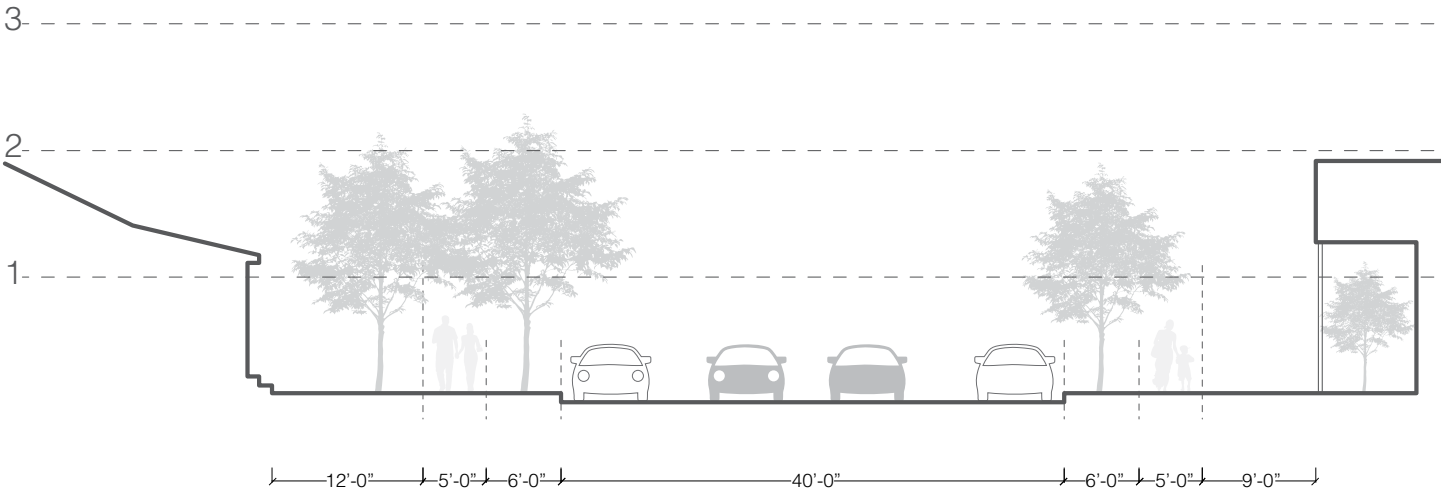


PARKING CONDITIONS



LOT SIZING

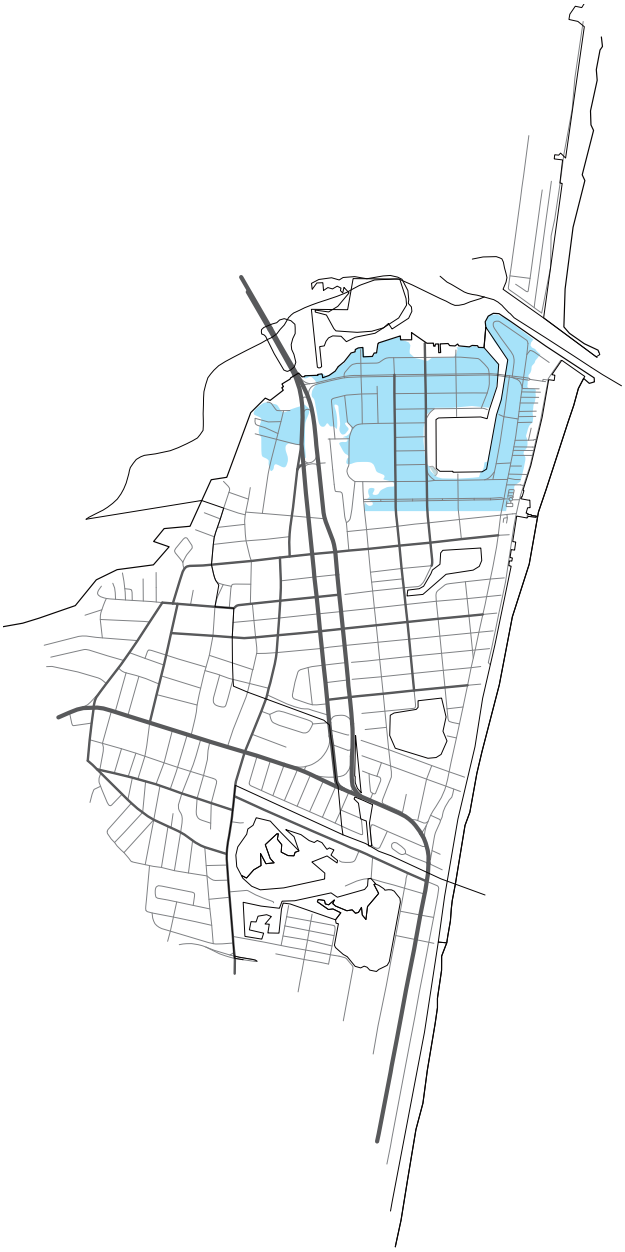
SECTIONAL CONDITION



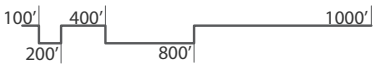
INTRODUCTORY NARRATIVE

SITE LOCATIONS

POINT PLEASANT BEACH



FEMA FLOOD ZONE AE 7-8



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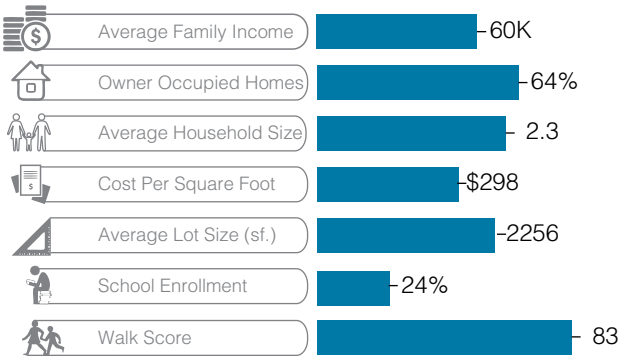


SANDY DAMAGE

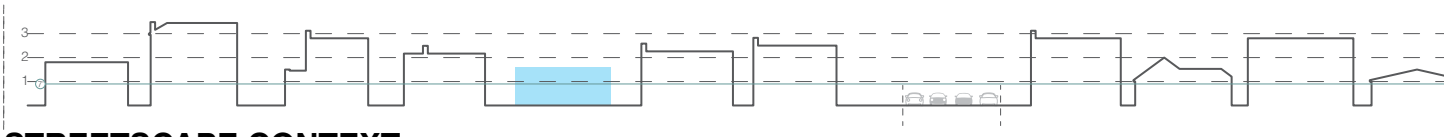
BIRDS EYE VIEW

STREET PERSPECTIVE

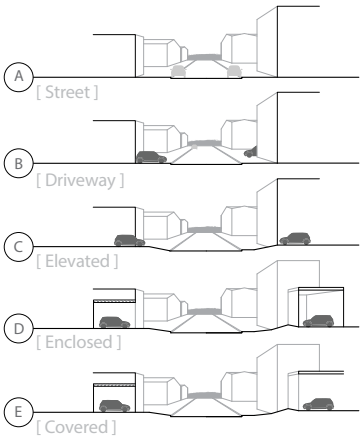
INTRODUCTORY NARRATIVE

SITE LOCATIONS

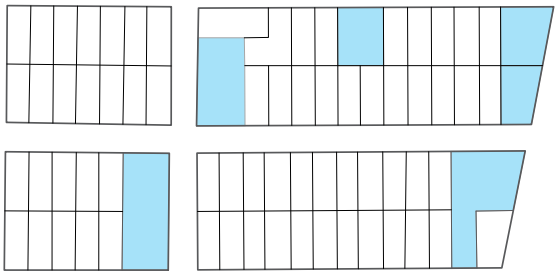
POINT PLEASANT BEACH



STREETSCAPE CONTEXT

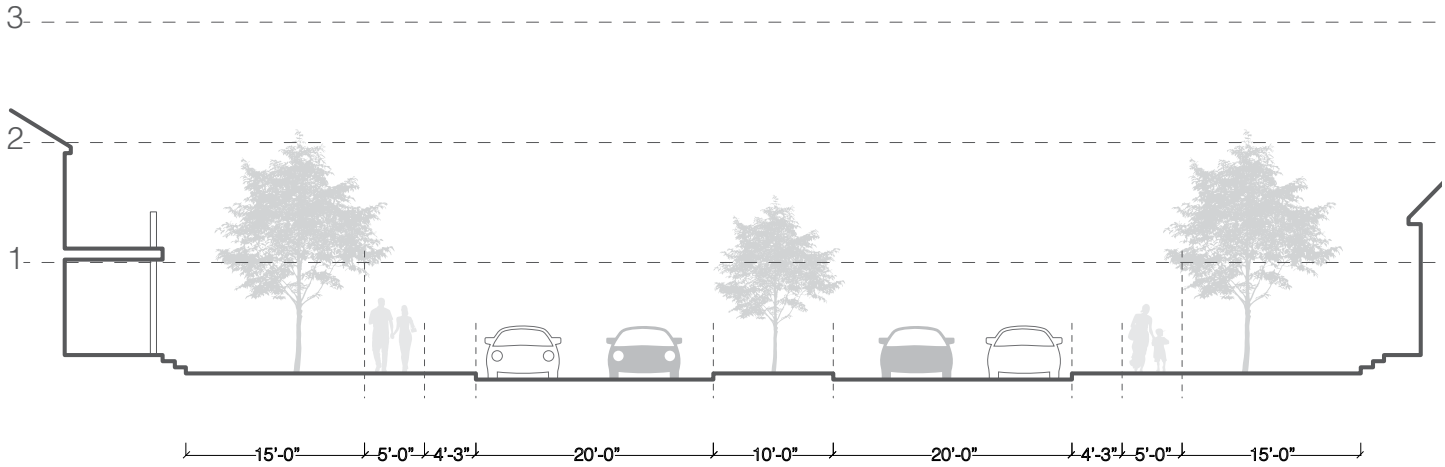


PARKING CONDITIONS



LOT SIZING

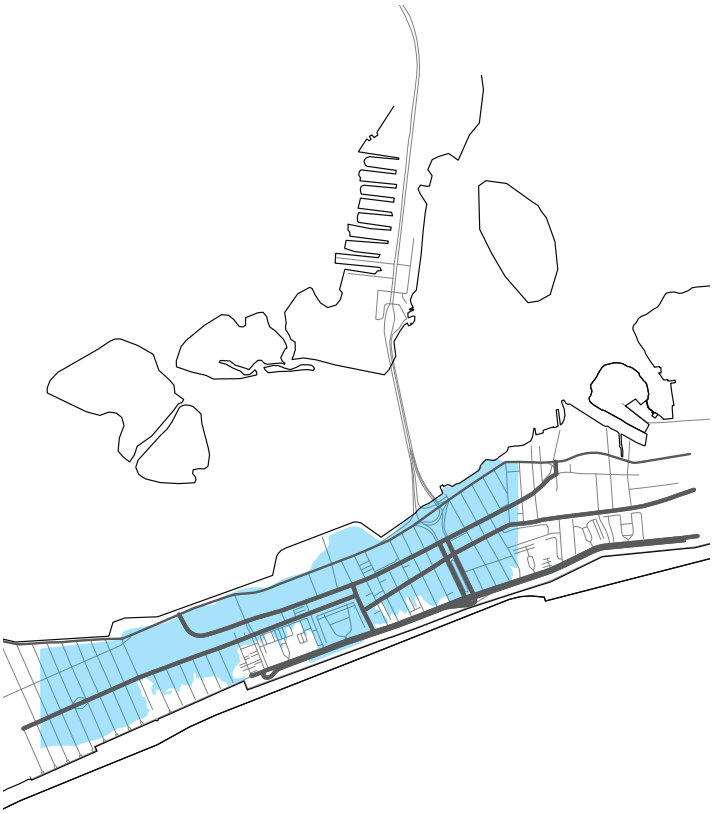
SECTIONAL CONDITION



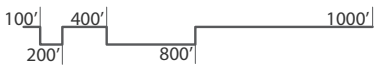
INTRODUCTORY NARRATIVE

SITE LOCATIONS

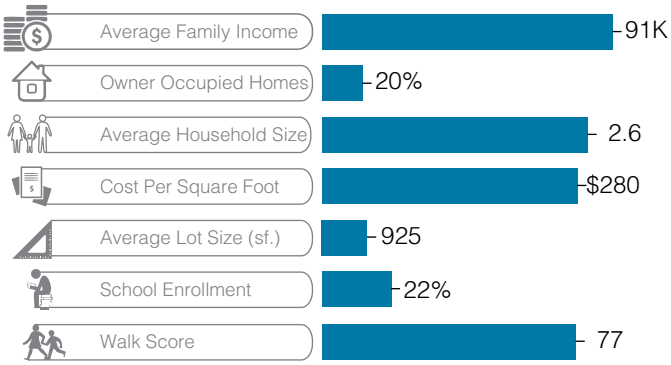
ROCKAWAY BEACH



FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



SANDY DAMAGE

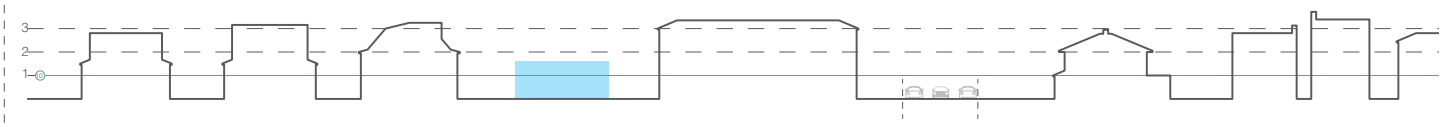
BIRDS EYE VIEW

STREET PERSPECTIVE

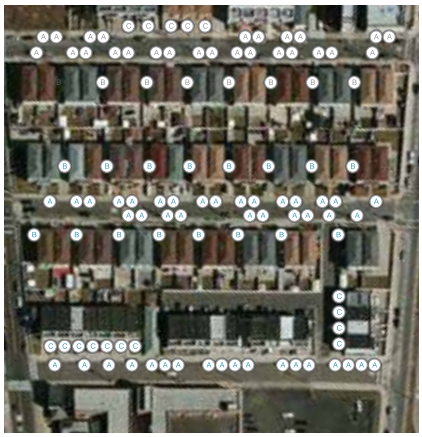
INTRODUCTORY NARRATIVE

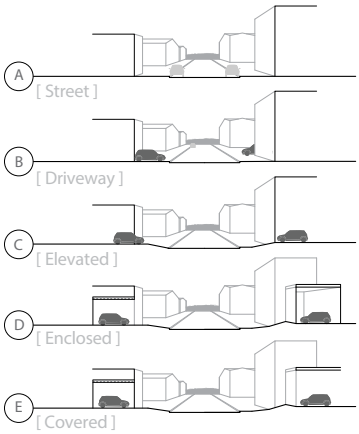
SITE LOCATIONS

ROCKAWAY BEACH

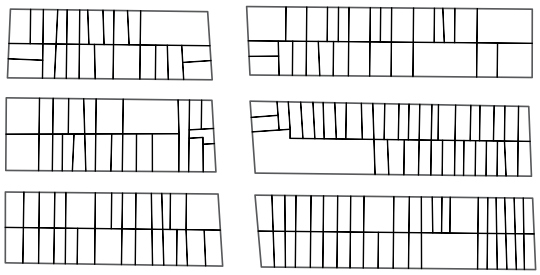


STREETSCAPE CONTEXT



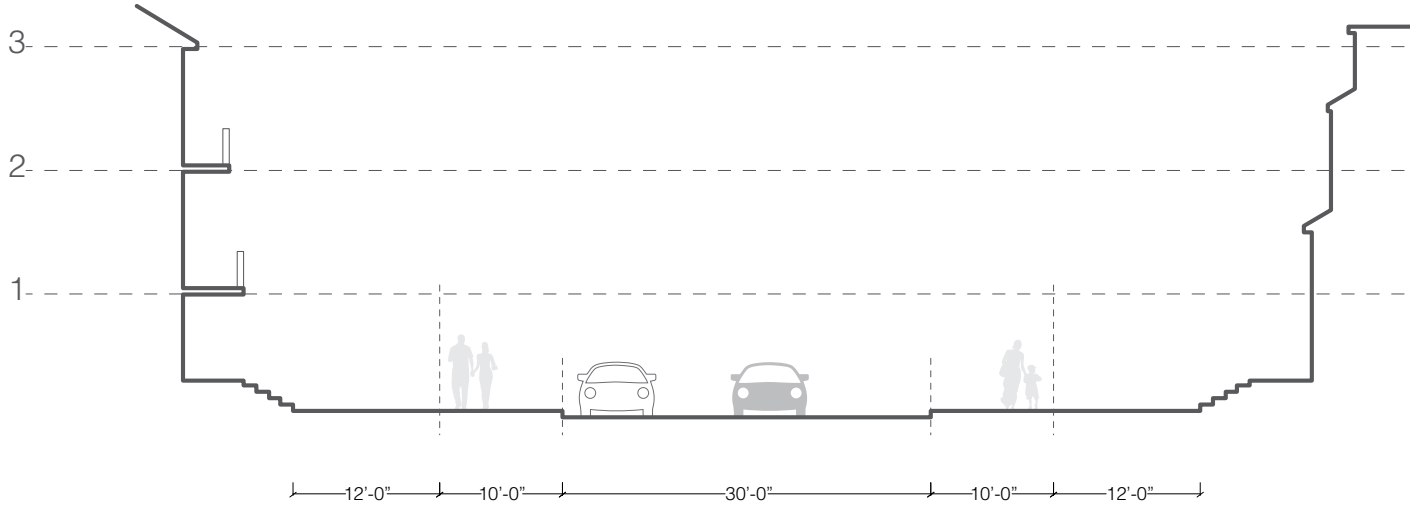


PARKING CONDITIONS



LOT SIZING

SECTIONAL CONDITION

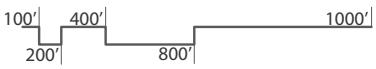


INTRODUCTORY NARRATIVE

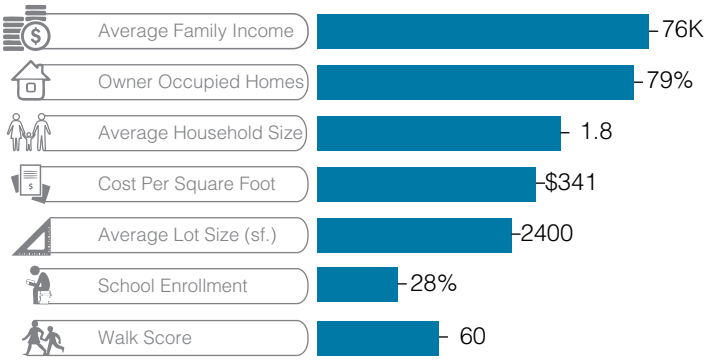
SITE LOCATIONS

SEA BRIGHT

FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



SANDY DAMAGE

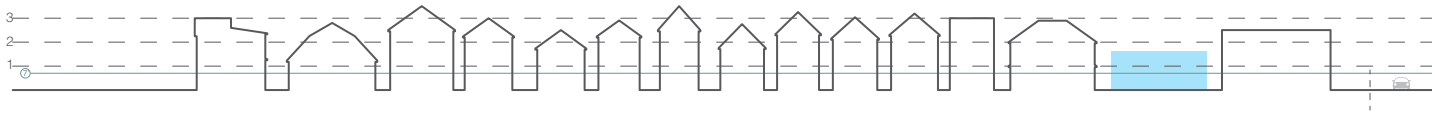
BIRDS EYE VIEW

STREET PERSPECTIVE

INTRODUCTORY NARRATIVE

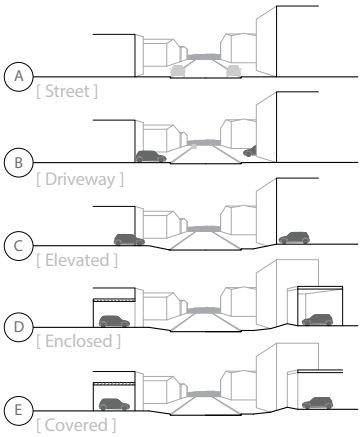
SITE LOCATIONS

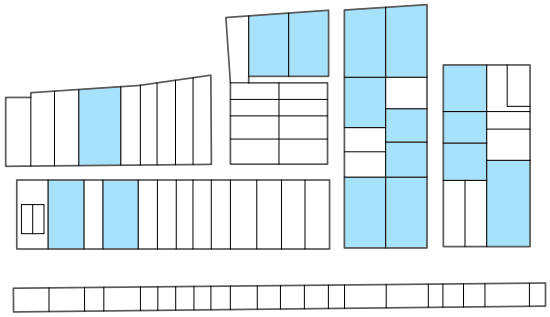
SEA BRIGHT



STREETSCAPE CONTEXT

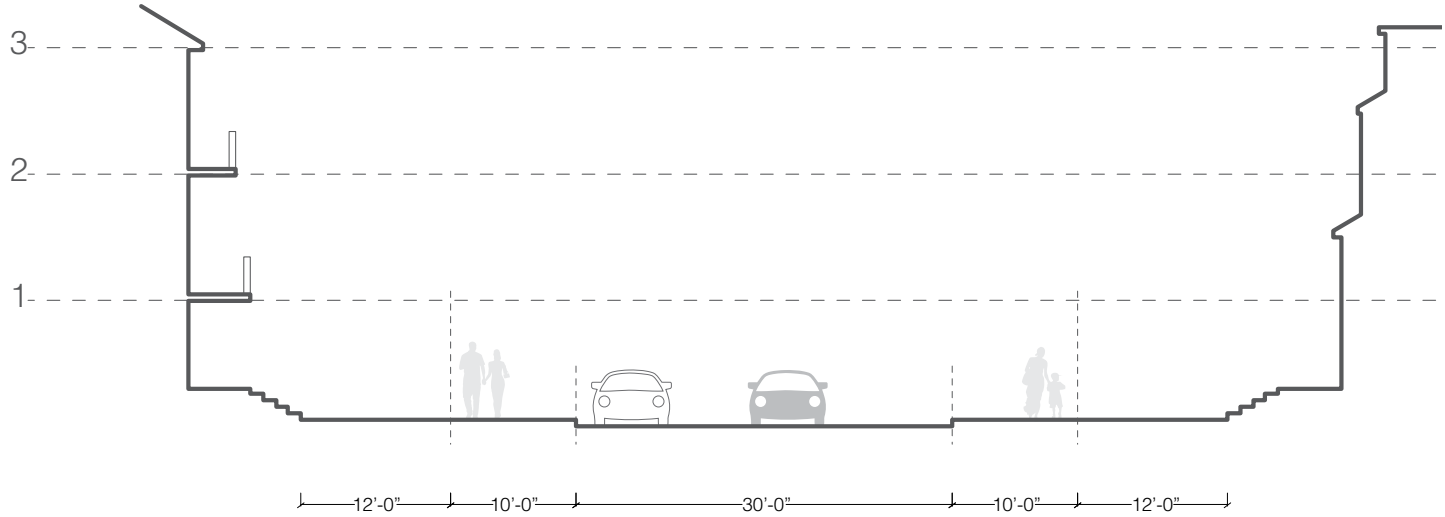
PARKING CONDITIONS





LOT SIZING

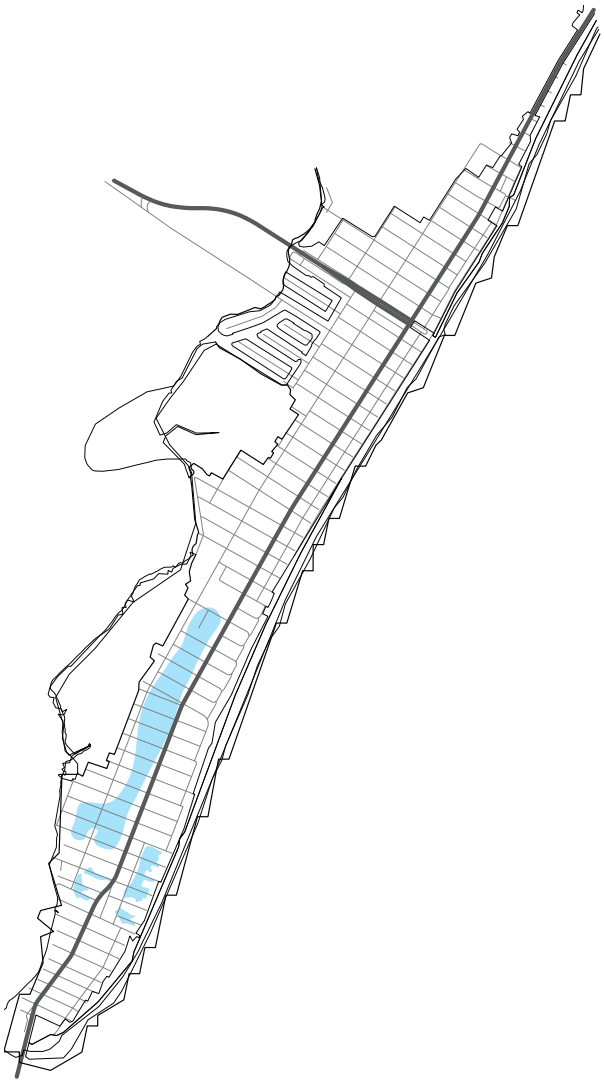
SECTIONAL CONDITION



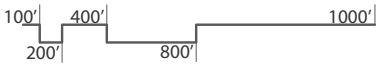
INTRODUCTORY NARRATIVE

SITE LOCATIONS

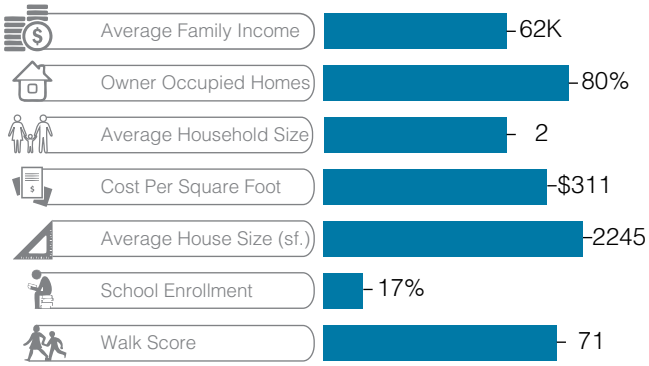
SEA ISLE CITY



FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



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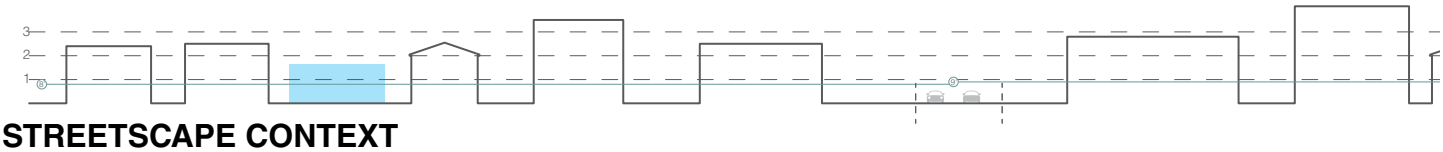
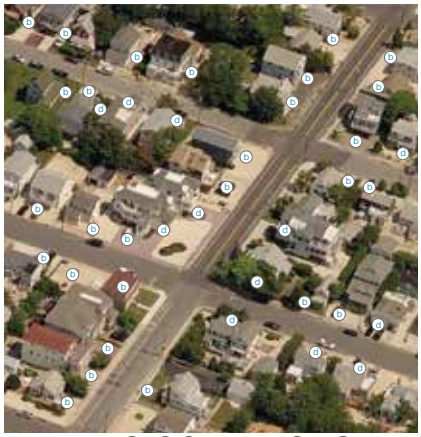
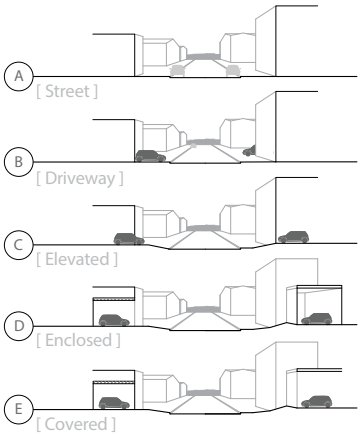
SITE LOCATIONS

SEA ISLE CITY

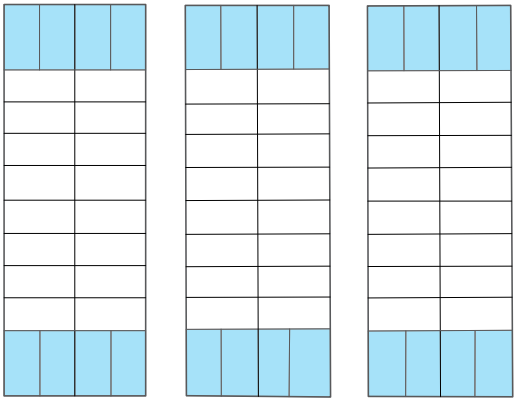


STREETSCAPE CONTEXT



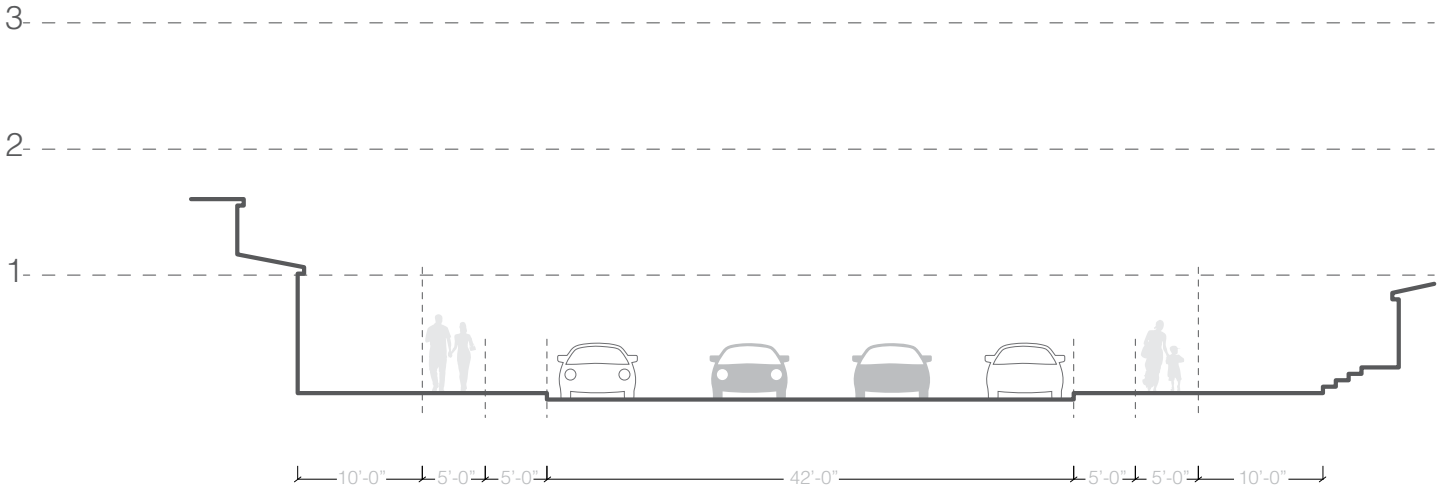


PARKING CONDITIONS



LOT SIZING

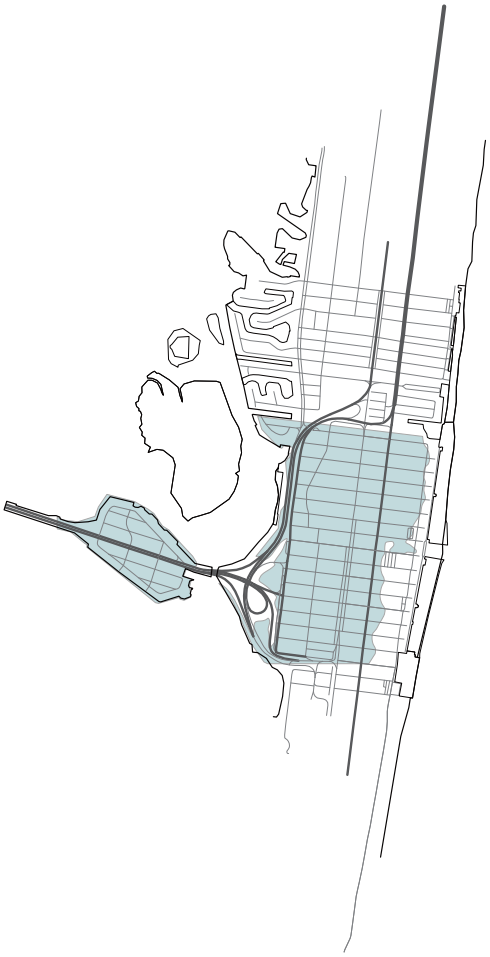
SECTIONAL CONDITION



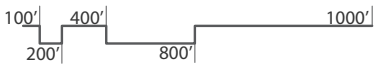
INTRODUCTORY NARRATIVE

SITE LOCATIONS

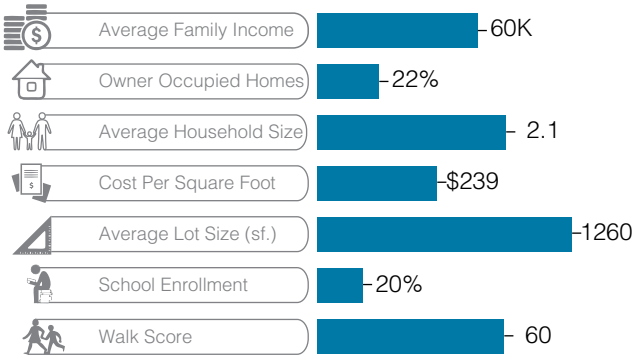
SEASIDE HEIGHTS



FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



SANDY DAMAGE

BIRDS EYE VIEW

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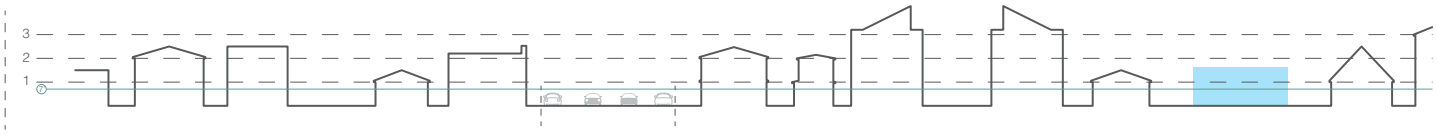
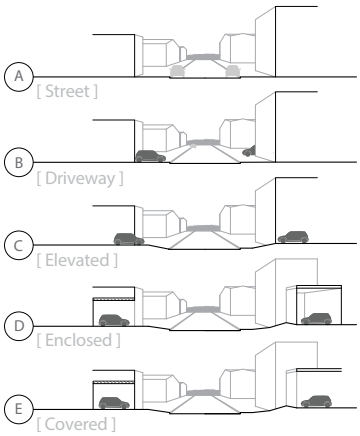
SITE LOCATIONS

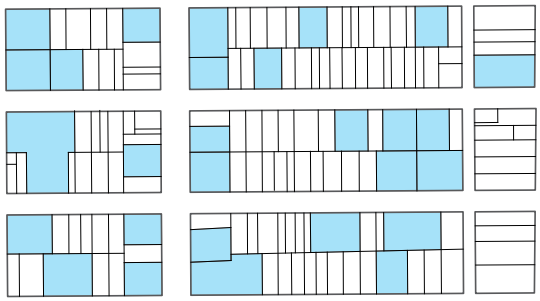
Seaside Heights



STREETSCAPE CONTEXT

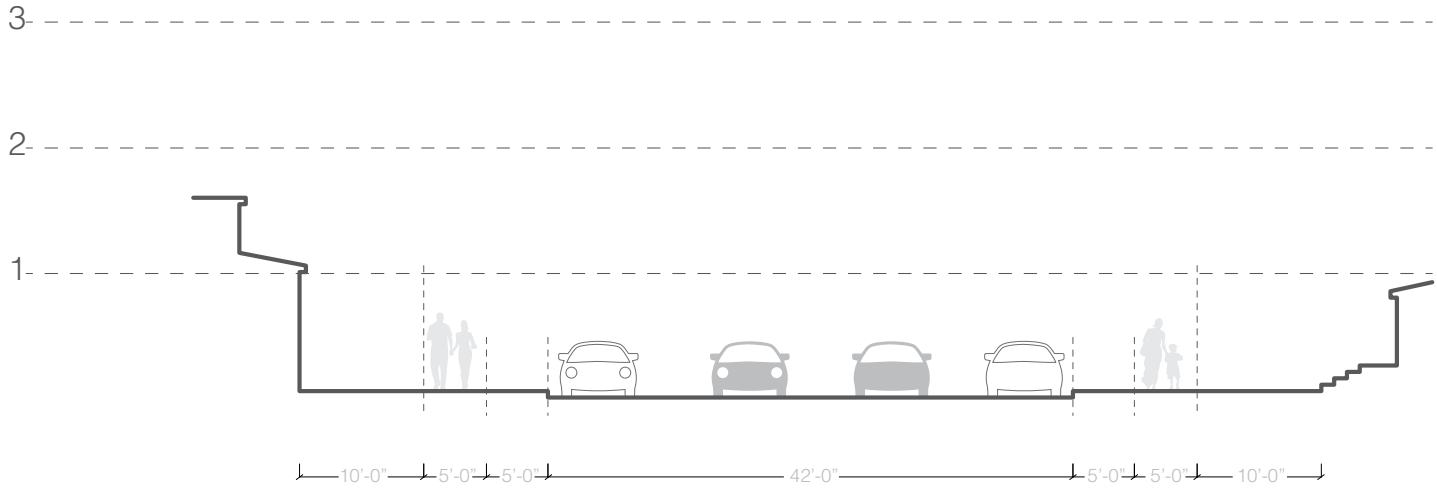


PARKING CONDITIONS



LOT SIZING

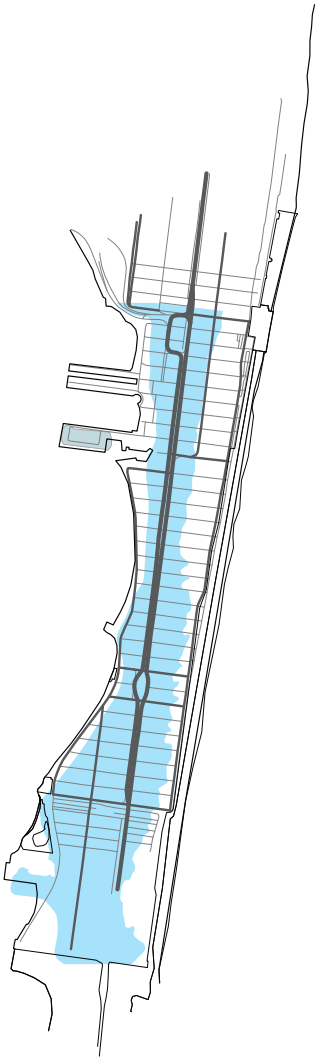
SECTIONAL CONDITION



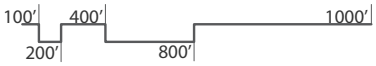
INTRODUCTORY NARRATIVE

SITE LOCATIONS

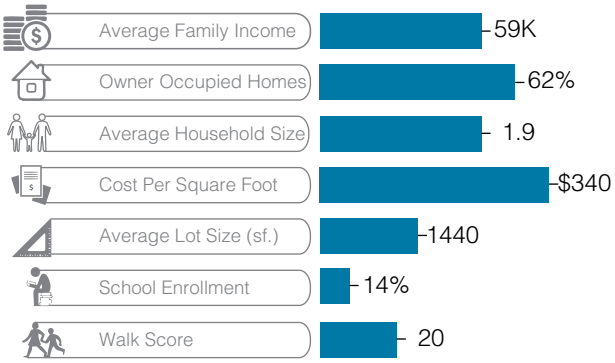
SEASIDE PARK



FEMA FLOOD ZONE AE 7-8



DEMOGRAPHICS



SANDY DAMAGE

BIRDS EYE VIEW

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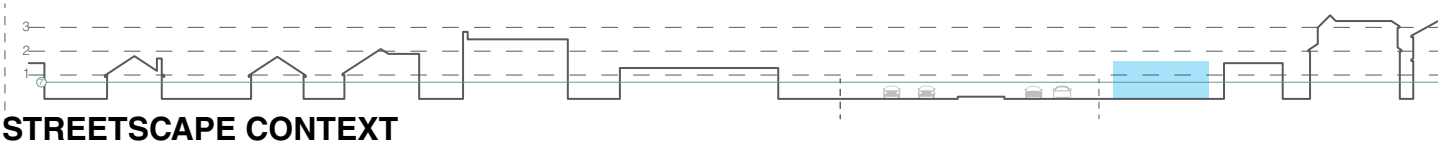
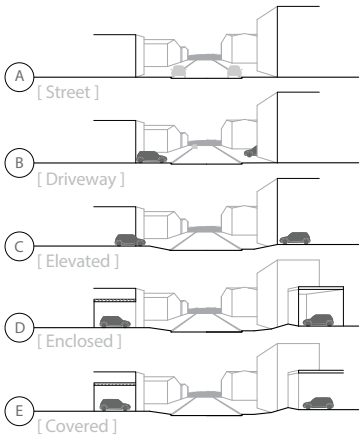
SITE LOCATIONS

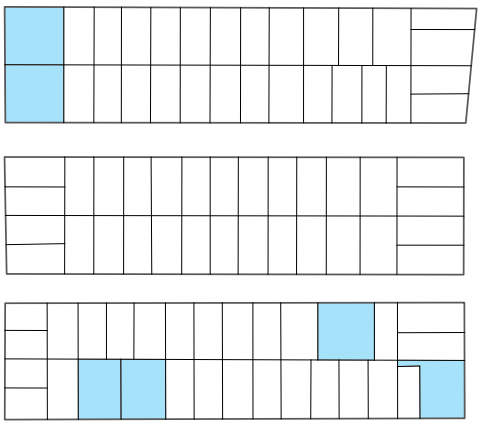
SEASIDE PARK



STREETSCAPE CONTEXT

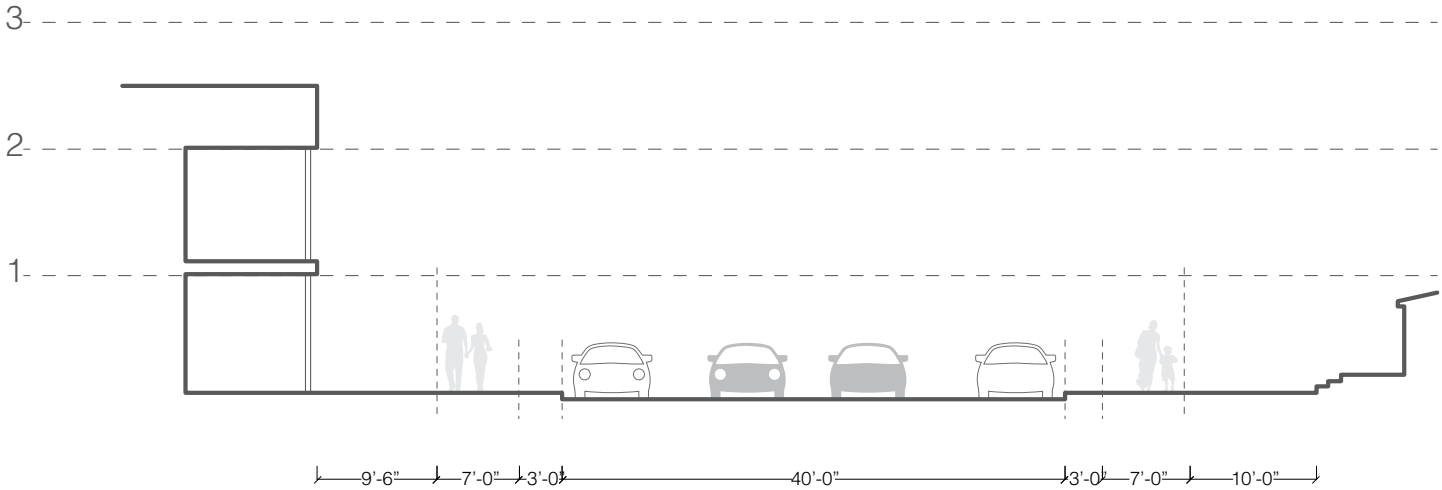
PARKING CONDITIONS





LOT SIZING

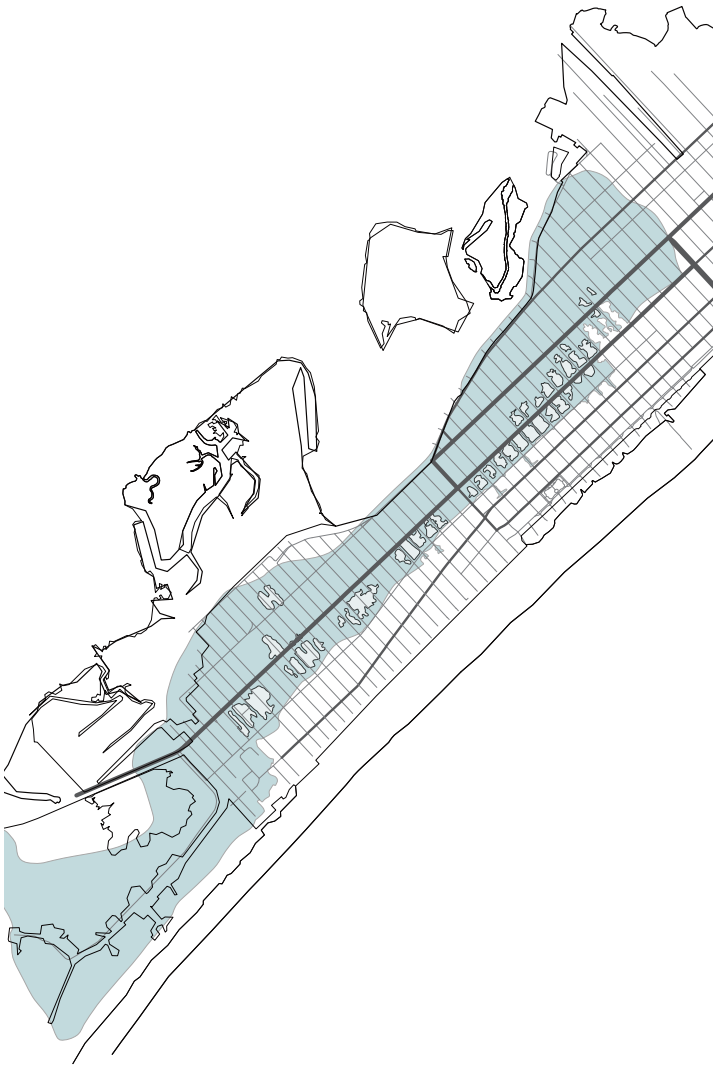
SECTIONAL CONDITION



INTRODUCTORY NARRATIVE

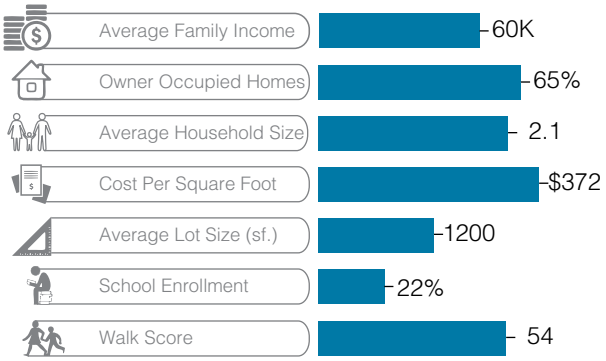
SITE LOCATIONS

WILDWOOD CREST



FEMA FLOOD ZONE AE 7-8

DEMOGRAPHICS



SANDY DAMAGE

BIRDS EYE VIEW

STREET PERSPECTIVE

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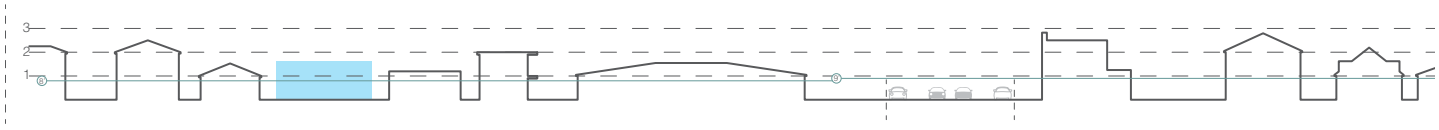
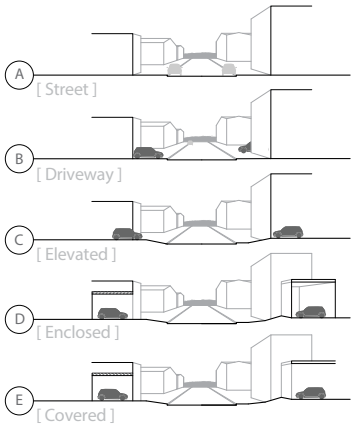
SITE LOCATIONS

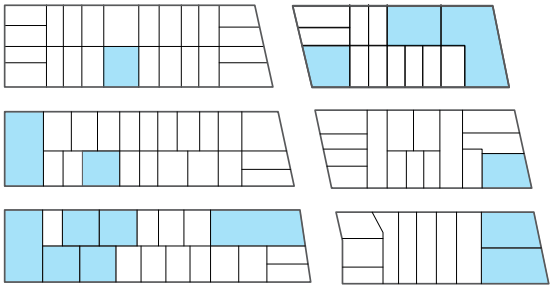
WILDWOOD CREST



STREETSCAPE CONTEXT

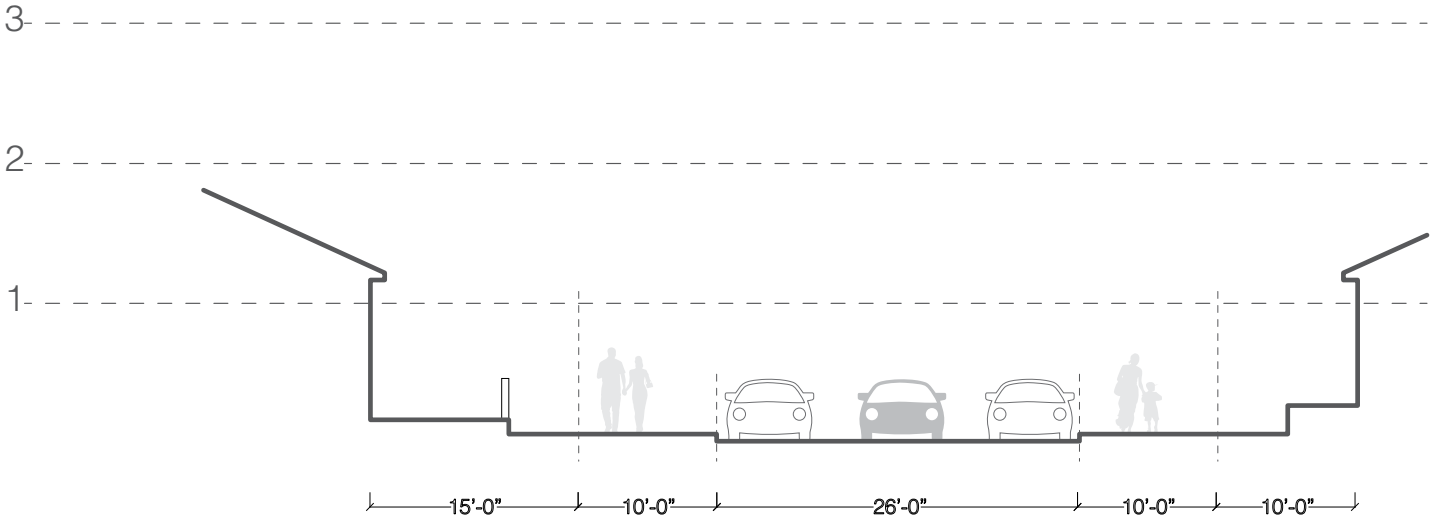


PARKING CONDITIONS



LOT SIZING

SECTIONAL CONDITION



INTRODUCTORY NARRATIVE

CONCLUSION

The impact of Hurricane Sandy, which made landfall in October 2012, cannot be overstated. With over $68 billion dollars in damage, over 280 people killed and almost 350,000 homes damaged or destroyed in New Jersey alone, Hurricane Sandy has redifined what it means to live along the shore today.

The SURE house prototype addresses the need for sustinable, resilient homes in communities along the New Jersey and New York shorelines.

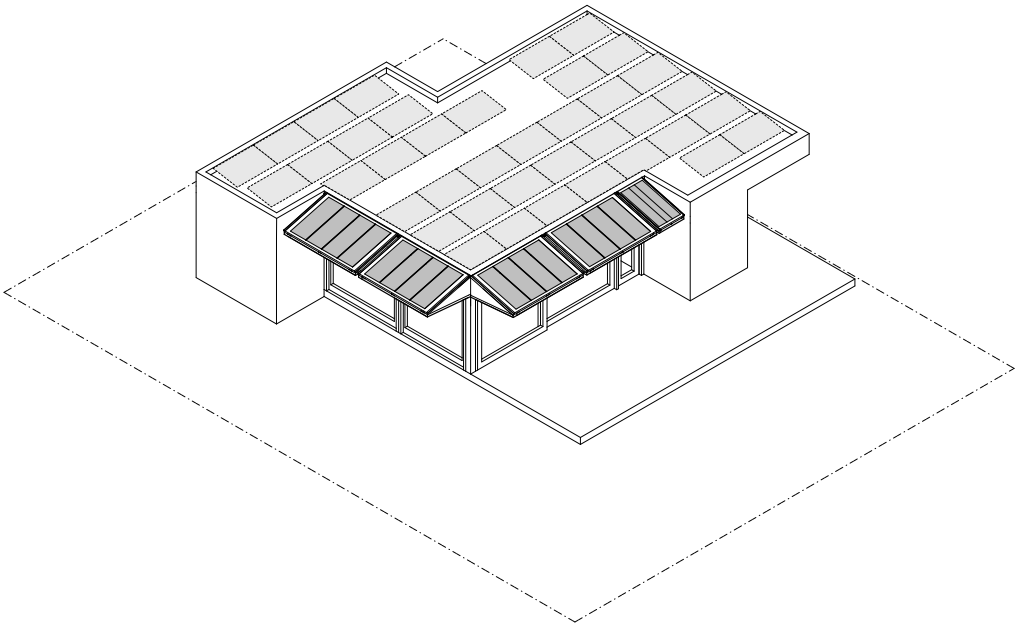


Fig 0.8 Summer Mode : Shutters Have Ability to Shade the House + Collect Energy

CONCLUSION

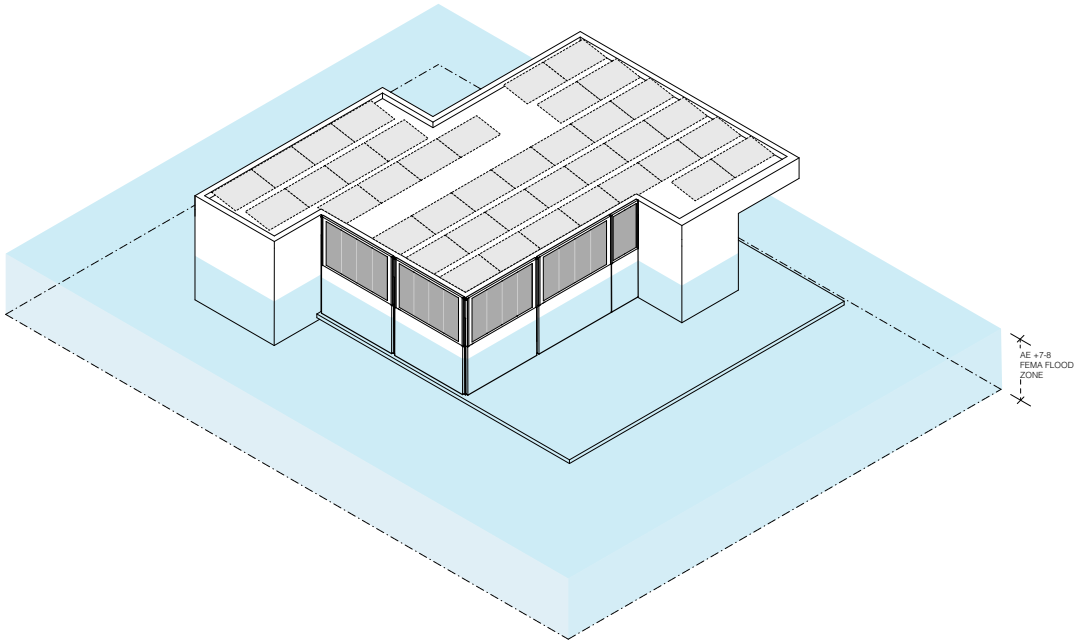


Fig 0.9 Resilient Mode : Shutters Have Ability Protect House from Flooding, Withstands Up to AE 7-8 FEMA Flood Zones.

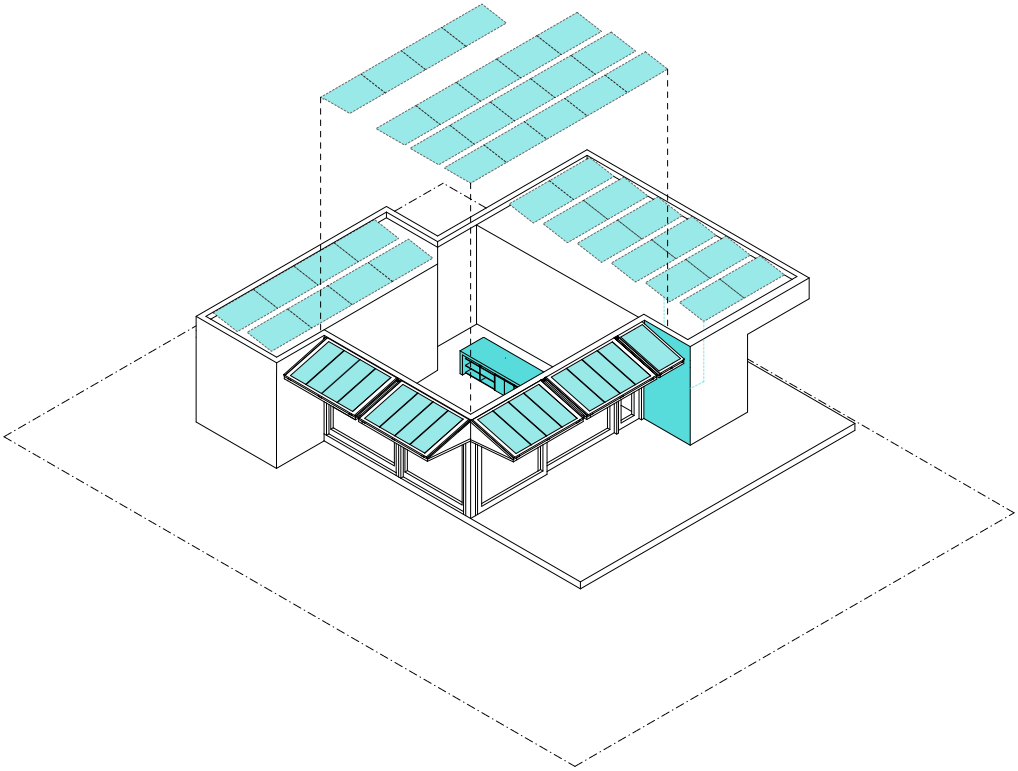


Fig 0.10 Post Storm Mode : House Stores Thermal Energy in Island and Kitchen

01 SUMMARY of CHANGES

SUMMARY OF CHANGES

10.08.14 Design Development Drawing Set

The changes to the SURE House project have been so significant since the Schematic Design Summary submission that a bulleted change list would be unruly and would describe a huge portion of the project. Therefore, the Design Development drawings and Project Manual should be reviewed in toto essentially as the summary of changes.

02 RULES COMPLIANCE **CHECKLIST**

RULES COMPLIANCE CHECKLIST

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	0-101
Rule 4-2	Construction Equipment	Specifications for heavy machinery	0-601
Rule 4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	C-101
Rule 4-4	Impact on the Competition Site	Drawing(s) showing the locations of all low impact footings that shall be used to support all house and site components	0-101
Rule 4-5	Generators	Specifications for generators (including sound rating)	E-604
Rule 4-6	Spill Containment	Drawings for all equipment, containers, and pipes that will contain liquids at any point during the event	H-501
Rule 4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	C-501
Rule 4-8	Electric Vehicles	Drawings showing electric vehicles are compliant with solar envelope lot limits	G-101,201
Rule 5-1	Lot Sizes	Drawings showing lot dimensions within the solar envelope	G-101,201,202
Rule 5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	G-201,202
Rule 5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A

RULES COMPLIANCE CHECKLIST

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 6-1	Structural Design Approval	List of, or marking on all drawing and project manual sheets that will be stamped by the qualified, licensed design professional in the stamped structural submission; the stamped submission shall consist entirely of sheets that also appear in the drawings and project manual	S-001
Rule 6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G-101
Rule 6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	N/A
Rule 6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route	G-103
Rule 6-4	Competition Prototype Alternate	Drawing(s) showing the competition prototype house and the associated competition prototype site components on a featureless lot equal in size and orientation to the solar envelope.	G-601
Rule 7-1	Placement	Drawing(s) showing the location of all vegetation, and if applicable, the movement of vegetation designed as part of an integrated mobile system	L-101
Rule 7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	L-102
Rule 8-1	PV Technology Limitations	Specifications for photovoltaic components	E-602
Rule 8-2	Energy Sources	Drawing(s) showing the only sources of energy that may be consumed in the operation of the house without the requirement of subsequent energy offsets	E-603

RULES COMPLIANCE CHECKLIST

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	M-501
Rule 8-4	Desiccant Systems	Specifications for desiccant system components	M-501
Rule 8-5	Village Grid	Completed interconnection application form	E-001
Rule 8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-102
Rule 8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-602
Rule 8-5	Village Grid	One-line electrical diagram	E-601
Rule 8-5	Village Grid	Calculation of service/feeder net computer load per NEC 220	E-604
Rule 8-5	Village Grid	Site plan showing the house,decks,ramps,tour paths, and terminal box	A-101
Rule 8-5	Village Grid	Elevations(s) showing the meter housing, main utility disconnect, and other service equipment	M-201
Rule 9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	H-101

RULES COMPLIANCE CHECKLIST

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 9-1	Container Locations	Drawing(s) demonstrating that the primary supply water tank(s) is fully shaded from direct solar radiation between 9 a.m. and 5 p.m. PDT between 8 a.m. and 4 p.m. solar time on October 1	H-101
Rule 9-2	Team Provided Liquids	Quantity, specifications, and delivery date(s) of all team-provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	H-101
Rule 9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	L-102
Rule 9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	N/A
Rule 9-5	Evaporation	Water may be used for evaporation purposes	N/A
Rule 9-6	Thermal Mass	Drawing(s) showing the locations of liquid based thermal mass systems	N/A
Rule 9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	N/A
Rule 9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	N/A
Rule 9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	O-103
Rule 9-8	Water Delivery	Specifications for the containers to which water will be delivered	P-601
Rule 9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	P-601
Rule 9-9	Water Removal	Specifications for the containers to which water will be removed	P-601
Rule 11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-103

03 STRUCTURAL CALCULATIONS

STRUCTURAL CALCULATIONS

Structural Calculations

This project manual provides an evaluation of construction methods and structural calculations as stipulated by ASCE 7-10 and the Department of Energy for the 2015 Solar Decathlon. The objective of the Structures Team is to create a safe and sensible structural system that maximizes efficiency, minimizes the use of materials that require high energy during production, while taking the structural integrity into consideration in a coastal environment. After working with the Architecture Team to choose appropriate building materials, it became apparent one of the main objectives was creating a floodproof house, which could seal from the outside. The group designed a hybridized structural insulated panel (SIP) by replacign the typical wood-based sheathing with a fiberglass composite on both sides of the panel. The structure consists of a steel exo-skeleton which creates minimal thermal bridgin in the building envelope as well as takes the bouyancy forces of water in flood-prone communities into account. The dimensions of the house were constrained by practical transportation concerns and additional structural analysis was performed for the bridging between the modules and the floodproofing shutter system on the southern and western facades. The majority of the calculations were done in Microsoft Excel, along with the use of Autodesk ROBOT, to provide the designers with flexibility throughout the process to make alterations easy to implement and check.

Project Overview

The structural design must accommodate multiple phases of loading, including construction, transportation, and reassembly. Because of the nature of the competition and the location, the house was designed in modular components, wet and dry. The building must be transportable on US highways from Hoboken, New Jersey to Irvine, California. Further investigation is being done as to additional supports that will be provided during shipping to ensure there is enough rigidity and frame support. The service loads account for a three week duration at Orange County Great Park with elevated load criteria and a permanent location in Southern California close to the competition site, using conservative values. The final geographic location is within a FEMA AE 7/8 flood zone in a coastal community on the Jersey Shore.

STRUCTURAL DESIGN NARRATIVE

GENERAL

SURE House has a very innovative and resilient structure. By using glass fiber composite structurally insulated panels (SIPs) as the walls, floors, and roof of the house, the team has created a cohesive structure that can effectively meet higher than average energy standards and perform against NJ hurricane loadings. The structure includes a steel exoskeleton structure that supports the floor of the house and the entirety of the deck and shading structures. The house can be split into a “wet”, or systems intensive, and “dry”, or bedroom module, for shipping. The remaining sections of the house can be built quickly by using SIPs and simple repeatable connection details.

FOUNDATION

The SURE House team has completed the following analysis for a temporary foundation that will be utilized during competition. This will not be used after the competition as a permanent foundation. A new analysis will be completed to consider these loads.

DESIGN INTENT & RESILIENCY

The design presented in this analysis is for Irvine, CA and Solar Decathlon 2015 requirements only. This analysis does not include the final loads that will be on the house after competition. A different foundation and steel exoskeleton will be used after competition to account for these loads. The SIPs, however will be used for both competition and for the final resting place of the home, therefore they have been designed to resist both competition and post-competition conditions. All design was done using Load Resistance Factor Design, or LRFD, where applicable.

APPLICABLE CODES

- AISC Steel Construction Manual 14th Edition
- Solar Decathlon Building Code 2015
- 2015 International Residential Code (IRC)
- ASCE 7: Minimum Design Loads for Buildings and Other Structures

STRUCTURAL CALCULATIONS

STRUCTURAL INFORMATION

Type of Steel : A500 Grade B with Fy=46ksi & Fu=58ksi

LIST OF VARIABLES

Wind Load Calculations:
(GC_{pf}) = external pressure coefficient
(GC_{pi}) = internal pressure coefficient
I = importance factor
K_d = wind directionality factor
K_z = velocity pressure exposure coefficient
K_{zt} = topographic factor
V = basic wind speed (mph)
q_h = velocity pressure q_z calculated at mean roof height *h*

Seismic Load Calculations:
S_{DS}= design, 5 percent damped, spectral response acceleration parameter at short periods
Z = Seismic hazard factor designated by location
I = Importance factor based on building usage
V = Base Shear, lateral forces due to seismic movement (lb)

Steel Design:
A_g Gross Area Section (in^2)
b Base of Section (in)
C_w Warping Constant (in^6)
Δ Deflection (in)
E Modulus of Elasticity (ksi)
F_{cr} Critical Stress (ksi)
F_e Elastic Buckling Stress (ksi)
F_u Ultimate Stress (ksi)
F_y Yield Stress (ksi)
h Height of Section (in)
I_x Moment of Inertia (in^3)
J Torsional Constant (in^4)
K Effective Length Factor
k_v Web Plate Shear Buckling Coefficient
λ Width to Thickness Ratio (in/in)
λ_c Limiting Width to Thickness Ratio (in/in)
λ_r Limiting Width to Thickness Ratio (Nonslender/Slender) (in/in)
λ_p Limiting Width to Thickness Ratio (Compact/Noncompact) (in/in)

STRUCTURAL CALCULATIONS

STRUCTURAL INFORMATION

Type of Steel : A500 Grade B with Fy=46ksi & Fu=58ksi

LIST OF VARIABLES

L Length (ft)
L_b Unsupported Length (ft)
M_n Nominal Moment (k-ft)
M_p Plastic Moment (k-ft)
M_u Required Moment (kft)
φ Strength Reduction Factor
P_n Nominal Compressive Strength (k)
r_y Radius of Gyration around y axis (in)
S_x Elastic Section Modulus (in^3)
t Design thickness of Section (in)
t_f Flange thickness (in)
T_n Nominal Torsion
V_n Nominal Shear Strength (k)
Z_x Gross Plastic Section Modulus (in^3)

STRUCTURAL CALCULATIONS

LOAD SUMMARY

Dead Load :

Materials: SIPs = 4psf
Wood Furring Strips = .5plf
Flooring= 3psf
Solar Panels = 5psf

The team is using an assumed dead load to ensure safety. For more drtails concerning locations of different dead load values, please see seismic pier calculations.

Live Load :

Deck & Exterior Walkways = 100 psf
Interior Spaces = 50 psf

Snow Load :

25 psf

Lateral Loads :

Seismic (using ASCE 7, IRC)

Site Class	D
Importance Factor	II
Project City	Irvine, CA
S_{DS}	1.17g
V	

STRUCTURAL CALCULATIONS

LOAD SUMMARY

Constants:

$S_{DS} = D_2$ (Specified in IRC Section R301.2.2.) = 1.17g

Equation:

$V = m * S_{DS}$

Calculations:

Max loading situation on individual pier

Roof Dead Load $= 6.5\text{ft}^3 * 4.5\frac{\text{lb}}{\text{ft}^3} = 29.25$ lb

Wall Dead Load $= 41ft^3 * 4.5\frac{\text{lb}}{\text{ft}^3} = 184.5$ lb

Floor Dead Load $= 6.5ft^3 * 4.5\frac{\text{lb}}{\text{ft}^3} = 29.25$ lb

$29.25 \text{ lb} + 184.5 \text{ lb} + 29.25 \text{ lb} = 243 \text{ lb}$

$V = 243 \text{ lb} * 1.17\text{g} = 284.31 \text{ lb}$

STRUCTURAL CALCULATIONS

WIND LOAD DIAGRAM

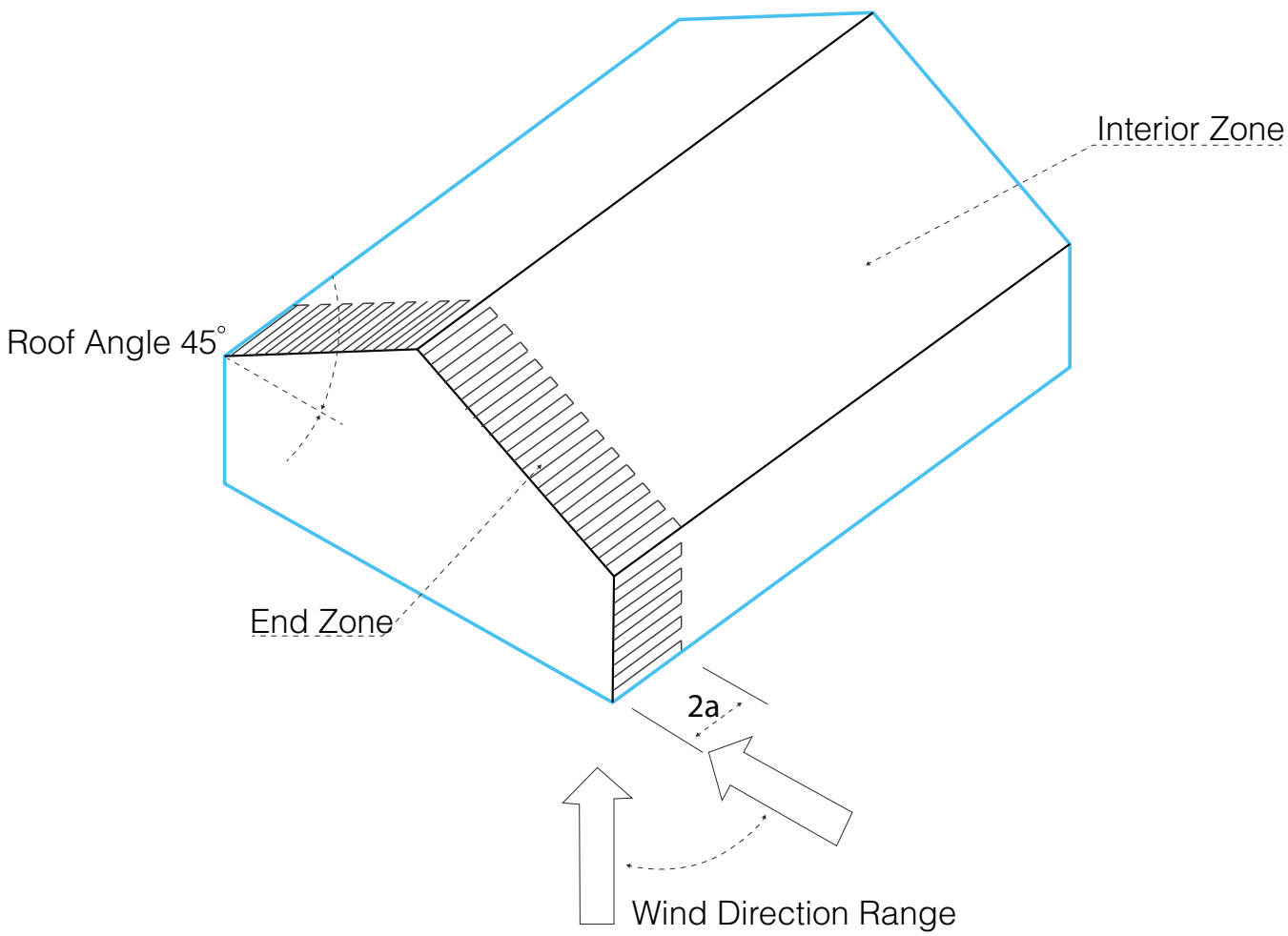


Fig 3.0 Wind Load Diagram

K_d	0.85
Importance Factor (I)	1
Load Case	B
Degree of Roof Angle	0
Gcpi (±)	0.18
	-0.18

Table 3.0 Wind Load Diagram

STRUCTURAL CALCULATIONS

MWFRS DESIGN PRESSURES

$P = qz\ (GC_{pf} - (+G_{cpi}))$

Bldg Zone	Velocity Pressure q_z	External Pressure Coeff. GC_{pf}	Design Pressures (P) psf (+) GC_{pi}	(-) GC_{pi}	P (lb/ft)
1	31.25824	-0.45	-19.6926912	-8.4397248	-265.8513
2	31.25824	-0.69	-27.1946688	-15.9417024	-367.128
3	31.25824	-0.37	-17.192032	-5.9390656	
4	31.25824	-0.45	-19.6926912	-8.4397248	-265.8513
5	31.25824	0.4	6.8768128	18.1297792	244.752
6	31.25824	-0.29	-14.6913728	-3.4384064	-198.3335
1E	31.25824	-0.48	-20.6304384	-9.377472	-278.5109
2E	31.25824	-1.07	-39.0728	-27.8198336	
3E	31.25824	-0.53	-22.1933504	-10.940384	
4E	31.25824	-0.48	-20.6304384	-9.377472	-278.5109
5E	31.25824	0.61	13.4410432	24.6940096	333.3691
6E	31.25824	-0.43	-19.0675264	-7.81456	-257.4116

Table 3.1 MWFRS Design Pressures

GOVERNING WIND LOAD CALCULATION EQUATIONS

28.4.1 Design Wind Pressure for Low-Rise Buildings - Eq. (28.4-1) :

- $P = q_h\ [(GC_{pf}) - (GC_{pi})]\ (lb/ft^2)$

28.3.2 Velocity Pressure - Eq. (28.3-1) :

- $q_z = 0.00256 k_z k_{zt} k_d V2I\ (lb/ft^{2)}$

WIND LOADS

RISK CATEGORY	2
BASIC WIND SPEED (MPH)	130 mph
Kz	0.85 Exposure C
KZT	1
KD	0.85
IMPORTANCE FACTOR (I)	1
LOAD CASE	B
DEGREE OF ROOF ANGLE	0
GCPI (±)	± 0.18

STRUCTURAL CALCULATIONS

ROBOT MODEL ANALYSIS

The SURE House team used Autodesk Robot Structural Analysis to analyze the moment, shear, and deflections in the steel exoskeleton of the house. All house loads were input to the correct beam to which the loads will transfer in the final house, even though the SIPs themselves were not included in this analysis. Moment, shear, and deflection inputs to steel design were derived from this model. LRFD Load factors were used.

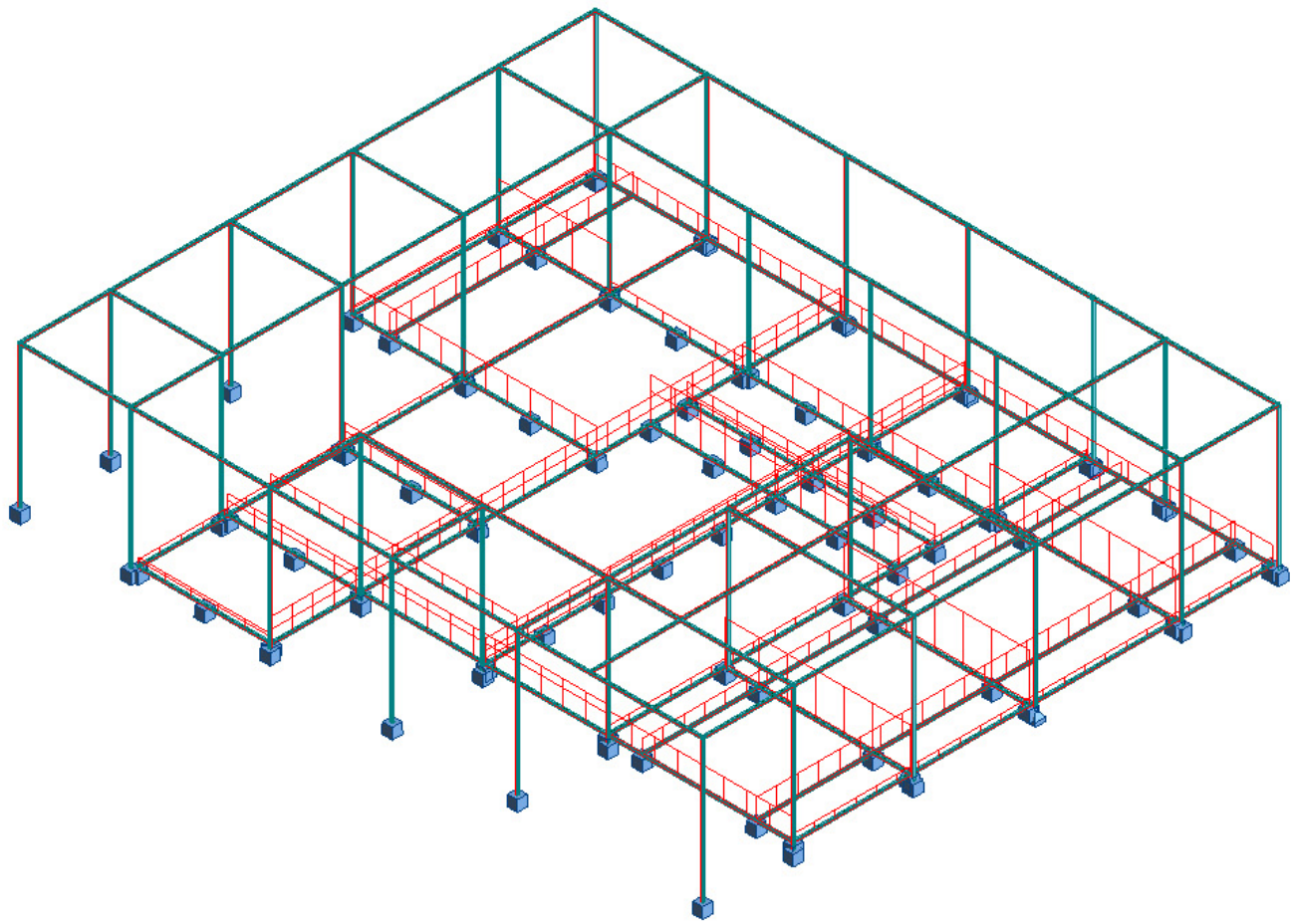


Fig 3.1 Robot Structural Analysis Model

STRUCTURAL CALCULATIONS

ROBOT MANUAL CHECK

$$M = \frac{wl^2}{8}$$

Beam Along C from 2-3: Dead Load Check

Robot Load: 0.19 k/ft

Length: 9.71 ft

Moment: 2.23 k-ft

Manually Checked Moment: 2.23 k-ft

Beam Along G from 1-2: Snow Load Check

Robot Load: 0.05 k/ft

Length: 7.33 ft

Moment: 0.36 k-ft

Manually Checked Moment: 0.36 k-ft

Beam Along 1 from 4-8: Live Load Check

Robot Load: 0.45 k/ft

Length: 11.80 ft

Moment: 5.25 k-ft

Manually Checked Moment: 7.80 k-ft

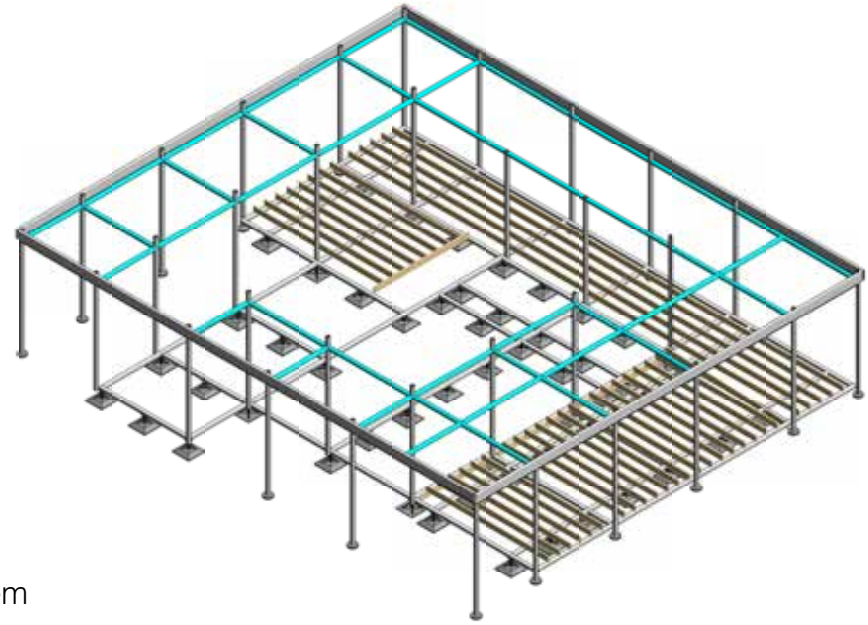
STRUCTURAL CALCULATIONS

STRUCTURAL DESIGN

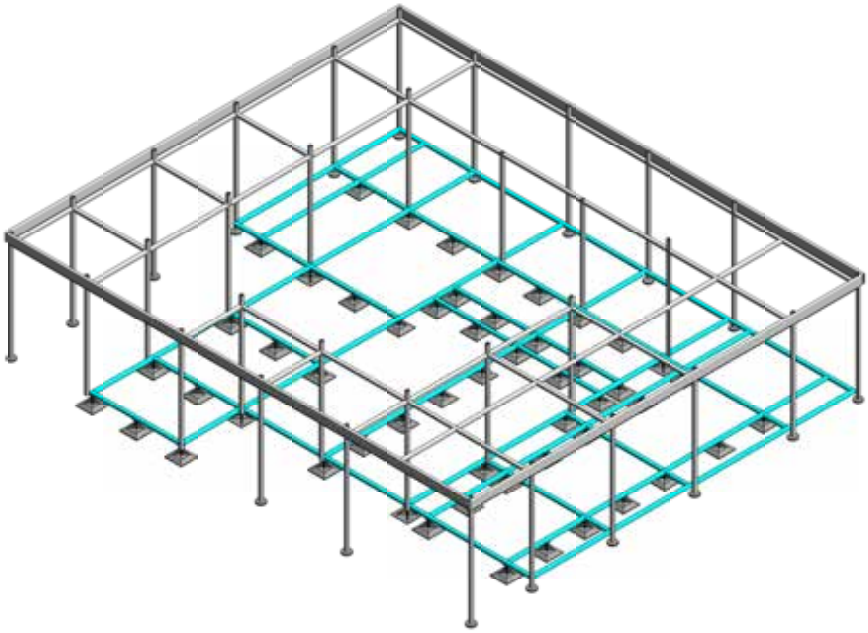
In order to meet height requirements for the house, Hollow Structural Section (HSS) steel sections are used as the main structural systems. CP Seismic Piers are used as the temporary California foundation; designs can be seen below. Cut sheets for the different CP Seismic Piers designed can be found Section 12 of Project Manual.

STRUCTURAL CALCULATIONS

BEAM SYSTEMS



Roof Beam System
Fig 3.2



Floor Beam System
Fig 3.3

STRUCTURAL CALCULATIONS

BEAM SYSTEMS

Governing Beam Calculation Equations

Yielding (AISC Steel Manual Section F7): $M_n = M_p = F_y Z$

Flange Local Buckling (AISC Steel Manual Section F7)

Noncompact Flange Sections $M_n = M_p - (M_p - F_y S)\left(3.57\frac{b}{t_f}\sqrt{\frac{F_y}{E}} - 4\right) if\ <\ M_p$

Slender Flange Sections $M_n = F_y S_e$ where S_e is determined from a b_e

$$b_e = 1.92 t_f \sqrt{\frac{E}{F_y}}\left(1 - \frac{.38}{b/t_f}\sqrt{\frac{E}{F_y}}\right) if < b$$

Compact Flange Sections: Flange Local Buckling does not apply

Web Local Buckling (AISC Steel Manual Section F7)

Compact Web Sections: Web Local Buckling does not apply

Noncompact Webs $M_n = M_p - (M_p - F_y S)(.305\frac{h}{t_w}\sqrt{\frac{F_y}{E}} - .738)\ if <\ M_p$

Web and Flange State Check (AISC Steel Manual Table B4.1b)

Flange (Case 17) $\lambda = \frac{b}{t}$ $\lambda_p = 1.12\sqrt{\frac{E}{F_y}}$ $\lambda_r = 1.4\sqrt{\frac{E}{F_y}}$

Web (Case 19) $\lambda = \frac{h}{t}$ $\lambda_p = 2.42\sqrt{\frac{E}{F_y}}$ $\lambda_r = 5.70\sqrt{\frac{E}{F_y}}$

STRUCTURAL CALCULATIONS

BEAM SYSTEMS

Shear Check (AISC Steel Manual Section G5 and G2.1)

$A_w = 2ht$ t= design wall thickness $V_n = .6F_yA_wC_v$ where C_v is determined by the respective equations below

If $\frac{h}{t_w} < 1.1\sqrt{\frac{k_vE}{F_y}}$ then C_v=1

If $1.1\sqrt{\frac{k_vE}{F_y}} < \frac{h}{t_w} < 1.37\sqrt{\frac{k_vE}{F_y}}$ then $C_v = \frac{1.1\sqrt{k_vE/F_y}}{h/t_w}$

If $\frac{h}{t_w} > 1.37\sqrt{\frac{k_vE}{F_y}}$ then $C_v = \frac{1.51k_vE}{(h/t_w)^2F_y}$

Deflection Check

$\Delta < \frac{L}{360}$ where L is in inches and only live load deflections are considered

Note: All M_n values are multiplied by Øof .9 before compared to M_u values to ensure AISC Steel Manual Eq 2-1 ($ØM_n > M_u$) is satisfied. Similar concepts are used in shear checks. All Ø values are taken to be .9 for LRFD design, as is completed in this project manual.

STRUCTURAL CALCULATIONS

BEAM SYSTEMS CALCULATIONS

Architecturally + Robot Determined Components

Architecturally and Robot Determined Components						Steel Member
Beam Loading	Beam Location	Unsupported Length (ft)	Deflection (from Robot) (in)	Shear (from Robot) (k)	Moment (from Robot) (kft)	Section Choice
Floor : Longest Span	On 3 from E-F	10.667	-0.016	3.540	3.170	HSS4X3X1/4
Floor: Highest Moment	On 2 from E-G	10	-0.250	8.170	13.790	HSS4X3X1/4
Floor : Highest Deflection	On D from 2-8	9.583	-0.238	3.080	5.470	HSS4X3X1/4
Roof: Longest Span	On C from 4-7	11.5	0.000	0.270	0.800	HSS3X3X3/16
Roof: Highest Moment	On 1 from E-F	10.333	0.000	2.680	6.790	HSS3X3X3/16
Roof: Highest Deflection	On 1 from F-G	9.667	0.000	2.620	6.460	HSS3X3X3/16

Table 3.2 Robot Component Analysis

General Steel Properties

General Steel Properties				Member Properties						
Beam	E (ksi)	Fy (ksi)	Fu (ksi)	b (in)	tf (in)	Ix (in4)	r (in	Zx (in3)	kv	h/t
Floor : Longest Span	29000	46	58	3	0.233	6.15	3	3.81	5	14.2
Floor: Highest Moment	29000	46	58	3	0.233	6.15	3	3.81	5	14.2
Floor : Highest Deflection	29000	46	58	3	0.233	6.15	3	3.81	5	14.2
Roof: Longest Span	29000	46	58	3	0.174	2.46	2	1.97	5	14.2
Roof: Highest Moment	29000	46	58	3	0.174	2.46	2	1.97	5	14.2
Roof: Highest Deflection	29000	46	58	3	0.174	2.46	2	1.97	5	14.2

Table 3.3 Steel Properties

STRUCTURAL CALCULATIONS

BEAM SYSTEMS CALCULATIONS

Structural Calculations

Structural Calcs													
Beam	Mp (k-ft)	λ flange	λp Flange	λr Flange	λ flange	λp Web	λr Web	φMn Yielding (kft)	φMn FLB (kft)	φMn WLB (kft)	φMn Controlling (kft)	φV (k)	Δmax (in)
Floor : Longest Span	14.605	6.438	28.121	35.152	14.200	60.762	143.118	14.605	N/A	N/A	14.605	38.299	0.356
Floor: Highest Moment	14.605	12.876	28.121	35.152	14.200	60.762	143.118	14.605	N/A	N/A	14.605	38.299	0.333
Floor : Highest Deflection	14.605	12.876	28.121	35.152	14.200	60.762	143.118	14.605	N/A	N/A	14.605	38.299	0.319
Roof: Longest Span	7.552	17.241	28.121	35.152	14.200	60.762	143.118	7.552	N/A	N/A	7.552	21.358	0.383
Roof: Highest Moment	7.552	17.241	28.121	35.152	14.200	60.762	143.118	7.552	N/A	N/A	7.552	21.358	0.344
Roof: Highest Deflection	7.552	17.241	28.121	35.152	14.200	60.762	143.118	7.552	N/A	N/A	7.552	21.358	0.322

Table 3.4 Structural Calculations

Results

Results								
	Strength Check (ø Mυ > Mυ?)	Flange State	Web State	Deflection Check	Shear Check	Moment Utiliation (%)	Shear Utilization (%)	Deflection Utilization (%)
Floor : Longest Span	Ok	Compact	Compact	Ok	Ok	22%	9%	5%
Floor: Highest Moment	Ok	Compact	Compact	Ok	Ok	94%	21%	75%
Floor : Highest Deflection	Ok	Compact	Compact	Ok	Ok	37%	8%	75%
Roof: Longest Span	Ok	Compact	Compact	Ok	Ok	11%	1%	0%
Roof: Highest Moment	Ok	Compact	Compact	Ok	Ok	90%	13%	0%
Roof: Highest Deflection	Ok	Compact	Compact	Ok	Ok	86%	12%	0%

Table 3.5 Results

STRUCTURAL CALCULATIONS

COLUMN DESIGN

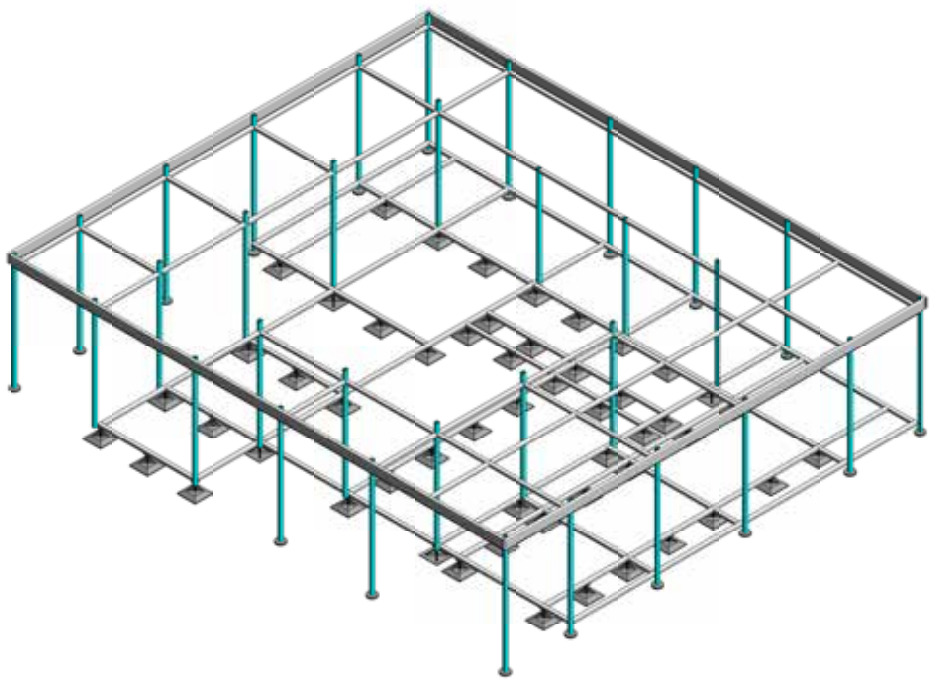


Fig 3.4 Structural Column Grid

STRUCTURAL CALCULATIONS

COLUMN DESIGN OF HSS MEMBERS

Design of Members for Compression (AISC Chapter E) :

- **Effective Length Check**
  - $\frac{KL}{r_y} < 200$
- **Slenderness**

  If $\frac{b}{t} \leq 1.40\sqrt{\frac{E}{F_y}}$, the section is non-slender.

  Otherwise, the section is slender > **Redesign Needed**
- **Flexural Buckling**
  - $F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$

  If $\frac{KL}{r} \leq 4.71\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right]F_y$

  If $\frac{KL}{r} \geq 4.71\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = 0.877F_e$
- **Torsional Buckling**

  For double symmetric members:

  $$F_e = \left[\frac{\pi^2 E C_w}{(K_z L)^2} + GJ\right]\frac{1}{I_x + I_y}$$

  If $\frac{KL}{r} \leq 4.71\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right]F_y$

  If $\frac{KL}{r} \geq 4.71\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = 0.877F_e$
- Nominal Strength

  $$\varphi P_n = 0.9 * A_g * \min(FB\ F_{cr};\ TB\ F_{cr})$$

STRUCTURAL CALCULATIONS

COLUMN DESIGN OF HSS MEMBERS

Design of Members for Flexure (AISC Chapter F) :

- **Yielding**

$$M_n = M_p = F_y Z$$

- **Flange Local Buckling**

If $\frac{b}{t} < 1.12\sqrt{\frac{E}{F_y}}$, the section is compact.

If $1.12\sqrt{\frac{E}{F_y}} < \frac{b}{t} < 1.40\sqrt{\frac{E}{F_y}}$, the section is non-compact.

If $\frac{b}{t} > 1.40\sqrt{\frac{E}{F_y}}$, the section is slender > **Redesign Needed**

For compact sections, the limit state of flange local buckling does not apply.

For sections with non-compact flanges:

$$M_n = M_p - (M_p - F_y S)\left(3.57\frac{b}{t_f}\sqrt{\frac{F_y}{E}} - 4.0\right) \leq M_p$$

- **Web Local Buckling**

If $\frac{h}{t} < 2.42\sqrt{\frac{E}{F_y}}$, the section is compact.

If $2.42\sqrt{\frac{E}{F_y}} < \frac{h}{t} < 5.70\sqrt{\frac{E}{F_y}}$, the section is non-compact.

If $\frac{h}{t} > 5.70\sqrt{\frac{E}{F_y}}$, the section is slender > **Redesign Needed**

For compact sections, the limit state of flange local buckling does not apply.

For sections with non-compact flanges:

$$M_n = M_p - (M_p - F_y S)\left(0.305\frac{h}{t_w}\sqrt{\frac{F_y}{E}} - 0.738\right) \leq M_p$$

- **Nominal Moment**

$$\varphi M_n = 0.9 * \min(\text{Yielding } M_n; \text{FLB } M_n; \text{WLB } M_n)$$

STRUCTURAL CALCULATIONS

COLUMN DESIGN OF HSS MEMBERS

Design of Members for Shear (AISC Chapter G):

- For HSS Sections , $k_v = 5$
- If $\frac{h}{t_w} \leq 1.10\sqrt{\frac{k_v E}{F_y}} \rightarrow C_v = 1.0$
- If $\frac{h}{t_w} > 1.37\sqrt{\frac{k_v E}{F_y}} \rightarrow C_v = \frac{1.57 k_v E}{\left(\frac{h}{t_w}\right)^2 F_y}$
- If $\frac{h}{t_w} > 1.37\sqrt{\frac{k_v E}{F_y}} \rightarrow C_v = \frac{1.57 k_v E}{\left(\frac{h}{t_w}\right)^2 F_y}$
- $h_{shear} = h - 2 * 1.5 * t_{des}$
- $A_w = 2 * h_{shear} * t_{des}$
- Nominal Shear
  $\varphi V_n = 0.9 * 0.6 * F_y * A_w * C_v$

Design of Members for Combined Force and Tension (AISC Chapter H):

- **HSS Subject to Torsion**
- If $\frac{h}{t} \leq 2.45\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = 0.6F_y$
- If $2.45\sqrt{\frac{E}{F_y}} < \frac{h}{t} \leq 3.07\sqrt{\frac{E}{F_y}} \rightarrow F_{cr} = \frac{0.6F_y\left(2.45\sqrt{\frac{E}{F_y}}\right)}{\frac{h}{t}}$
- If $3.07\sqrt{\frac{E}{F_y}} < \frac{h}{t} \leq 260 \rightarrow F_{cr} = \frac{0.458\pi^2}{\left(\frac{h}{t}\right)^2}$
- Nominal Torsion
  $\varphi T_n = 0.9 * F_{cr} * C$

STRUCTURAL CALCULATIONS

COLUMN DESIGN OF HSS MEMBERS

Design of Members for Shear (AISC Chapter G):

- HSS Subject to Combined Torsion, Shear, Flexure, and Axial Force

$$\left(\frac{P_r}{P_c}+\frac{M_r}{M_c}\right)+\left(\frac{V_r}{V_c}+\frac{T_r}{T_c}\right)^2 \leq 1.0$$

Where P_r = required axial strength using LRFD load combinations
$P_c = \varphi P_n$
M_r = required flexural strength using LRFD load combinations
$M_c = \varphi M_n$
V_r = required shear strength using LRFD load combinations
$V_c = \varphi V_n$
T_r = required torsion strength using LRFD load combinations
$T_c = \varphi T_n$

STRUCTURAL CALCULATIONS

COLUMN DESIGN CALCULATIONS

Architecturally + Robot Determined Components

Robot Input Values								Steel Member	General Steel Properties			
Loading Type	Column Location	Max Axial Load Robot (Fx)	Max Shear Robot (Fz)	Mz Robot (k-ft)	My Robot (k-ft)	Torsion Robot	L (ft)	AISC Section	E (ksi)	Fy (ksi)	Fu (ksi)	G (ksi)
Maximum Axial Force	1F	6.06	0	0	0	0	12.33	HSS3X3X3/16	29000	46	58	11200
Maximum My Moment	3A	2.02	0.48	0.07	1.95	0	12.33	HSS3X3X3/16	29000	46	58	11200
Maximum Mz Moment	4A	1.59	0.02	2.48	0.13	0	12.33	HSS3X3X3/16	29000	46	58	11200
Maximum Shear	3E	5.18	0.53	0.02	1.85	0	12.33	HSS3X3X3/16	29000	46	58	11200

Table 3.6 Robot Column Components

Member Properties

Member Properties													
Column Name	K	b/t	Cw	J	Ix	Iy	Ag (in2)	Zx (in3)	Sx (in3)	h/t	tdes (in)	h (in)	ry (in)
Maximum Axial Force	1	14.2	2.76	4.03	2.46	2.46	1.89	1.97	1.64	14.2	0.174	3	1.14
Maximum My Moment	1	14.2	2.76	4.03	2.46	2.46	1.89	1.97	1.64	14.2	0.174	3	1.14
Maximum Mz Moment	1	14.2	2.76	4.03	2.46	2.46	1.89	1.97	1.64	14.2	0.174	3	1.14
Maximum Shear	1	14.2	2.76	4.03	2.46	2.46	1.89	1.97	1.64	14.2	0.174	3	1.14

Table 3.7 Material Properties

Design of Members for Compression

DESIGN OF MEMBERS FOR COMPRESSION (AISC Chapter E)									
Column Name	KL/ry	AISC E2 Check	λ_r	Slenderness	FB Fe	FB, Fcr	Torisional Fe	Torsional Fcr	ϕPn
Maximum Axial Force	129.8245614	OK	35.15	Nonslender	16.98	14.89	7.33	6.43	10.94
Maximum My Moment	129.8245614	OK	35.15	Nonslender	16.98	14.89	7.33	6.43	10.94
Maximum Mz Moment	129.8245614	OK	35.15	Nonslender	16.98	14.89	7.33	6.43	10.94
Maximum Shear	129.8245614	OK	35.15	Nonslender	16.98	14.89	7.33	6.43	10.94

Table 3.8 Compression Design

Design of Members for Flexure

DESIGN OF MEMBERS FOR FLEXURE (AISC Chapter F)										
Column Name	Yielding Mn (k-ft)	Flange λp	Flange λc	Flange Property	Flange Local Buckling Mn (kft)	Web λp	Web λc	Web Property	Web Local Buckling Mn (kft)	ϕMn
Maximum Axial Force	7.55	9.54	25.11	Noncompact	10.06	60.76	143.12	Compact	N/A	6.80
Maximum My Moment	7.55	9.54	25.11	Noncompact	10.06	60.76	143.12	Compact	N/A	6.80
Maximum Mz Moment	7.55	9.54	25.11	Noncompact	10.06	60.76	143.12	Compact	N/A	6.80
Maximum Shear	7.55	9.54	25.11	Noncompact	10.06	60.76	143.12	Compact	N/A	6.80

Table 3.9 Flexure Design

STRUCTURAL CALCULATIONS

COLUMN DESIGN CALCULATIONS

Design of Members for Shear

DESIGN OF MEMBERS FOR SHEAR (AISC Chapter G)						DESIGN OF MEMBERS FOR COMBINED FORCES AND TORSION (Chapter H)			
Column Name	Cv	t (in)	shear h (in)	Aw (in2)	ϕVn (kips)	Column Name	Torsion Fcr	ϕTn	Combined T, V, P, M
Maximum Axial Force	1.00	0.17	2.48	0.86	21.42	143.118	27.600	68.558	0.554
Maximum My Moment	1.00	0.17	2.48	0.86	21.42	143.118	27.600	68.558	0.472
Maximum Mz Moment	1.00	0.17	2.48	0.86	21.42	143.118	27.600	68.558	0.510
Maximum Shear	1.00	0.17	2.48	0.86	21.42	143.118	27.600	68.558	0.747

Table 3.10 Shear Design

Column Design Checks

COLUMN DESIGN CHECKS									
Column Name	AISC Section	Axial	Shear	Shear Utilization (%)	Moment	Flexural Moment Utilization (%)	Torsion	Combined	Combined Utilization(%)
Maximum Axial Force	HSS3X3X3/16	OK	OK	0%	OK	0%	Ok	Ok	55%
Maximum My Moment	HSS3X3X3/16	OK	OK	2%	OK	29%	Ok	Ok	47%
Maximum Mz Moment	HSS3X3X3/16	OK	OK	0%	OK	36%	Ok	Ok	51%
Maximum Shear	HSS3X3X3/16	OK	OK	2%	OK	27%	Ok	Ok	75%

Table 3.11 Column Checks

STRUCTURAL CALCULATIONS

CP SEISMIC PIER TESTING RESULTS (Per C.P. Seismic Cut Sheet)

Vertical Load Design Capacity for Concrete Pads

10,667 lbs of Vertical Loading per Pier

LOAD RESISTANCE FACTOR DESIGN (LRFD)

(1.2) Dead Load + (1.6) Live Load + (.5 Snow Load)

DECK LOADING

Max loading situation used as most conservative estimation across all corresponding situations.

Live Load = 100 psf
Dead Load = 20 psf
Snow Load = 5 psf

DRY MODULE/LIVING AREA LOADING

Max loading situation used as most conservative estimation across all corresponding situations.

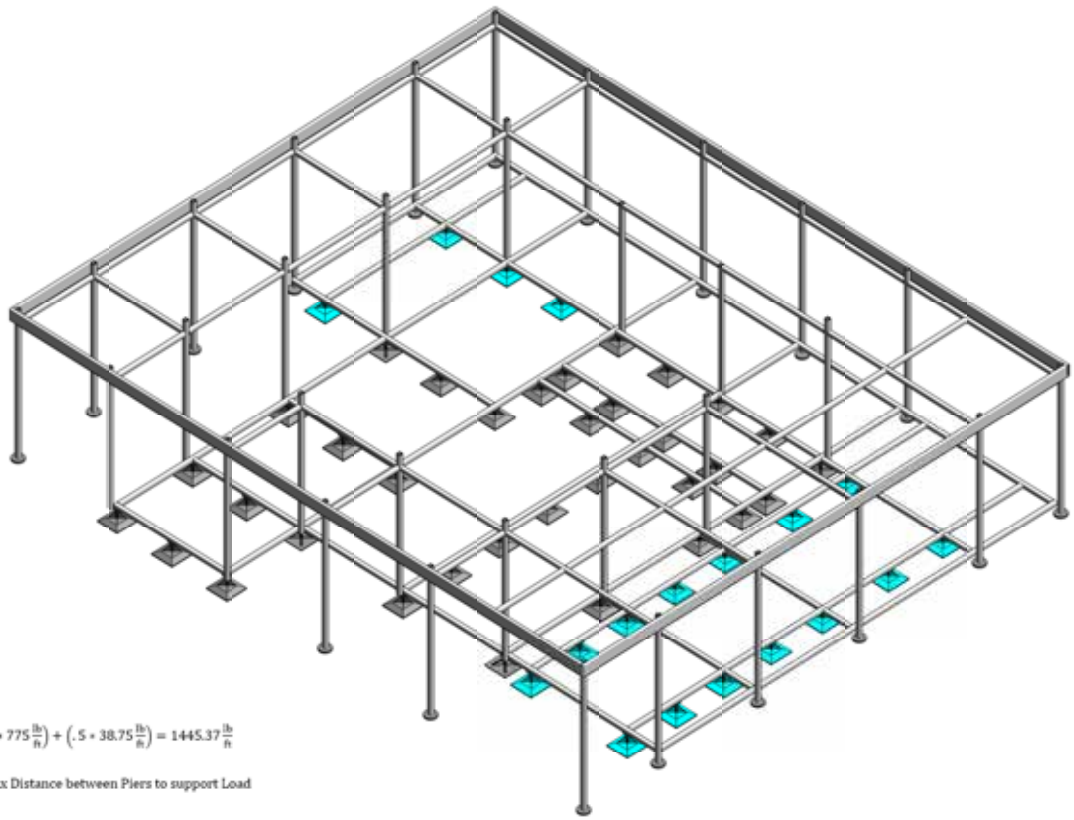
Live Load = 50 psf
Dead Load = 35 psf
Snow Load = 5 psf

STRUCTURAL CALCULATIONS

WET / SYSTEM INTENSIVE MODULE LOADING

Max loading situation used as most conservative estimation across all corresponding situations.

Live Load = 50 psf
Dead Load = 100 psf
Snow Load = 5 psf



Deck Loading

$LL = 100\ psf * 7.75\ ft = 775 \frac{lb}{ft}$

$DL = 20\ psf * 7.75\ ft = 155 \frac{lb}{ft}$

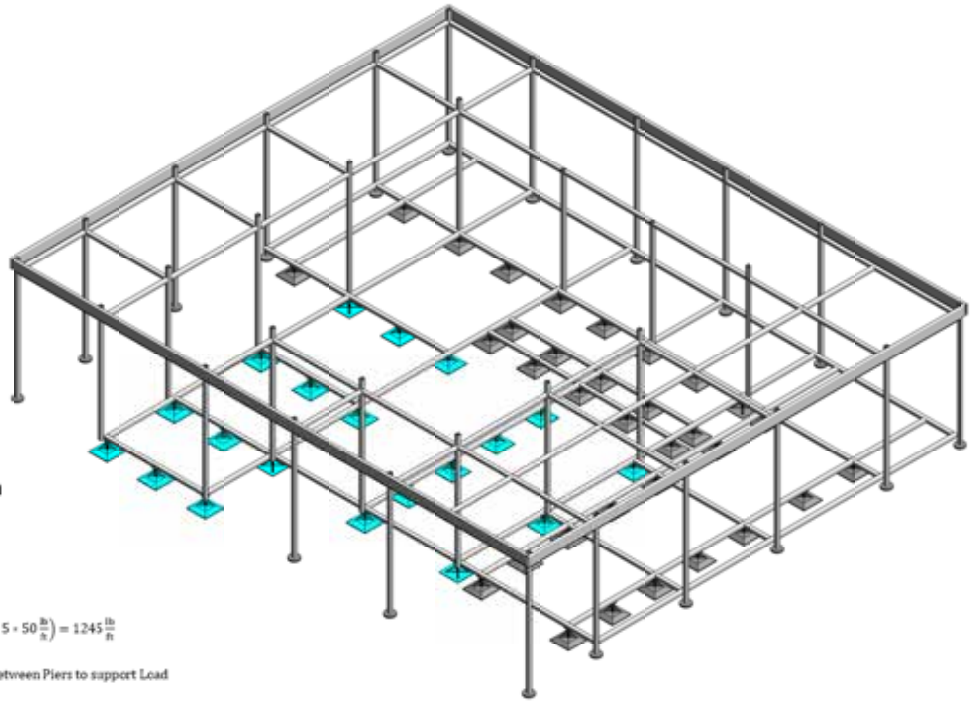
$SL = 5\ psf * 7.75\ ft = 38.75 \frac{lb}{ft}$

$Loading = \left(1.2 * 155 \frac{lb}{ft}\right) + \left(1.6 * 775 \frac{lb}{ft}\right) + \left(.5 * 38.75 \frac{lb}{ft}\right) = 1445.37 \frac{lb}{ft}$

$\frac{10{,}667 \frac{lb}{pier}}{1445.37 \frac{lb}{ft}} = 7.38 \frac{ft}{pier}$ ← Max Distance between Piers to support Load

SEISMIC DECK IMAGE
Fig 3.4

STRUCTURAL CALCULATIONS



Dry Module/ Living Room

$LL = 50\ psf * 10\ ft = 500 \frac{lb}{ft}$

$DL = 35\ psf * 10\ ft = 350 \frac{lb}{ft}$

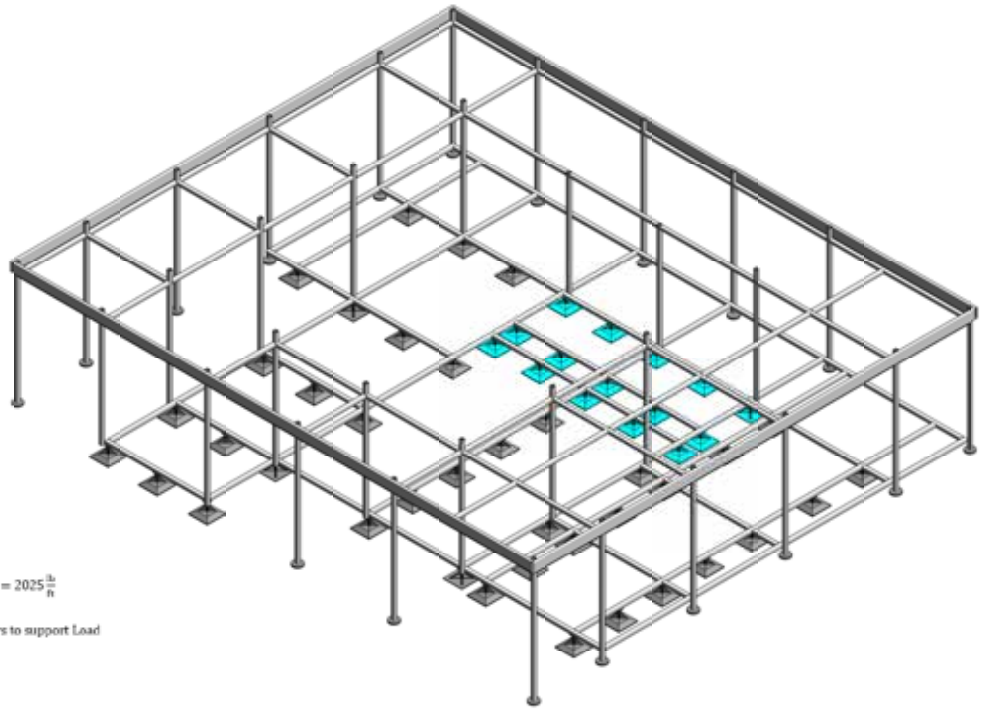
$SL = 5\ psf * 10\ ft = 50 \frac{lb}{ft}$

$Loading = \left(1.2 * 350 \frac{lb}{ft}\right) + \left(1.6 * 500 \frac{lb}{ft}\right) + \left(.5 * 50 \frac{lb}{ft}\right) = 1245 \frac{lb}{ft}$

$\frac{10{,}667 \frac{lb}{pier}}{1245 \frac{lb}{ft}} = 8.57 \frac{ft}{pier}$ ← Max Distance between Piers to support Load

SEISMIC DRY MODULE IMAGE

Fig 3.5



Wet Module

$LL = 50\ psf * 10\ ft = 500 \frac{lb}{ft}$

$DL = 100\ psf * 10\ ft = 1000 \frac{lb}{ft}$

$SL = 5\ psf * 10\ ft = 50 \frac{lb}{ft}$

$Loading = \left(1.2 * 1000 \frac{lb}{ft}\right) + \left(1.6 * 500 \frac{lb}{ft}\right) + \left(.5 * 50 \frac{lb}{ft}\right) = 2025 \frac{lb}{ft}$

$\frac{10{,}667 \frac{lb}{pier}}{2025 \frac{lb}{ft}} = 5.27 \frac{ft}{pier}$ ← Max Distance between Piers to support Load

SEISMIC WET MODULE IMAGE

Fig 3.6

STRUCTURAL CALCULATIONS

COMPOSITE DESIGN

Composite construction is defined by the combination of multiple dissimilar materials that which create a stronger result than any of the individual components. In our case it is the joining of glass fiber skins with a semi-structural core to create a rigid, stand-alone panel system for all envelop components of the SURE house.

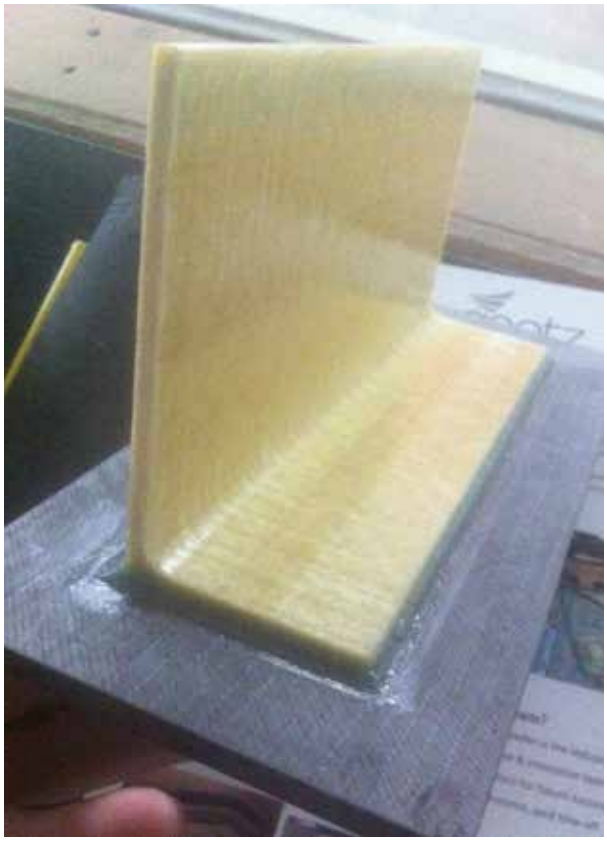
A large driving factor of glass fiber construction for this competition is transport and shipping logistics. A similar dimension composite section will have an 80% weight reduction compared to steel and 40% compared to aluminum, according to the Creative Pultrusions Pultex Pultrusion Global Design Manual. With regard to standard SIP Construction with OSB, a structural fiberglass skin will weigh in about 40% less per square foot. These numbers translate directly to fuel savings for trucking, moving and installation of a full house from Hoboken, NJ to Irvine, CA (and back).

Waterproofing is a second factor that pushed our design toward composite construction. With a closed cell foam core and fiberglass skin, the panel itself is waterproof with no other additions. As compared to to a standard EPS foam and OSB SIP system that must be clad and waterproofed to survive the elements. The SURE House is designed to spend its life along the Jersey Shore, in a high salt environment. Without a protective coating, or galvanization, steel will rust rather quickly. Composite pultrusions, can be tailored to be highly corrosion resistant during the initial manufacturing process, with a secondary operation needed. The benefits of composite construction techniques are virtually limitless, these are only a very few of the possibilities over traditional building methodologies.

STRUCTURAL CALCULATIONS

COMPOSITE BINDING STUDIES

Angle Binding



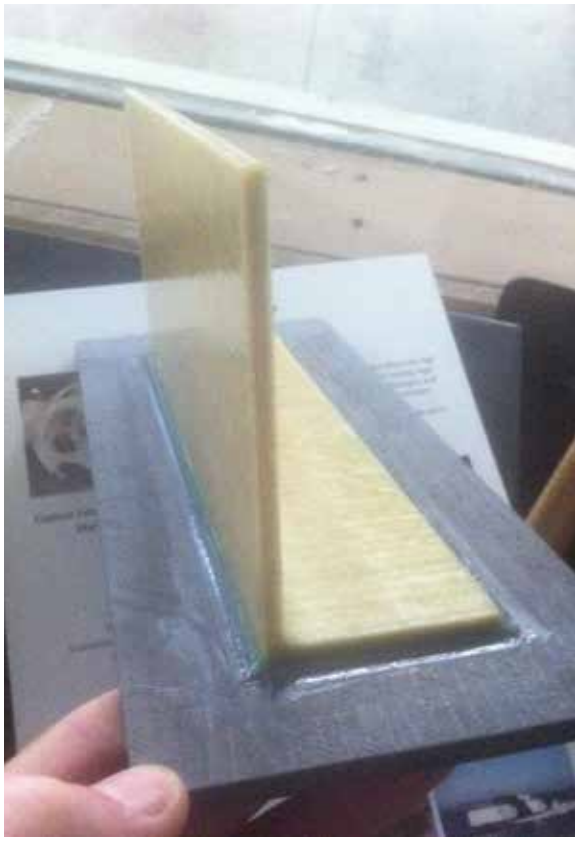


Fig 3.7 Angle Bracket w/ Compound Agent

STRUCTURAL CALCULATIONS

COMPOSITE BINDING STUDIES

Panel to Module Connection

Fig 3.8 Panel to Panel w/ Compound Agent

STRUCTURAL CALCULATIONS

COMPOSITE BINDING STUDIES

Insert and Square Tube Section

Fig 3.9 Portruded Composite Sections

STRUCTURAL CALCULATIONS

SUMMARY OF STRUCTURAL CALCULATIONS

In summary, the main structure of this house will be composed of HSS 4x3x1/4 floor beams, HSS 3x3x3/16 roof beams, and HSS 3x3x3/16 columns. Three different types of seismic pier (anchor, 7", 11") will be used to support the house in California. The design is completed for California loading conditions only, and only the SIPs are designed to meet floor conditions appropriate for the permanent building site. A different steel frame will be used in New Jersey to account for any additional loads related to the permanent site.

04 DETAILED WATER BUDGET

DETAILED WATER BUDGET

FUNCTION	WATER USE (Gallons)	CALCULATIONS Gallons	x Events	NOTES
Clothes Washing	112	8	14	Running clothes washer
Cooking	5	1	5	Boiling 5 pounds of water
Dinner	6	3	2	Dinner for 8 guests (bottled water)
Dish Washing	10	2.5	4	Running dish washer
Fire Protection	260	260	1	Use if necessary
Hot Water Draws	240	15	16	15 gallon hot water draw
Movie	2	2	1	Water for guests (bottled water)
Vaporization	5	1	5	Losses
Vegetation	270	135	2	
Calculated Use	902			
Safety Factor (10%)	90.2			
Water Required	**992.2**			

Table 4.1 Detailed Water Budget

05 SUMMARY of UNLISTED ELECTRICAL COMPONENTS

SUMMARY OF UNLISTED ELECTRICAL COMPONENTS

All electrical components carry an approved testing agency's listing per Section 6-7 of the SD 2015 Building Code. However, we would like to point out that our Advanced Energy AV PV heater is not readily available in the US. It is CE listed and well documented. There is a cut sheet for this product in Division 22 of the Product Cut Sheets section of this manual. For additional product information and specs, go here: http://solarenergy.advanced-energy.com/en/PV_Heater.html . For information on product certifications, go here: http://solarenergy.advanced-energy.com/upload/File/Solar/Certificates/3TL%20Certificates%20Overview%20 2014-09-30.pdf

06 SUMMARY of RECONFIGURABLE FEATURES

SUMMARY OF RECONFIGURABLE FEATURES

The design incorpotates four reconfigurable components.

A. CASEMENT STORMSHUTTER SYSTEMS

1. The casement stormshutter systems incorporate a protective layer to the casement windows located in the bedrooms. Operable for jurors only.

Design Drawing Set Page TBD.

B. WILSON DOOR STORMSHUTTER SYSTEMS

1. The wilson door stormshutter systems incorporate a protective layer to the perimeter of the living room. The stormshutter system acknowledges various scenarios/modes the user or natural environment may have. Operable for jurors only.

See drawing(s) A-311.

D. ZOLA LIFT AND SLIDE DOORS

1. The Zola Lift and Slide Doors have various qualities that enhance the experience, space, and aesthetics of SURE House. This feature allows for the blending of interior and exterior space. Operable for jurors only.

See drawing(s) A-311.

SUMMARY OF RECONFIGURABLE FEATURES

A. CASEMENT STORMSHUTTER SYSTEMS

Introduction

Bearing the effects of Hurricane Sandy in mind, the Stevens SURE House has been designed with a durable and effective resiliency program. To protect the home during hurricanes and one hundred year floods, the home will incorporate a casement window stormshuttter system that will primarily protect against floodproofing and water infiltration. The storm shutter doors are multi-purposed, acting as a protection against storms, a shading system, and as solar collectors.

SUMMARY OF RECONFIGURABLE FEATURES

A. CASEMENT STORMSHUTTER SYSTEMS

Demonstration of Reconfigurable Feature

During the competition the shutters will be shown to the jury closed (resiliency mode) and open (shade mode). Under normal operation, the shutters will predominantly remain open for shade and solar collection. They are intended to be closed during storm events. As this system is manually operated and is not feasible to fully demonstrate live to visitor to the home, the reconfiguration will be clearly presented in our video walkthroughs during the competition. The operable shutters will be demonstrated to the jury during the competition.

See Design Drawing Set (TBD).

SUMMARY OF RECONFIGURABLE FEATURES

B. WILSON DOOR STORMSHUTTER SYSTEMS

Introduction

Bearing the effects of Hurricane Sandy in mind, the Stevens SURE House has been designed with a durable and effective resiliency program. To protect the home during hurricanes and one hundred year floods, the home will incorporate a storm shutter system that will protect against typical loadings and additional loads that are experienced during intense storms. The storm shutter doors are multi-purposed, acting as a protection against storms, a shading system, and as solar collectors.

Fig 6.1 Stormshutters in a Shade + Flood Scenario

SUMMARY OF RECONFIGURABLE FEATURES

B. WILSON DOOR STORMSHUTTER SYSTEMS

Details

In the aftermath of Hurricane Sandy, the Stevens SURE house has been designed to withstand loadings typically associated with hurricanes. The bi-folding, dynamic storm shutters are designed to shade the glazing of a residential structure during normal use and act as the primary defensive barrier that protect the home during inclement weather. The shutters will be made with (+/- 45 degree) 12oz biaxial fiberglass, which will surround and be reinforced by Pultex Fiber Reinforced Polymer structural beams.

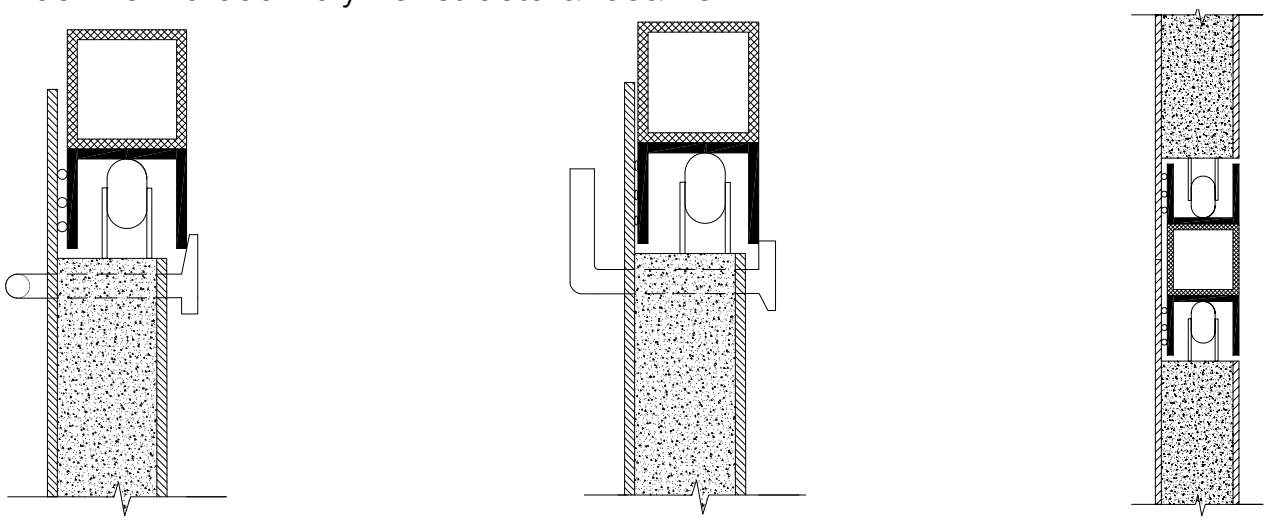


Fig 6.2 Section View of Shutter

The upper half of the shutter system will house photovoltaic panels that provide the residence with auxiliary power during power outages. The solar collectors operate off grid so that in the event of emergency the house can still be powered. Similar to a garage door system, the bi-fold shutters will run along aluminum tracks. The shutters are operated using either an automatic motor system or manual hand crank and can be raised or lowered to any desired height to provide shading or optimal solar collection by the integrated PV panels.

B. WILSON DOOR STORMSHUTTER SYSTEMS

Demonstration Of Reconfigurable Feature

The operable window shading and shutter system will close when necessary to properly condition/protect the home. As this system is manually operated and is not feasible to fully demonstrate live to visitor to the home, the reconfiguration will be clearly presented in our video walkthroughs during the competition. The operable shutters will be demonstrated to the jury during the competition.

See Design Drawing Set (A-311).

SUMMARY OF RECONFIGURABLE FEATURES

B. WILSON DOOR STORMSHUTTER SYSTEMS

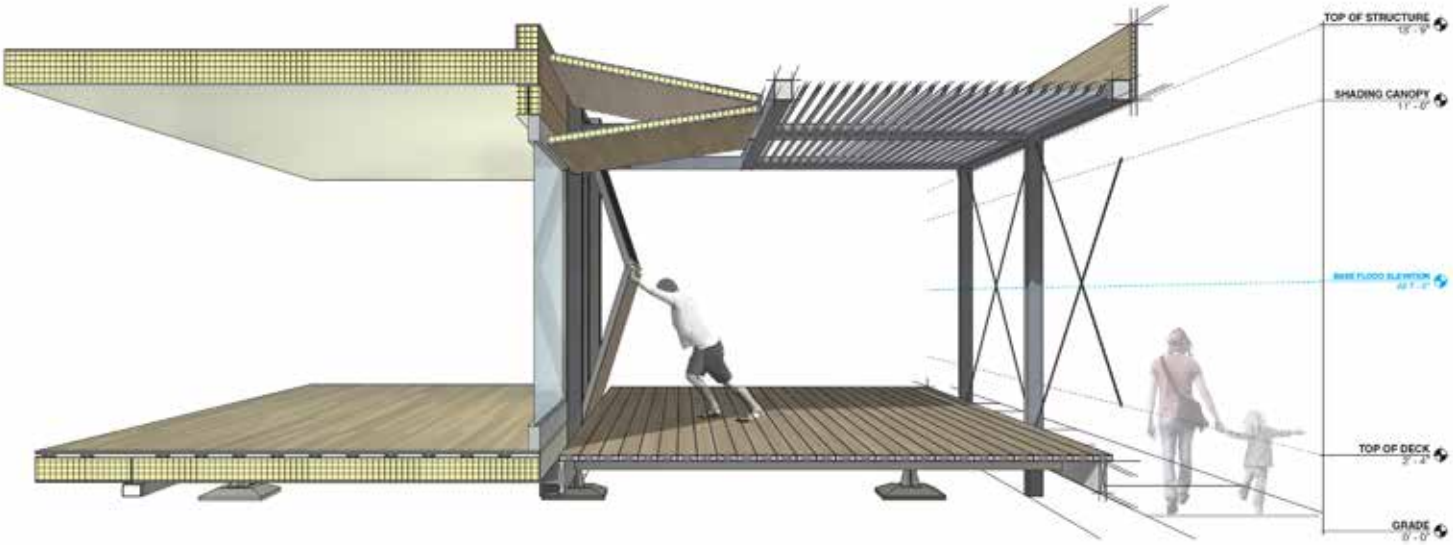


Fig 6.3 Shutter Operation

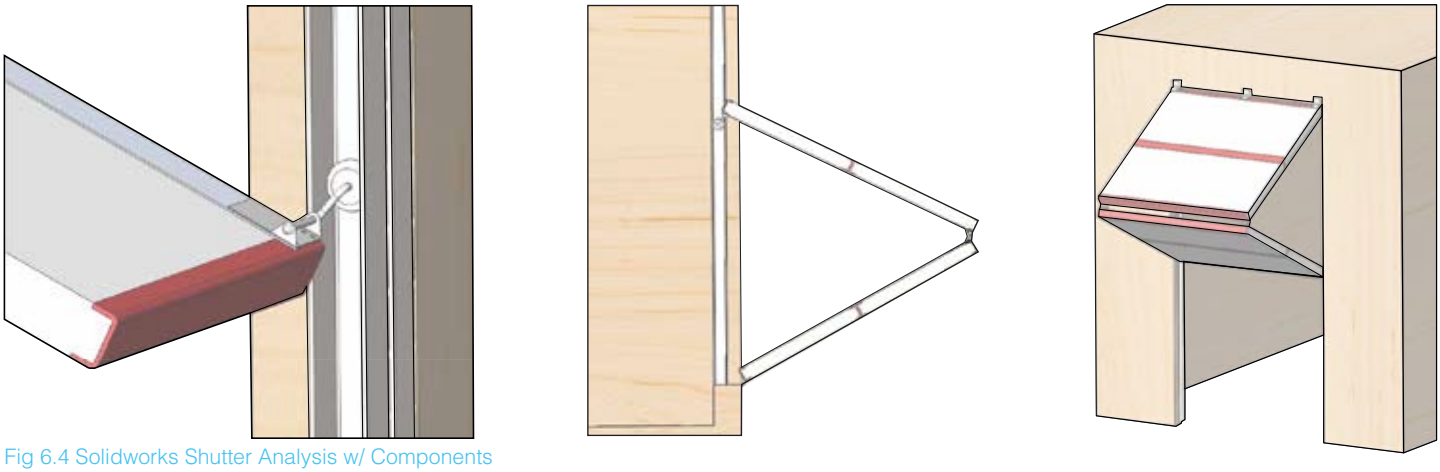


Fig 6.4 Solidworks Shutter Analysis w/ Components

SUMMARY OF RECONFIGURABLE FEATURES

C. ZOLA LIFT AND SLIDE DOORS

Introduction

Lift-Slide doors are a quintessential tool for contemporary living. No other type of patio door can offer equivalent expanses of glass without dividers which limit views. Zola Sliding Doors are super-insulated to ensure cozy comfort and energy efficiency with only glass in between occupant and view. In the SURE House these doors allow for maximum flexibility to the kitchen and living space, allowing these spaces to spill outside and thereby blurring the line between interior and exterior.

Fig 6.5 Casement Stormshutter Windows Perspectives

SUMMARY OF RECONFIGURABLE FEATURES

C. ZOLA LIFT AND SLIDE DOORS

Demonstrations of Reconfigurable Features for the Jury

During the competition, the lift and slide doors will primarily be open. During the morning hours, the door will be closed to demonstrate the continutity of space visually with the doors closed. During the afternoon,the open doors demonstrates the continuity of space. The doors help frame the local neighborhood context on the shore, as well as the garden space. They are essential in the layered levels of enclosure the house exhibits. The doors have the option to remain closed during the winter months with a smaller egress adjacent to the kitchen space.

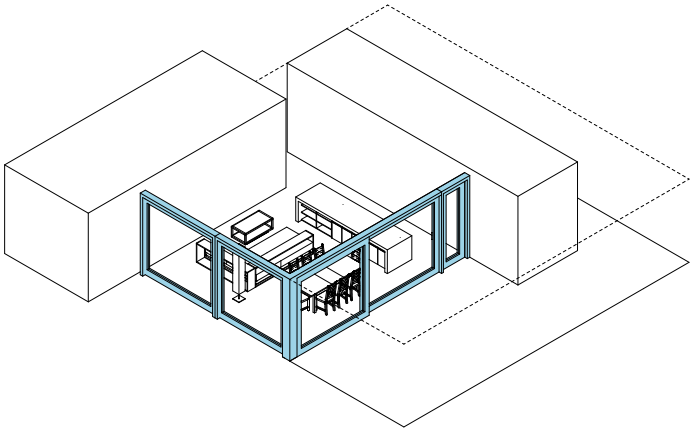


Fig 6.6 Closed Zola Door Mode - Enclosed Space

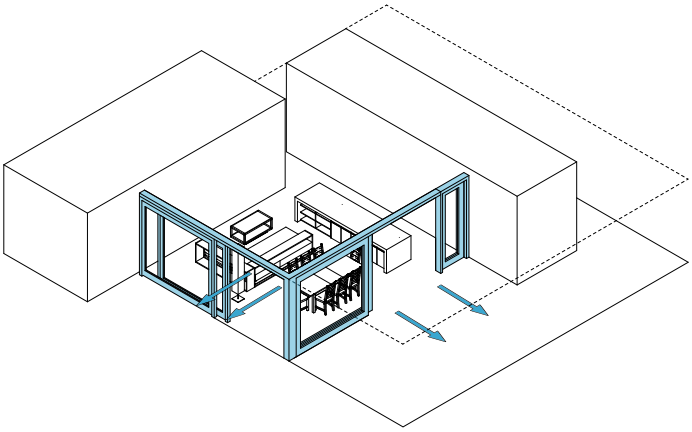


Fig 6.7 Open Zola Door Mode - Continuous Space

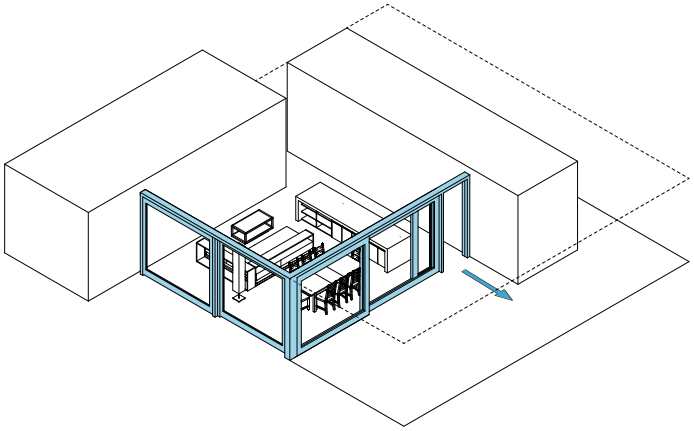


Fig 6.8 Winter Zola Door Mode - Private Single Door Entry

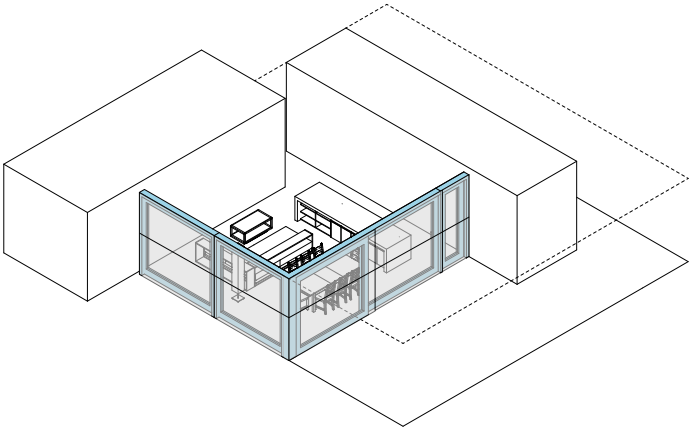


Fig 6.9 Enclosed Zola - Flood Protection From Shutters

07 INTERCONNECTION APPLICATION FORM

INTERCONNECTION APPLICATION FORM

SURE House - Lot #101

PV SYSTEMS

MODULE MANUFACTURER	SHORT DESCRIPTION OF ARRAY	DC RATING OF ARRAY (W)
Solar World	Inverter 1: String A – 11 modules, with TIGO Dual DC Maximizers	3,025
Solar World	Inverter 1: String B – 11 modules, with TIGO Dual DC Maximizers	3,025
Solar World	Inverter 2: String C – 13 modules, with TIGO Dual DC Maximizers	3,575
	Total DC Power Of All Arrays is 9.625 kW	

INVERTERS

INVERTER MANUFACTURER	MODEL NUMBER	VOLT-AGE	RATING (KVA OR KW)	QUANTITY
SMA America	SB 6000TL-US-22	240 V	6 kW	1
SMA America	SB 3800TL-US-22	240 V	3.78 kW	1

REQUIRED INFORMATION

	LOCATION
One - Line Electrical Schematic	E - 601
Calculations Of Service / Feeder Net Computed Load And Neutral Load (Nec 220)	E - 601
Plan View Of The Lot Showing The House, Decks, Ramps, Tour Paths, The Service Point, And The Distribution Panel Or Load Center	E - 601

SURE House Team Electrical Engineer - Armando Elliott
aelliott@stevens.edu

08 ENERGY ANALYSIS

RESULTS and DISCUSSION

ENERGY ANALYSIS RESULTS AND DISCUSSION

01 - INTRODUCTION AND GOALS

The following section discusses the entirety of the energy analysis carried out in the design of SURE HOUSE. After a brief introduction, the unique energy goals of SURE HOUSE are laid out followed by an explanation of the approach and tools used to conduct this analysis. Next weather data is discussed as well as the in depth shading analysis, HVAC and PV/solar thermal system designs and sizing approaches.

SURE HOUSE faces some very interesting challenges with regard to its energy balance, most of which are self-imposed. SURE HOUSE plans to obtain Passivhaus certification, perhaps the most stringent energy use standard in existence today. With limits on yearly heating and cooling energy demand as well as a building envelope air leakage maximum and a yearly primary energy limit, getting full points for Energy Balance during the competition is only a small part of what SURE HOUSE plans to achieve.

In fact, designing with both goals equally as important to SURE HOUSE makes for very unique conditions and requires a delicate look at the pros and cons of each design decision with the entire year in New Jersey in mind, as well as one week in October in Southern California where even the briefest interior comfort extremes are unacceptable.

In addition to all of this, SURE HOUSE is not only Sustainable, but Resilient and operating for as long as possible following an extreme weather event is essential. Our energy analysis includes quantifying what SURE HOUSE can realistically achieve with regard to providing heat, hot water and refrigeration while not connected to the grid.

While more analysis is still to take place, results up to this point have driven the design of SURE HOUSE to ensure that it is not only meeting the requirements, but revolutionizing how we think about green-built coastal housing.

ENERGY ANALYSIS RESULTS AND DISCUSSION

02 - PASSIVE HOUSE CERTIFICATION

Passivhaus is a building energy standard coming out of Germany that is rapidly becoming more popular in the United States. Certified buildings on average use 90% less energy than conventional comparison buildings. Along with receiving full points for Energy Balance during the competition, it is of the highest priority for SURE HOUSE to achieve this standard. The standard dictates that following:

FUNCTION	SI	IP
Heating Demand	15 kWh/m^{2}a	4.75 kBtu/ft^{2yr}
Cooling Demand	15 kWh/m^{2}a	4.75 kBtu/ft^{2yr}
Air Tightness	0.6 ACH_{50}	
Primary Energy	120 kWh/m^{2}a	38 kBtu/ft^{2yr}
Passivhaus Energy Requirements		

Table 8.1

Achieving this standard is no easy task, requiring in depth analysis and intelligent design from the beginning of the design process. For climates such as ours here in New Jersey, extremes are experienced in both winter and summer. The stringent Passivhaus standard dictates that a highly efficient building envelope be used to minimize and precisely control the energy that passes through it. This way, energy gains and losses can be accurately balanced in order to reduce the amount of energy needed to condition the space, making for a low energy demand as well as a desirable and controlled indoor climate. This is done through the use of super-insulated wall, roof and floor assemblies, reduction of thermal bridging, thermally efficient and air-tight windows, an air tight construction methodology, heat or energy recovery ventilation, and finally the use of passive solar gains and intelligent shading.

These design parameters dictate the equation governing this delicate energy balance which is broken down as follows:

$$Q_{TOT} = Q_I + Q_S + Q_v + Q_v + Q_T$$

Q_{TOT} = Total Specific Heating or Cooling Demand
Q_I = Internal Heat Gains
Q_S = Solar Heat Gains
Q_V = Ventilation Gains or Losses
Q_T = Transmission Gains or Losses

ENERGY ANALYSIS RESULTS AND DISCUSSION

PASSIVE HOUSE CERTIFICATION

Internal Heat Gains

The energy added to a space from the processes occurring within it can add a considerable amount of heat to the energy balance for better or for worse. While it is not the most efficient way to add heat to a space, most of our internal heat gains are inevitable and therefore should be utilized when needed and taken into account when unwanted. This factor is often calculated early on in the process and remains unchanged based mostly on appliance use and number of occupants for both the heating and cooling seasons.

Solar Heat Gains

Another inevitable source of heat for most buildings are the solar heat gains through the transparent surfaces of the envelope. Unlike internal heat gains, a much higher degree of control can be achieved with solar gains, making it an essential variable to accurately model and capitalize on. Several variables play into the intelligent utilization of solar gains, but the end goal should always remain the same: maximizing gains during the heating season while minimizing gains during the cooling season, beginning with passive strategies and ending with
active strategies.

ENERGY ANALYSIS RESULTS AND DISCUSSION

PASSIVE HOUSE CERTIFICATION

Ventilation Gains or Losses

A constant supply of fresh air in a building is essential, but a considerable amount of energy can be lost through this exchange. The average home built today can get most of the fresh air it needs from leaks through the envelope but this results in a considerable loss of energy used to condition that air. The goal of Passivhaus is to control the gains and losses through the envelope of a house as much as possible by reducing leakage, known as infiltration, and passing all fresh air through a heat recovery or energy recovery ventilation system in order to
reduce the amount of energy needed to condition the intake air.

Transmission Gains and Losses

The thermal resistance of the assemblies of the building surfaces combined with the design techniques used to reduce thermal bridging along with the temperature difference between inside and outside dictate the magnitude of the transmission losses through the envelope. While there is no limit to how much insulation can be used in a particular assembly, cost and space restrictions are often limiting factors. Due to the diminishing returns of additional thermal resistance, a cut-off point can often be determined where no more appreciable benefit will come from adding more insulation to a structure. Most homes today however are insulated well below this point.

Balancing these four variables for both the heating and cooling season is how the Passivhaus standard is achieved. This detailed calculation is performed with the certified modeling tool known as the Passive House Planning Package which will be discussed in the next section.

ENERGY ANALYSIS RESULTS AND DISCUSSION

COMPETITION ENERGY BALANCE

In order to receive full points during the competition, SURE HOUSE is being designed to handle the unique competition conditions and loads. The climate in New Jersey dictates that SURE HOUSE will be able to handle the hottest conditions that could be experienced in Irvine in October while easily covering any heating that might be need at night to maintain the competition temperature range.

The difficult part of the equation is the quick transitions experienced during the competition with regard to cooling, dehumidification, and potential nighttime heating. In order to control the indoor environment with certainty, our versatile HVAC and dehumidification system will be capable of performing both high rates of cooling and dehumidification, for instance after the Public Exhibition period, to ensure set points are reached in time for measuring. Outside of the competition, this function fits perfectly with the SURE HOUSE narrative. The encouraged use of the South deck and opening of the large sliding doors for social events makes for hot and humid indoor conditions. This cooling and dehumidification “boost mode” will be capable of quickly and efficiently reducing these conditions, quickly returning the home to easily maintainable and comfortable conditions.

Combined with sizing our array to handle our energy needs during the competition, SURE HOUSE aims to get full points for both the energy balance and the comfort zone contests.

POST HURRICANE EMERGENCY MODE

The final goal of SURE HOUSE is to be capable of supplying itself with a certain amount of heating, electricity, running water and refrigeration during a post-hurricane emergency where much of the New Jersey coastal area could be cut off from the electrical grid and/or municipal water. In order to understand this potentiality, the energy balance of the house under these conditions must be studied and new processes for space and water heating developed in response.

ENERGY ANALYSIS RESULTS AND DISCUSSION

03 - CLIMATE DATA

The climate data for this project needed to be as specific as possible to allow for very exact calculations on the performance of the house. Therefore, the data needed to be hourly to provide for the best degree of accuracy. The team decided to use Typical Meteorological Year (TMY) data released by the National Renewable Energy Laboratory (NREL). This data provides hourly solar insolation values as well as temperature and humidity values and can be manipulated to give exact insolation values for each cardinal direction making it invaluable for solar load calculation through windows. The data sets used for the analysis were the most representative that could be found for our project locations which run along the New Jersey coastline including communities such as Atlantic City and Belmar.

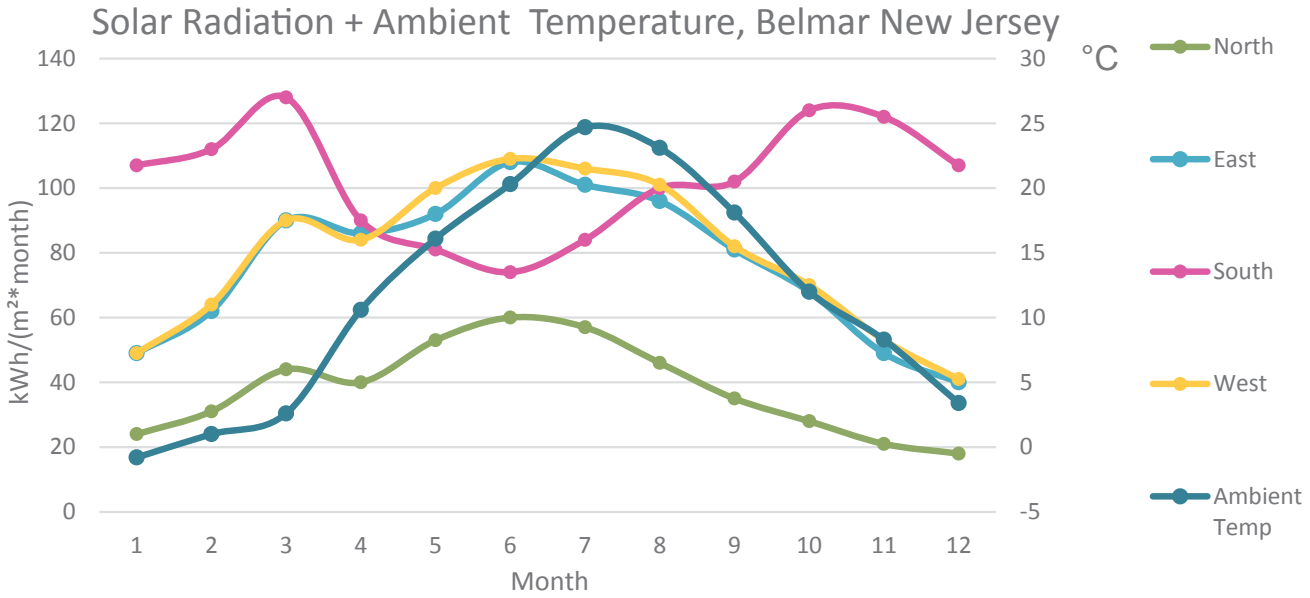


Fig 8.1

ENERGY ANALYSIS RESULTS AND DISCUSSION

CLIMATE DATA

Analysis for the competition site was exectued using the data from John Wayne Airport which is very representative of Irvine, California. These data sets allowed us to model the house in a “typical” year to benchmark its performance.

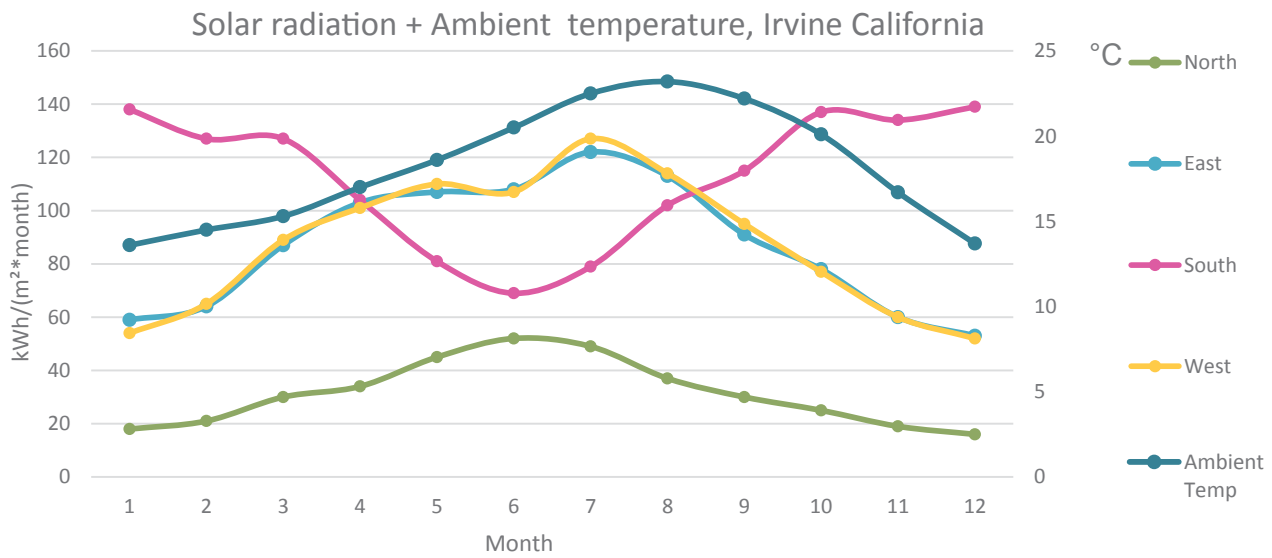


Fig 8.2

ENERGY ANALYSIS RESULTS AND DISCUSSION

04 - APPROACH AND TOOLS

The use of software tools to model and predict the performance of SURE House is critical to both competition energy balance, as well as, post hurricane emergency mode. In addition, the students at Stevens who are gaining experience with these applications through this project will be prepared to become innovators in sustainable and resilient building design for decades to come.

Passive House Planning Package (PHPP) – Monthly model developed by the Passivhaus Institut to be used for Passive House certification. Outputs monthly and yearly heating and cooling demands as well as primary energy values.

DesignPH - Sketchup – Links with PHPP software and used for basic geometry energy analysis.

DIVA for Rhino Shading and Daylighting Analysis – Used to evaluate complex shading geometries in a 3D modeling environment. DAYSIM and Radiance are used to calculate hourly irradiation levels on windows and walls.

THERM 6.3 – Two dimensional thermal modeling tool used to evaluate transmission losses through individual envelope components.

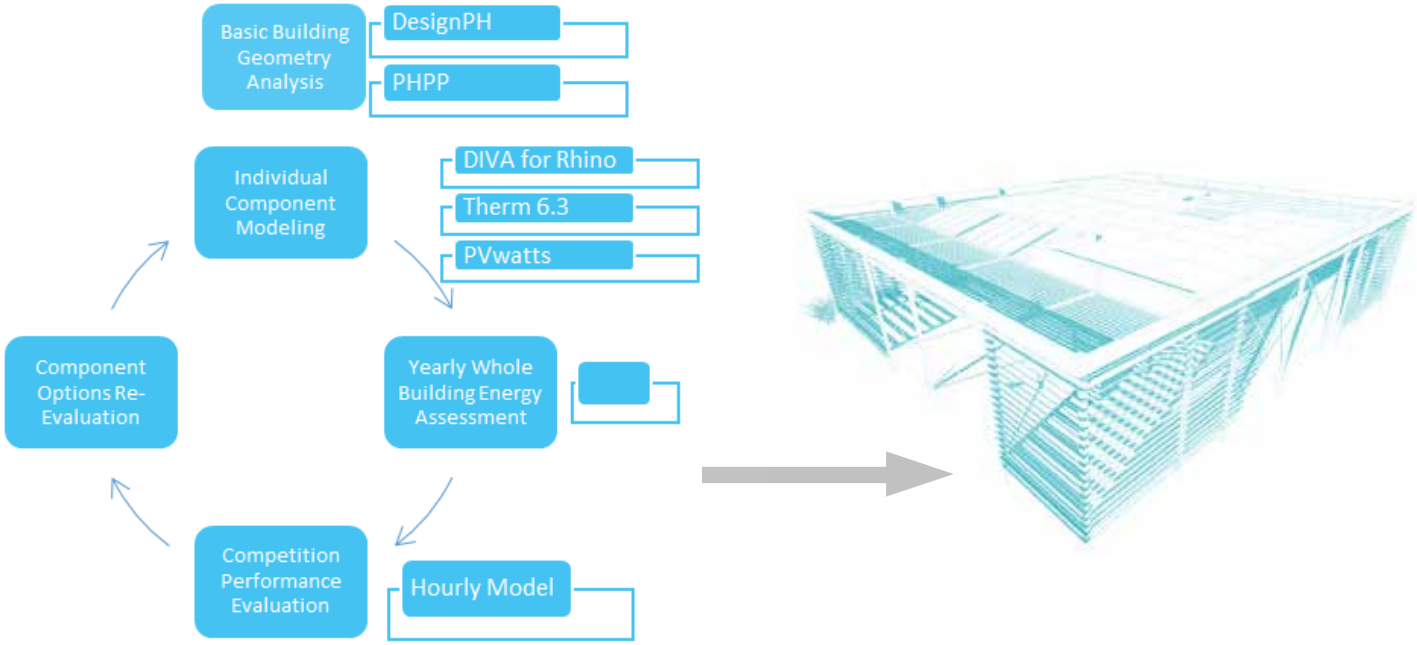


Fig 8.3

ENERGY ANALYSIS RESULTS AND DISCUSSION

APPROACH AND TOOLS

PVWatts – An online tool that calculates the performance of photovoltaic arrays used to size our system.

In order to accurately understand the energy performance of SURE HOUSE, individual components within the house, such as the shading or the mechanical systems, are modeled with different software and these results fed into whole building analysis tools to evaluate the overall energy impact on the building. Before individual components are analyzed however, the overall geometry and location of the house are investigated for potential use of passive building strategies.

Detailed Systems Sizing

Envelope optimization is driven by the Passivhaus Standard and the results from the Passivhaus modeling and certification tool, the PHPP. With these envelope specifications and our simple hourly model, loads were determined to size our mechanical systems. The next round of evaluations will include an in depth systems sizing analysis using TRNSYS.

Due to the unique nature of SURE HOUSE's split ventilation and heating/cooling system along with the innovative desiccant system, modeling how it will perform under various conditions is not an easy task. The high level of control possible with TRNSYS will give us the ability to understand just what our system is capable of and will further our efforts to size the system appropriately for the year and for the competition.

ENERGY ANALYSIS RESULTS AND DISCUSSION

05 - ANALYSIS OVERVIEW

-29.25 kBtu/yr 4,290 kBtu/yr

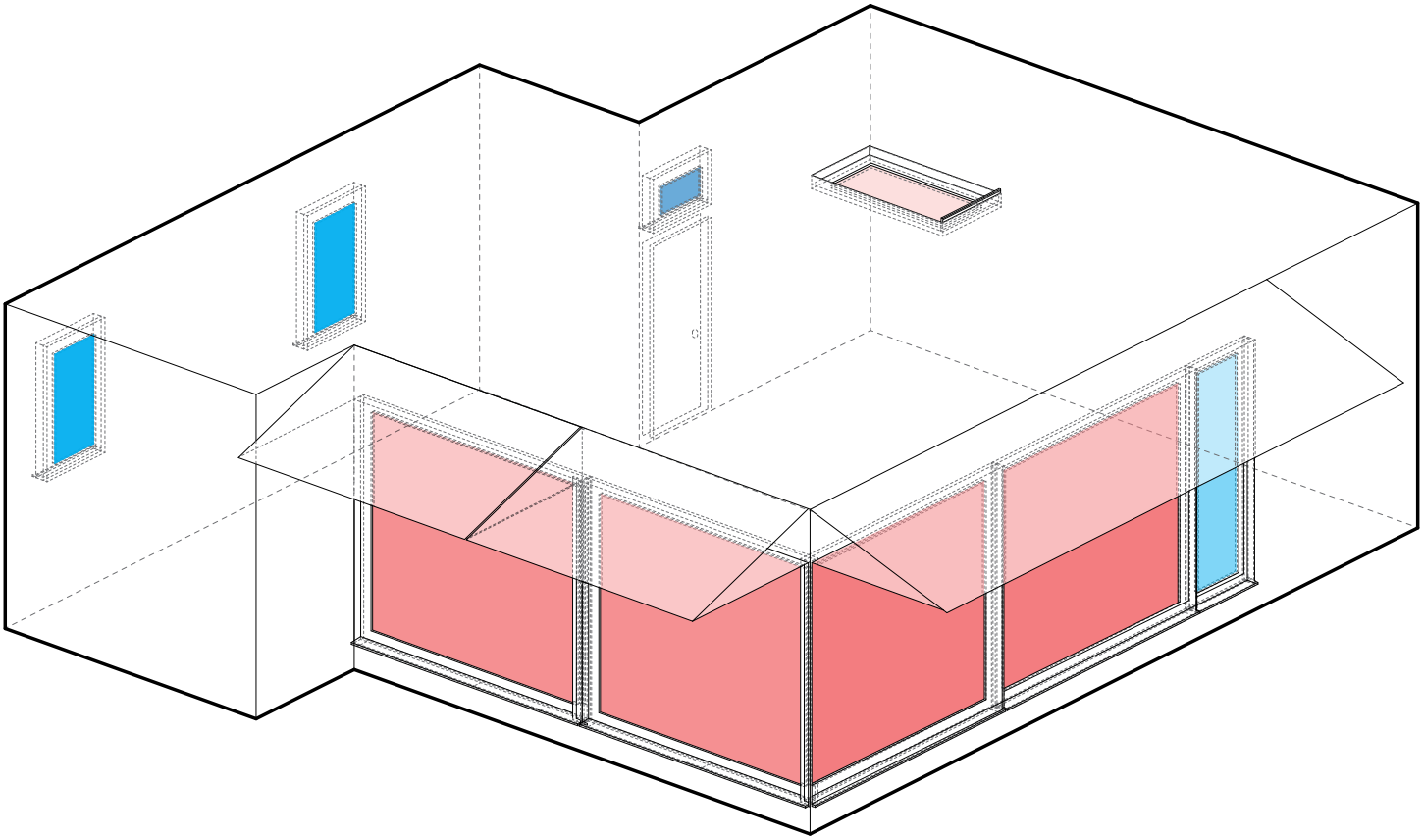


Fig 8.4

The graphic above shows the results from the PHPP using DesignPH. Graphics such as these quickly communicate how much heat is being gained or lost through each window and are essential to the optimization process.

ENERGY ANALYSIS RESULTS AND DISCUSSION

HEAT LOSS THROUGH ENVELOPE

Residential homes in New Jersey consume more energy for heating and cooling than any other use. In order to achieve Net-Zero and achieve Passive House certification, heat losses through the envelope of a house must be minimized. The SURE HOUSE envelope utilizes high levels of insulation in the walls and roof, efficient energy recovery ventilation, minimal thermal bridging, and air-tight construction. The biggest mode of heat loss for SURE HOUSE will be through its large percentage of windows which are the least thermally resistant part of the envelope.

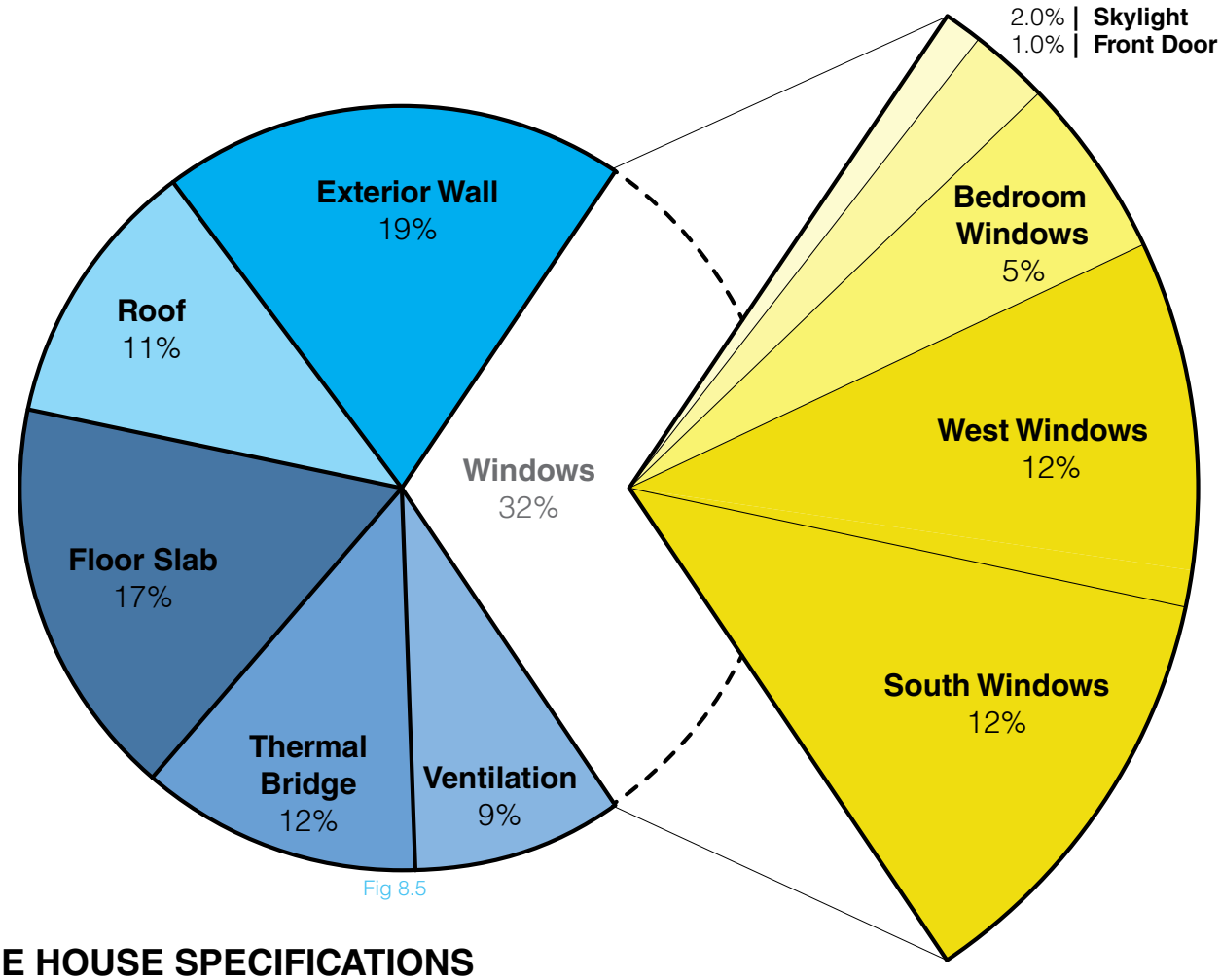


Fig 8.5

SURE HOUSE SPECIFICATIONS

Window Glass R-Value: 11.4 h ft^2 °F/Btu (0.0877 U-Value Btu / h ft^2 °F)
Window Frame R-Value: 5.7 h ft^2 °F/Btu (0.1786 U-Value Btu / h ft^2 °F)
Air Tightness: 0.6 Air Changes per Hour at 50 Pascals
Energy Recovery Ventilator Efficiency: 92% (Effective 85%)

ENERGY ANALYSIS RESULTS AND DISCUSSION

PRODUCTION & CONSUMPTION BREAKDOWN

Throughout the year SURE HOUSE will produce more energy than it will consume meaning that on an average year the house will have no heating, electrical, or even transportation costs thanks to the rooftop photovoltaic array. Below is a breakdown of how the energy is used throughout the year. This type of analysis can rigorously assure us the house will be a Net-Zero home.

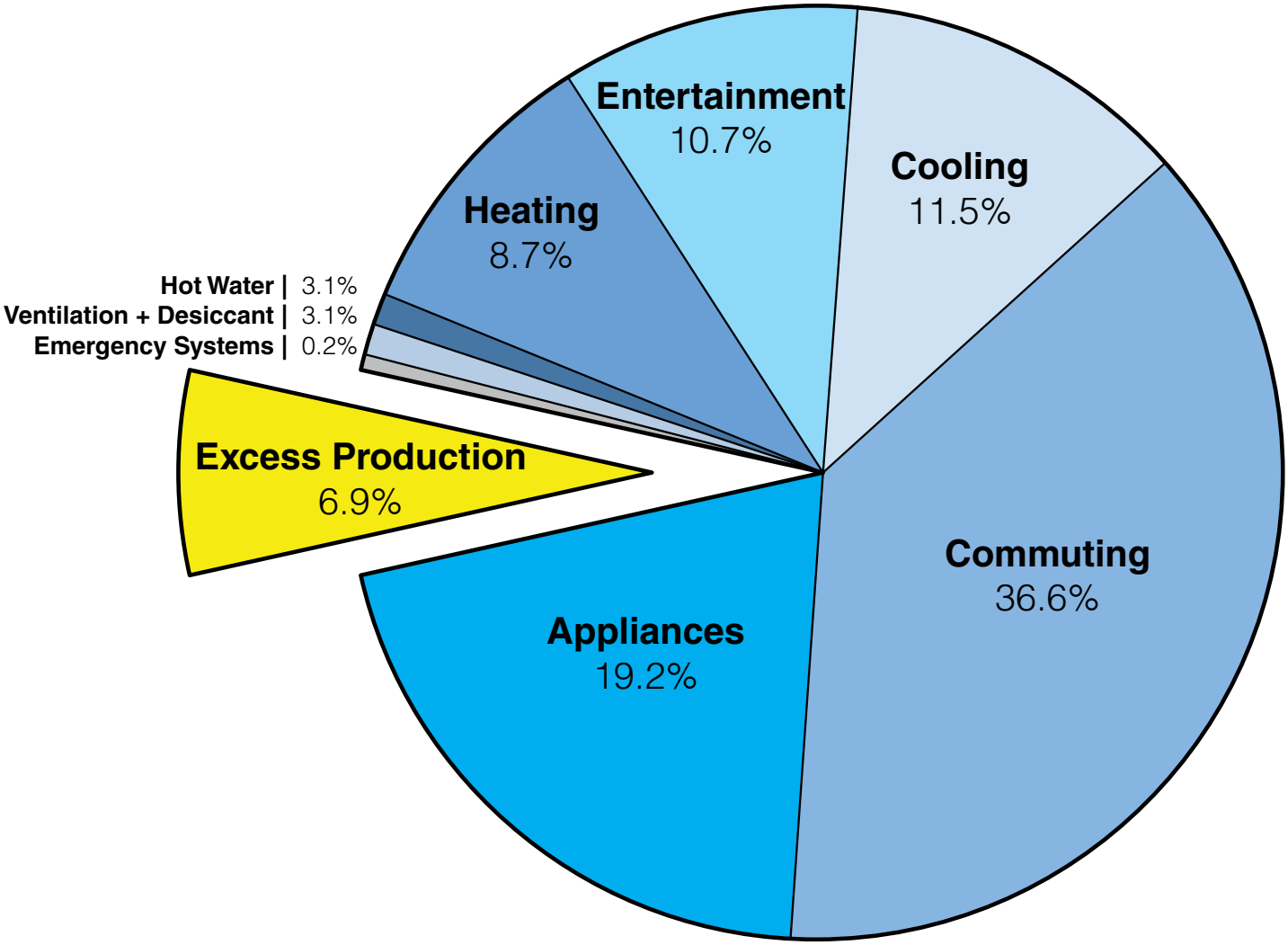


Fig 8.6

ENERGY ANALYSIS RESULTS AND DISCUSSION

07 - Cost of Heating & Cooling By Standard

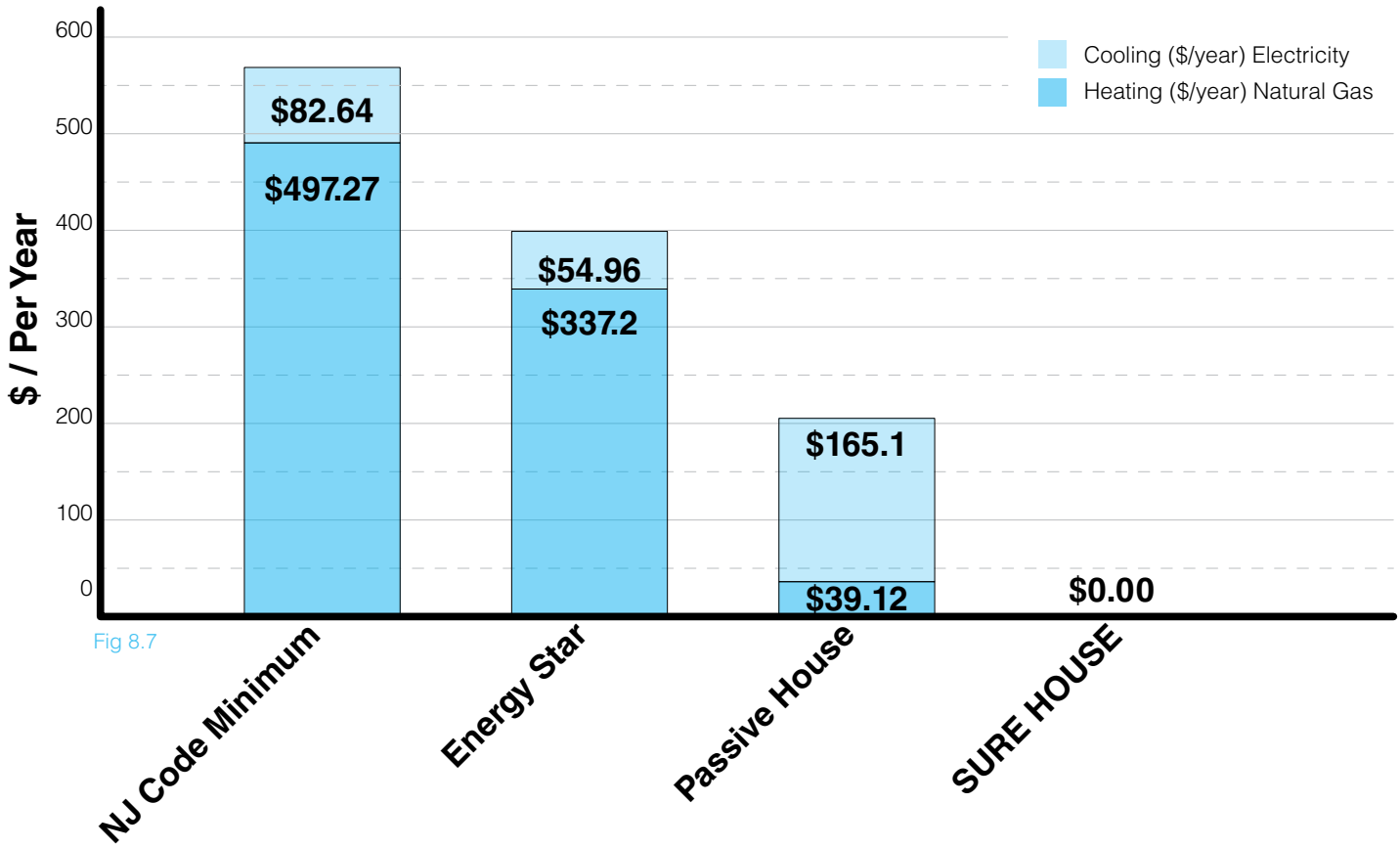


Fig 8.7

Heating and cooling costs vary greatly depending on the age of a building and the air-tightness that is achieved. The above graph shows how much energy four newly built homes will use based on the building standard applied. The SURE HOUSE, having fully electric heating and cooling, will be 100% powered by solar panels which eliminates any reliance on fossil fuels.

ENERGY ANALYSIS RESULTS AND DISCUSSION

R-Value Comparison

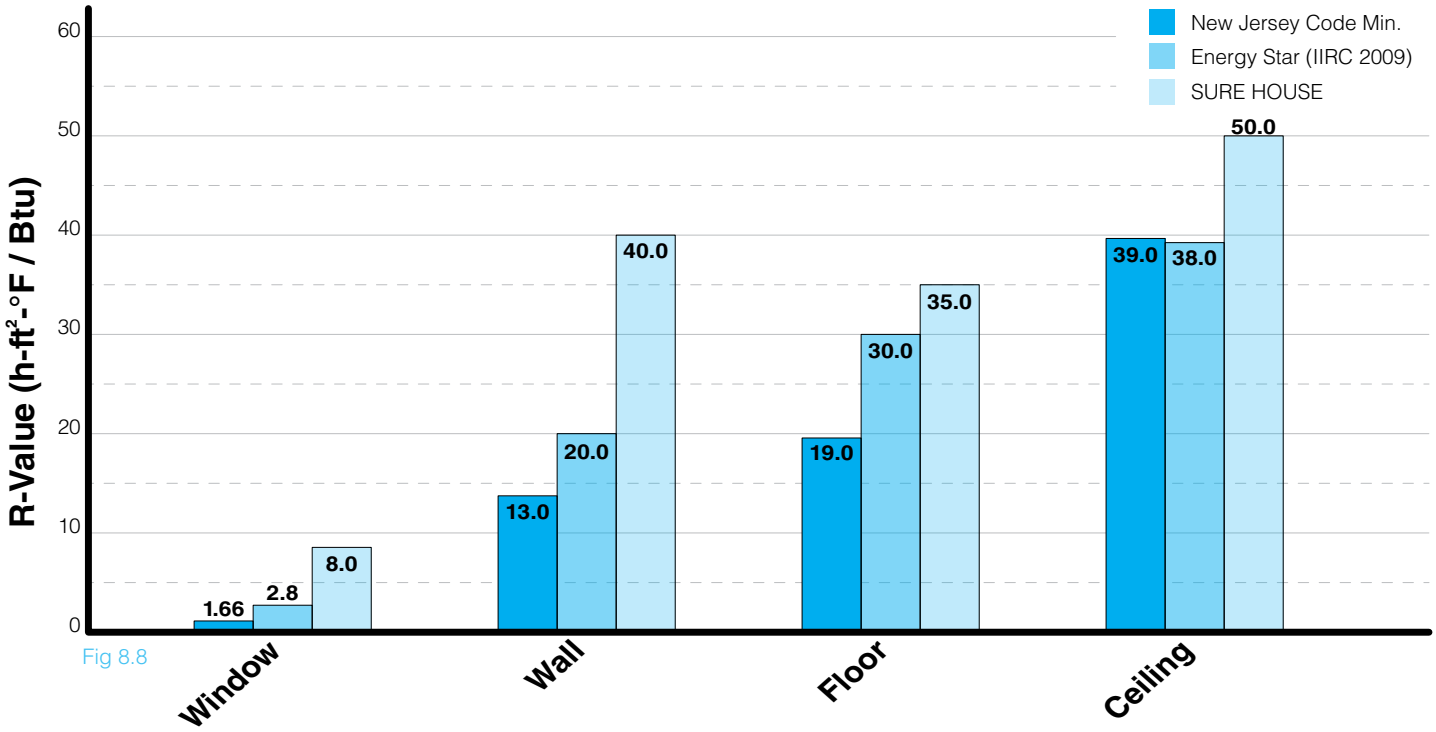


Fig 8.8

When doing a yearly energy balance one of the main problems is how to keep heat inside the home in the winter and keep heat out in the summer. The primary way to reduce energy use is to 'super insulate' the home's walls, floors, and roof which results in radically less energy use for space conditioning. The R-Values being used in SURE HOUSE are typical of Passive House's in the U.S. and are essential to the overall energy efficiency of the building.

ENERGY ANALYSIS RESULTS AND DISCUSSION

07 - SHADING ANALYSIS

SURE House has a glazing to floor area ratio of 38% which is a very high percentage. This offers a great opportunity for solar gains during the heating season, but is dangerous during the cooling season. For this reason, a detailed shading analysis is being performed to try and minimize gains during the cooling season while maximizing gains during the winter.

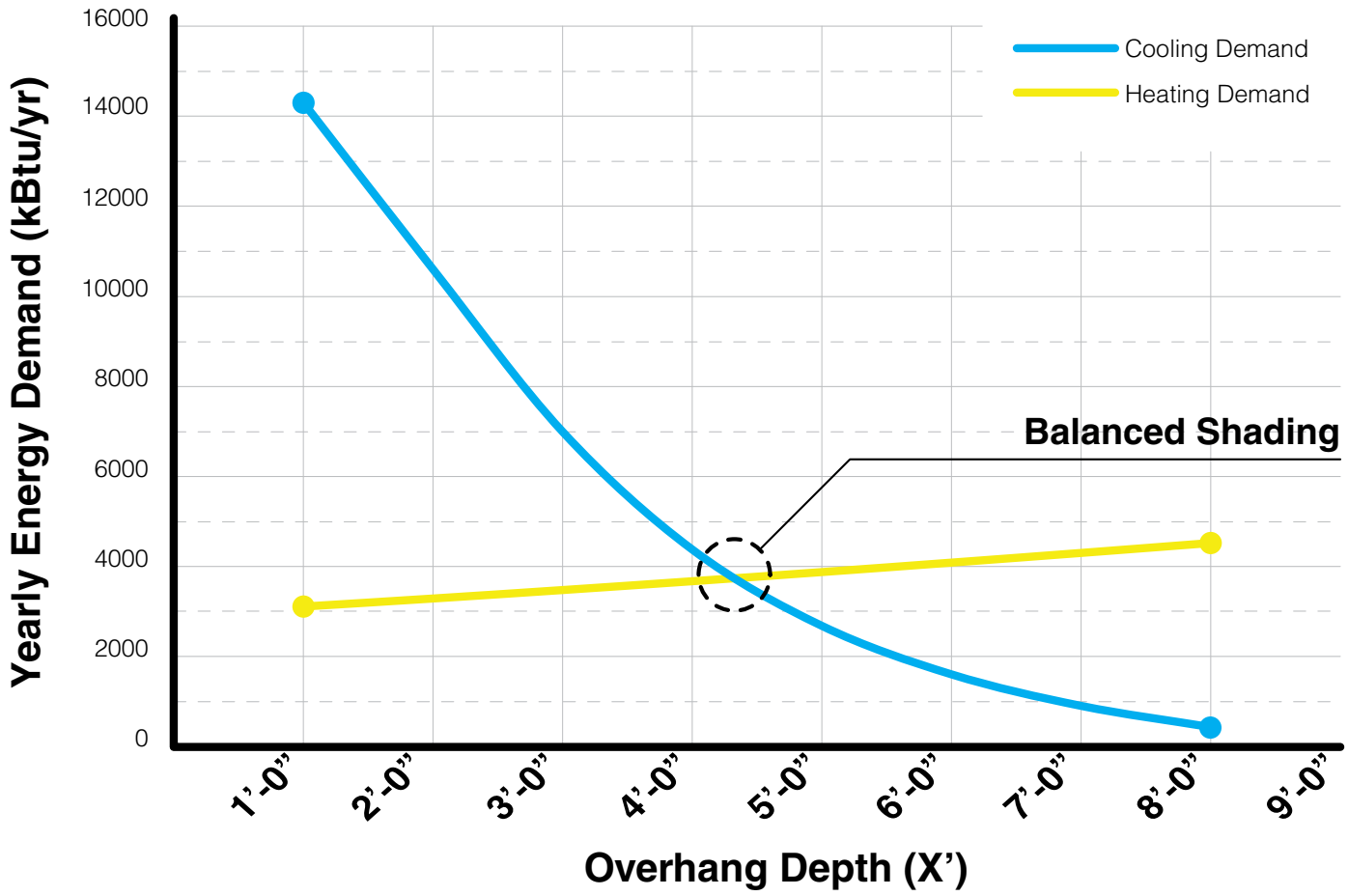


Fig 8.9

When in their folded position, the storm shutters form an overhang which shades a significant portion of our windows during cooling load dominated seasons. Increasing the depth of this shading increases the yearly heating demand and decreases the yearly cooling demand. The point where these two are equal gives the balanced shading depth, however other factors such as the area of the solar panels required to reach energy production needs must also be taken into account. Weighing these two will determine the dimensions in the final design.

ENERGY ANALYSIS RESULTS AND DISCUSSION

SHUTTER SHADING

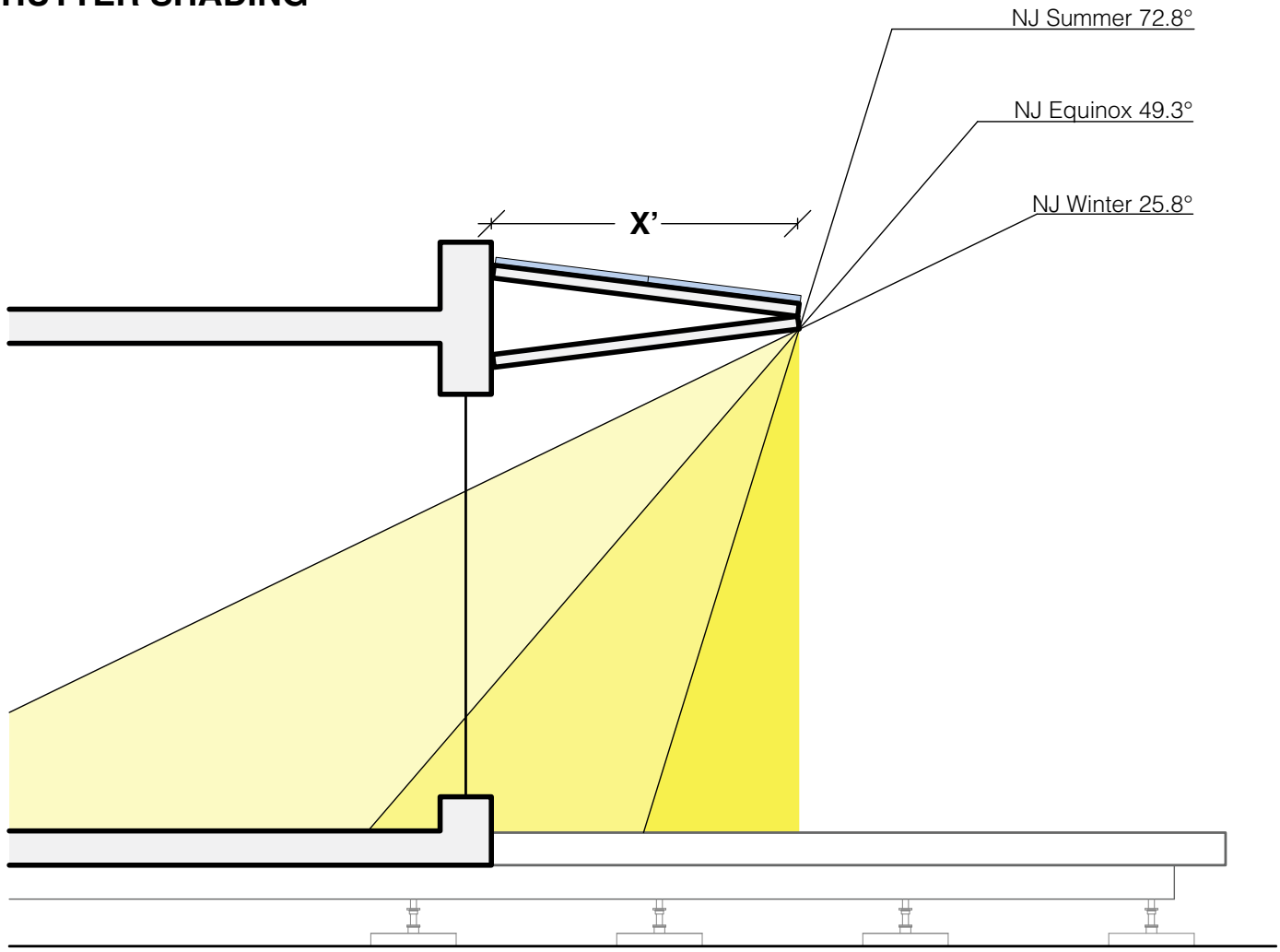


Fig 8.10

The innovative storm shutters of SURE HOUSE are primarily designed to provide flood resistance but have a dual purpose in helping us effectively shade the house during the summer months. When cooling the house we want to shade the windows as much as possible to keep out unwanted solar gains. Due to the sun's high position in the sky, a horizontal overhang is very effective at shading the south facing glass. In the winter, when the sun is lower in the sky, the overhang does not block the beneficial solar heat from entering the building, helping us by adding warmth to the house. These two functions make the overhang an effective year round feature to reduce heating and cooling energy demands on our mechanical systems.

ENERGY ANALYSIS RESULTS AND DISCUSSION

LOUVER SYSTEM ANALYSIS

The storm shutter system required to protect the South and West windows during a storm scenario will provide a large amount of essential shading while in their folded position above the windows. More shading is needed however to prevent overheating during the summer. The following analysis looks at the complicated louver system to evaluate its effect on heating and cooling demand for the year. The plugin DIVA for Rhino was used to determine the shading percentages for each window for each geometry and the effect on heating or cooling demand was calculated using the PHPP.

FUNCTION	BASE CASE	PASSIVE HOUSE GOAL
Heating Demand	15 kWh/m^{2}a (4.75 kBtu/ft^{2}yr)	15 kWh/m^{2}a (4.75 kBtu/ft^{2}yr)
Cooling Demand	21 kWh/m^{2}a (9.8 kBtu/ft^{2}yr)	16 kWh/m^{2}a (5.0 kBtu/ft^{2}yr)

Table 8.2

These results for the base case are a cause for concern because they indicate that even in the best possible scenario, our heating demand is only barely below the limit. However, the point of this analysis is to determine how beneficial each section of the louver system is and to decide how to proceed from there to achieve Passive House certification.

ENERGY ANALYSIS RESULTS AND DISCUSSION

LOUVER SYSTEM

The louver system currently proposed will have three different sections to enclose the South Deck and West Garden. The first section is made up of horizontal louvers over the South Deck, vertical louvers along the length of the South Deck, and vertical louvers in front of the West Garden.

ENERGY ANALYSIS RESULTS AND DISCUSSION

HORIZONTAL LOUVER

The first round of tests looks at louver angle to determine what angle will be optimal to reach our energy goals.

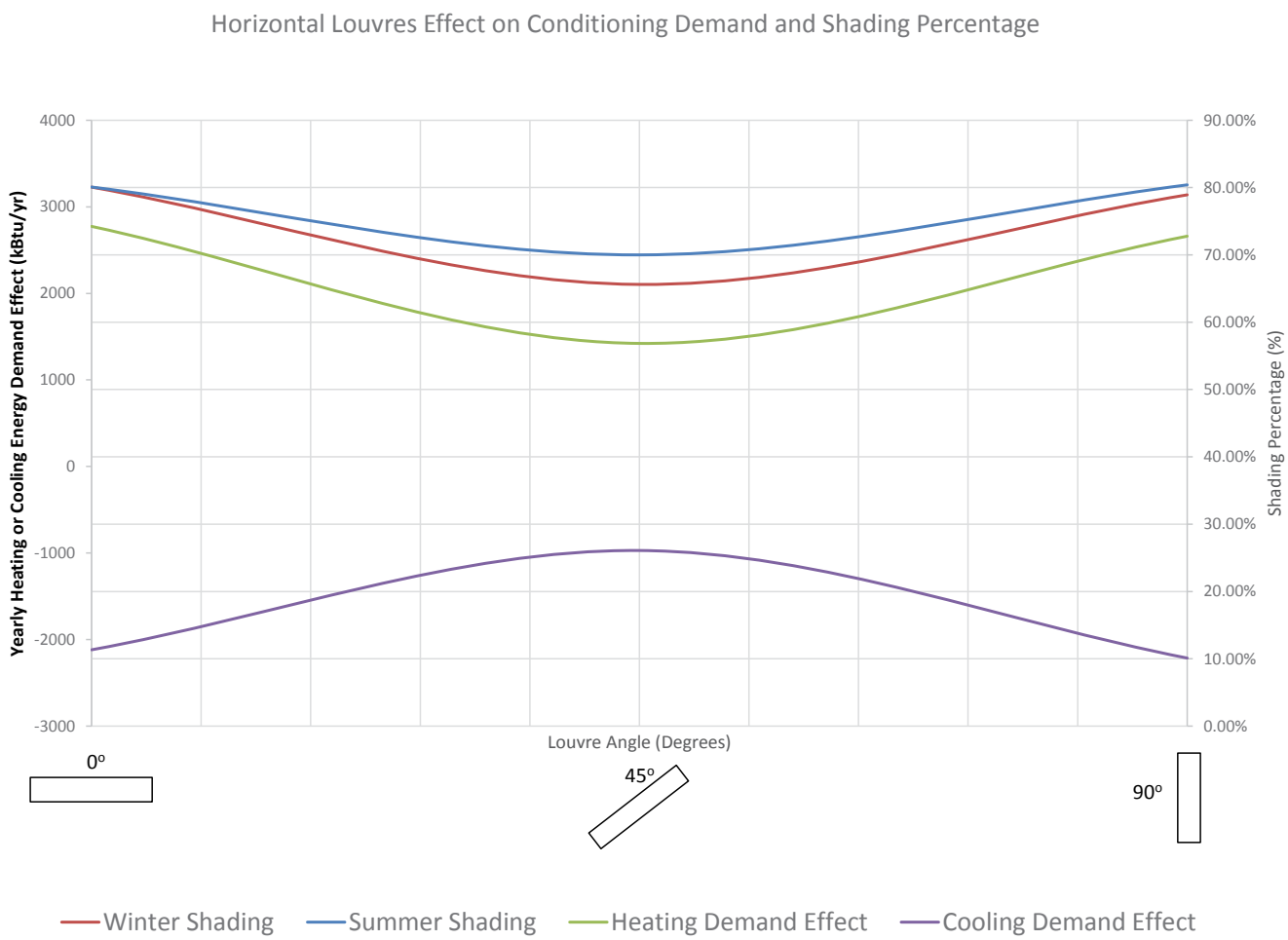


Fig 8.11

ENERGY ANALYSIS RESULTS AND DISCUSSION

HORIZONTAL LOUVER

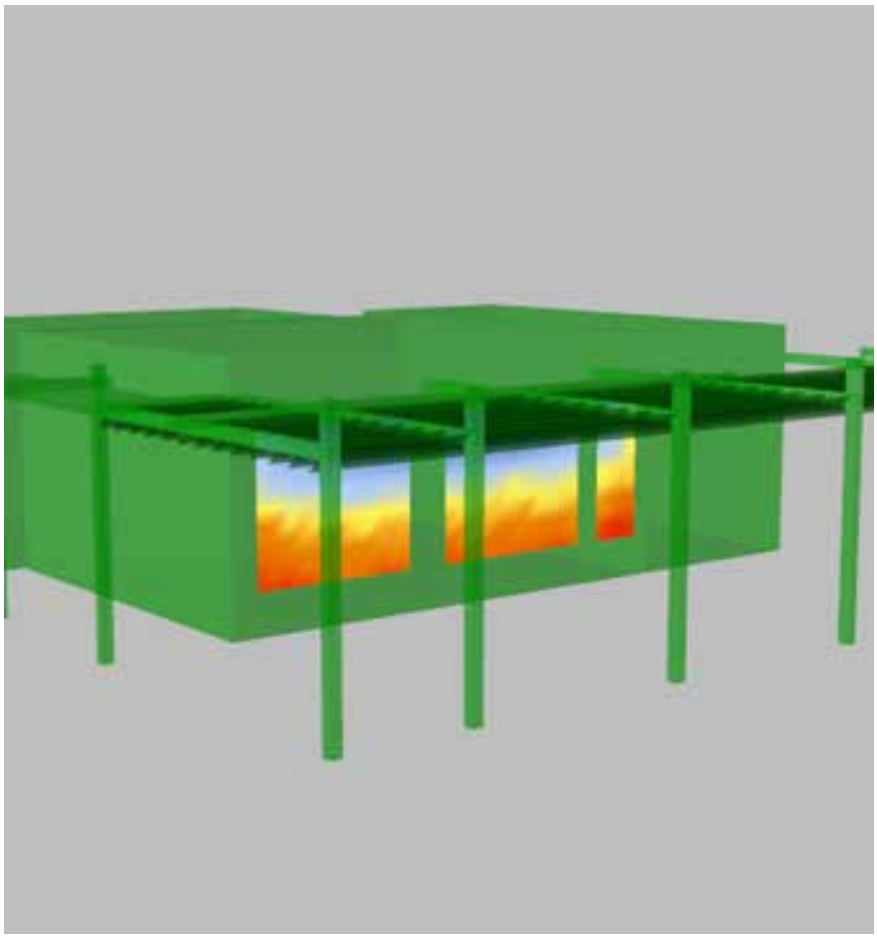


Fig 8.12

Fig 8.11 and Fig 8.12 shows the relationship between louver angle and shading percentage on the southern windows for each season as well as the effect on the heating and cooling demand. Overall, the horizontal louvers have a great effect on both heating and cooling demand, especially when fully closed or fully open. They have the potential to decrease cooling demand by 50% and increase heating demand by over 50%. Due to this fact, the configuration of these louvers will be considered very carefully for the final design and will be used to adjust our modeled loads to desired levels.

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOUTHERN VERTICAL LOUVER

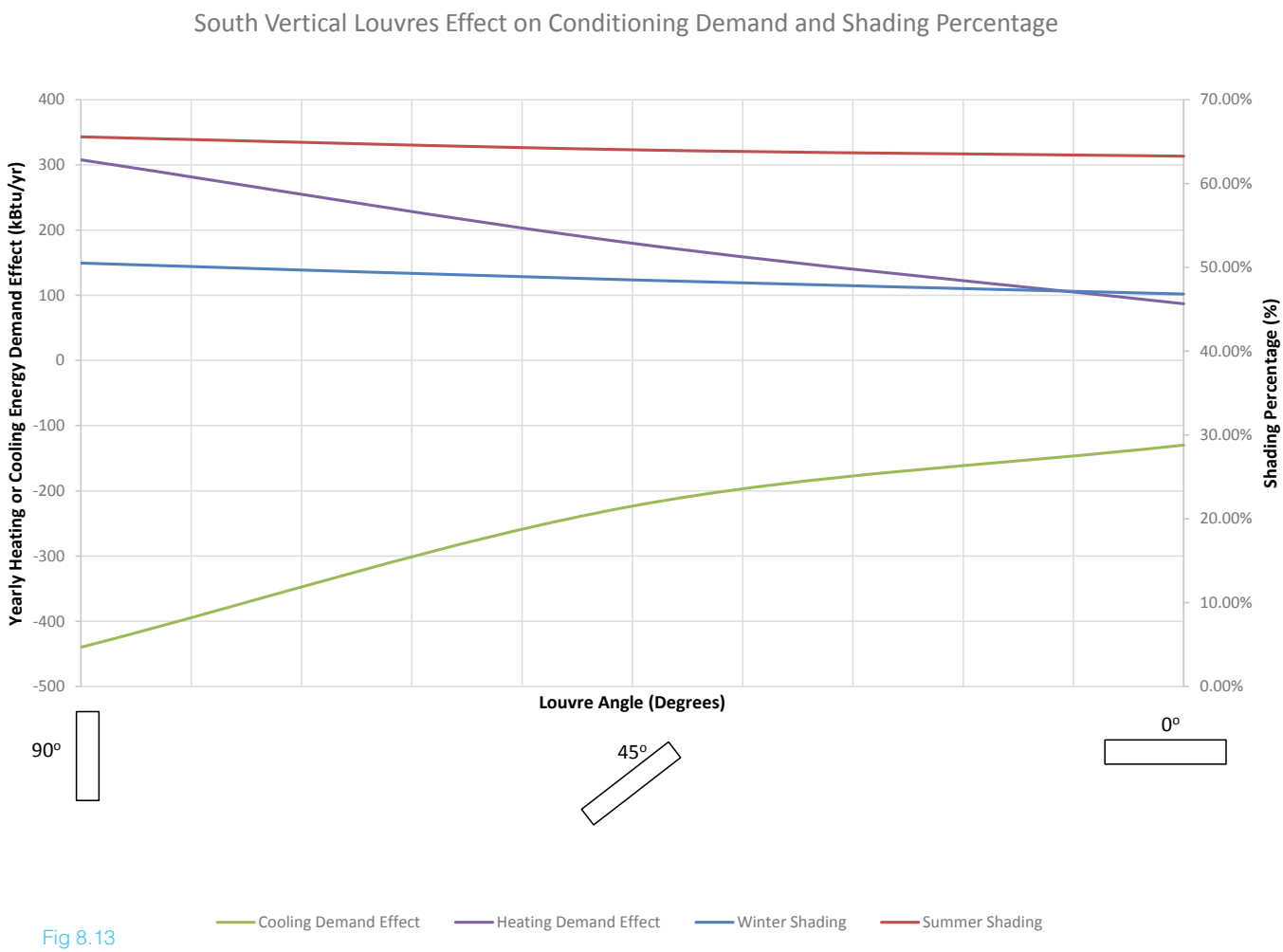


Fig 8.13

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOUTHERN VERTICAL LOUVER

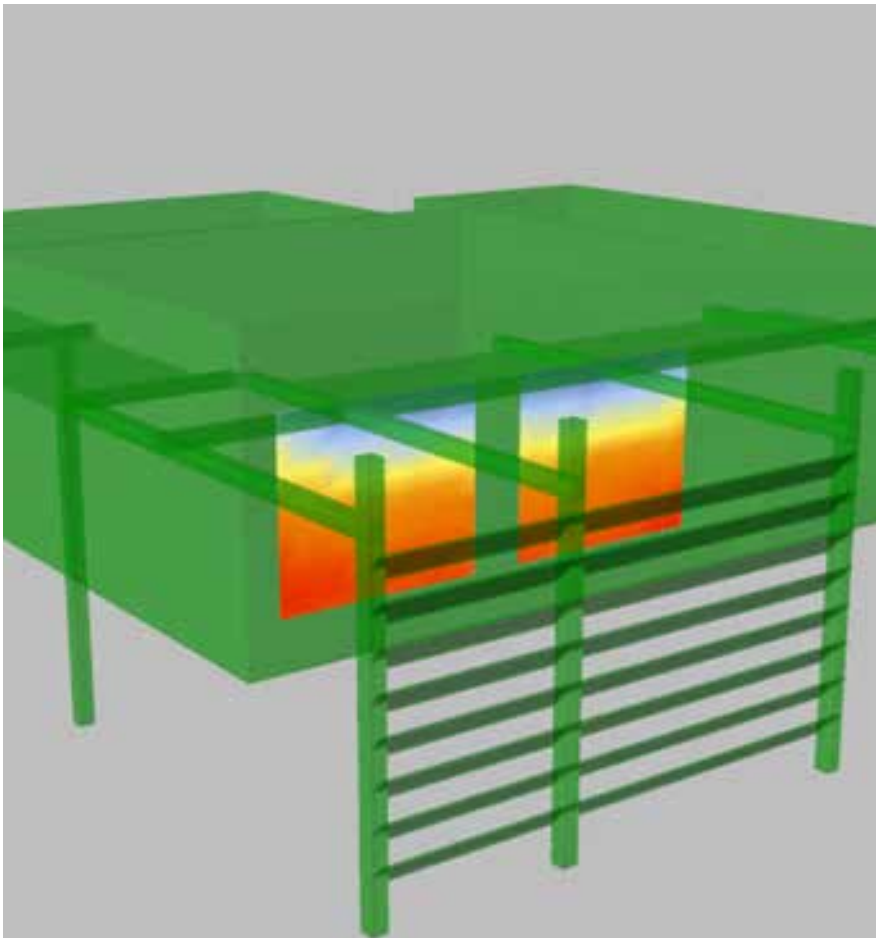


Fig 8.14

The effect of louver angle on the shading percentage and heating and cooling demand from the South Deck vertical louvers was minimal compared to the horizontal louvers. This can be accounted for by their distance from the windows at 16 feet from the edge of the house. Even in the winter, the solar elevation angle is still great enough that the majority of the sun's rays can reach the windows from above the vertical louvers. For this reason, these louvers can be assessed based on their aesthetic and privacy value without having to incur a large energy penalty.

ENERGY ANALYSIS RESULTS AND DISCUSSION

WEST VERTICAL LOUVER

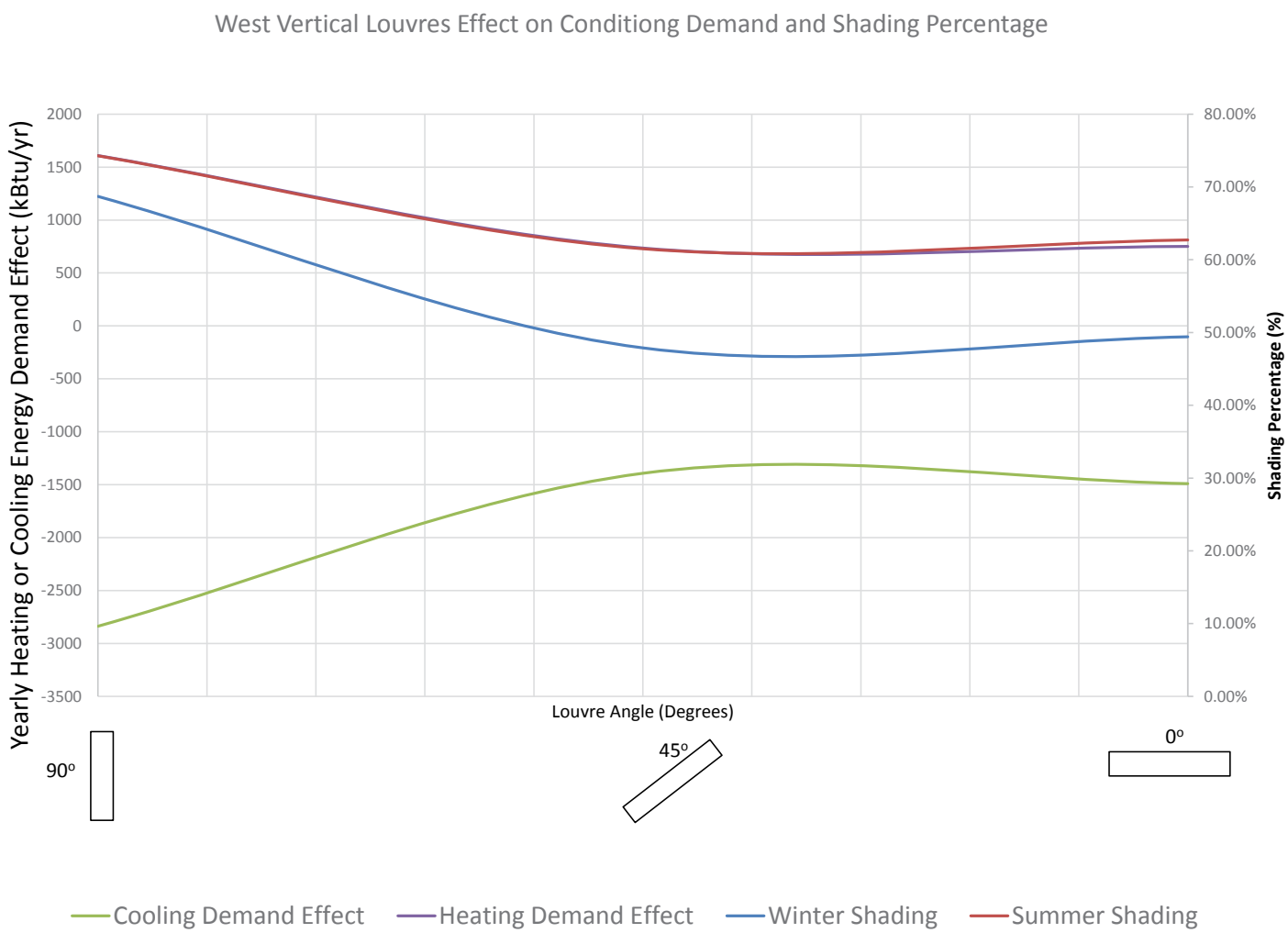


Fig 8.15

ENERGY ANALYSIS RESULTS AND DISCUSSION

WEST VERTICAL LOUVER

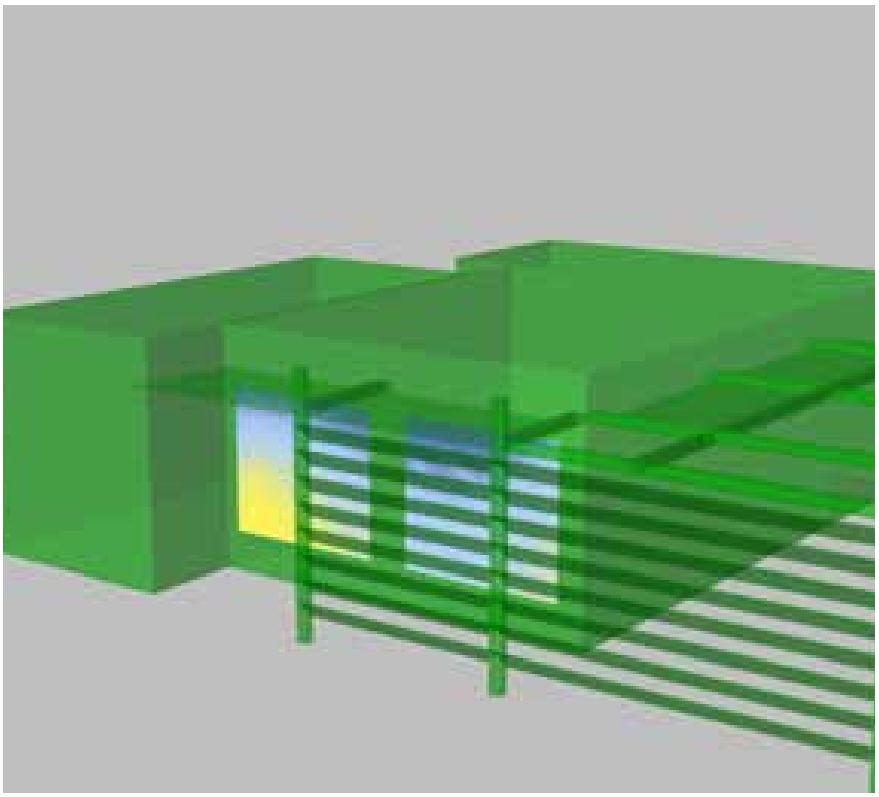


Fig 8.16

Finally, the West Garden vertical louvers had a much greater effect on heating and cooling than the South Deck vertical louvers. When fully closed, these louvers decreased cooling demand and increased heating demand by 30%. This is expected because of their close proximity to the West Windows but even more importantly because of the lower angle of the sun coming from the West. Vertical shading on the West can achieve a much higher percentage of shading because of this fact. As this graph shows, an optimal angle can be found to balance the effect on heating and cooling and therefore more analysis must be completed to find this angle. Another consideration is the effect of other buildings on the West side shading. Once a final location is known, this factor can be fully assessed, but the height and horizontal distance of an adjacent building could greatly affect the need for a shading device on the West side.

ENERGY ANALYSIS RESULTS AND DISCUSSION

SHADING ANALYSIS CONCLUSION

To evaluate the current condition of SURE House with regard to Passive House certification, the condition for each set of louvers that had the smallest effect on heating and cooling demand was chosen and the entire structure was evaluated. This condition was to have the West Garden louvers at 45 degrees, the South Deck louvers fully open, and the South Horizontal louvers at 45 degrees. With this condition, the heating demand is modeled to be 25 kWh/m2a, 67% more than Passivhaus, and the cooling is modeled to be 21 kWh/m2a, 31% more than Passivhaus.

More analysis will need to be completed to determine what parts of our shading strategy must be removed and what must be added. Finally, the decision to redcue the size of one of the sliding doors must be considered in order to increase the thermal performance of the envelope in the winter and to decrease the solar gains in the summer. However, before this decision is made, two variables must be accurately calculated and taken into account that are currently negatively affecting both the heating and cooling demands. These are thermal bridging and natural ventilation. The current model estimates losses from thermal bridging as 15% of the total transmission losses, accounting for 10 kWh/m2a during the heating season. Although the SURE House team plans to eliminate all thermal bridging, this is not an easy task and therefore a safety factor is often taken into account from the beginning. However, if these losses are removed from the heating demand calculation, SURE House suddenly is within range of Passivhaus certification for heating.

For cooling, natural ventilation can have an enormous effect. Opening one of the Southern sliding doors for one hour a day during the summer will reduce the cooling demand by 5 kWh/m2a, also enough to achieve Passive certification for cooling demand. Since neither of these conditions is out of the question, it is safe to say that achieving the necessary levels of heating or cooling energy demand is in reach with our current plan.

ENERGY ANALYSIS RESULTS AND DISCUSSION

LOAD CALCULATIONS

To calculate the maximum sensible loads encountered the team addressed the four main loads on the building; transmission, solar, internal, and ventilation. The transmission loads were calculated using an hourly model built into an Excel sheet. The inputs for this analysis were taken from the PHPP file of the house. These parameters include all of the house areas and configurations, the composite R-Values for all of the envelope features, as well as the volume of air contained by the house. These parameters combined with hourly TMY data were used to calculate the hourly transmission loads. The solar loads were calculated likewise using TMY data. The internal and ventilation loads were taken directly from the PHPP file as their calculations are relatively time invariant. The internal heat load derived from PHPP was then increased to account for the large amount of people coming through the house throughout the day. To verify this load model the team modeled Stevens' last solar decathlon house, the EcoHabit house, and plotted that against the temperatures during the competition last year. If the model was able to accurately predict the recorded indoor temperatures of the EcoHabit house it should also be able to do so for the SURE HOUSE performance. Shown below is the models prediction of the temperature as well as the actual temperature and the recorded hourly ambient temperature:

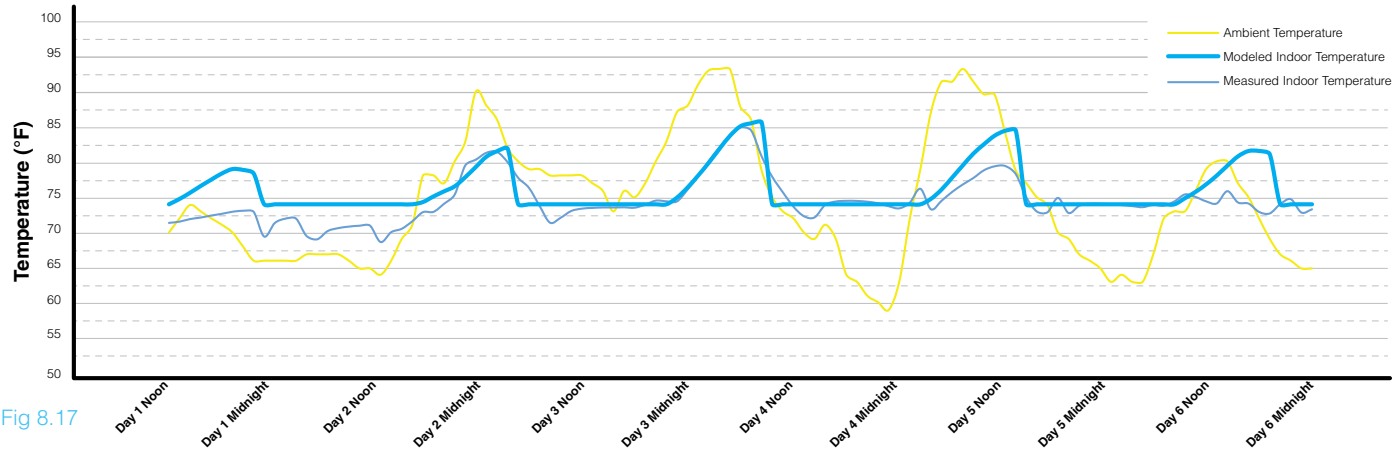


Fig 8.17

From this model we predicted the maximum encountered sensible load to be approximately 19,000 Btu/hr. The latent loads were calculated separately using the method outlined by ASHRAE combined with the proposed fan coil units properties and operating cfm range. This result using standards for people and other appliances gives a maximum latent load of 4,200 Btu/h. Combining the sensible and latent load gives a combined load on the system of 23,200 Btu/h. With this in mind a system size of 2 tons of refrigeration (24,000 Btu/h) was used for the house.

ENERGY ANALYSIS RESULTS AND DISCUSSION

08 - SHADE AND TILT CALCULATIONS

In order to optimize the solar generation on the surface of the SURE house roof, the team conducted a study/series of calculations to compare the amount of energy generation to the amount of square footage required of roof space – at different module angles. On a flat roof, increasing the tilt of individual solar modules increases the power yield, but at the cost of additional roof space taken up by shading. [It is good practice to space solar modules far enough away from one another that at no point during the year, they cast shadows on one another] Through the course of this study, it was determined that an angle of 10 degrees off the horizontal (facing due south) would most effectively use our defined roof space to produce the maximum amount of power.

In an ideal sense, a solar module should be perpendicular - or as close to perpendicular as possible - to incident light rays for the greatest portion of day, for the greatest amount of time of the year. Taking into account longitude and different solar zeniths throughout the year, the optimum tilt angle for a solar module in our target temperate regions is around 30-40 degrees.

However, what the SURE House team found was that by decreasing the tilt angle of individual solar modules, the team was able to significantly reduce shadow lengths and fit more solar panels on the roof. The increase in the number of solar panels actually significantly increases the overall power production, even at the cost of individual module efficiency. The increase in the number of panels does increase the costs of the solar array, however it can be argued that this balances out with the costs of not needing to create additional roof or raised racking systems to meet the desired energy needs.

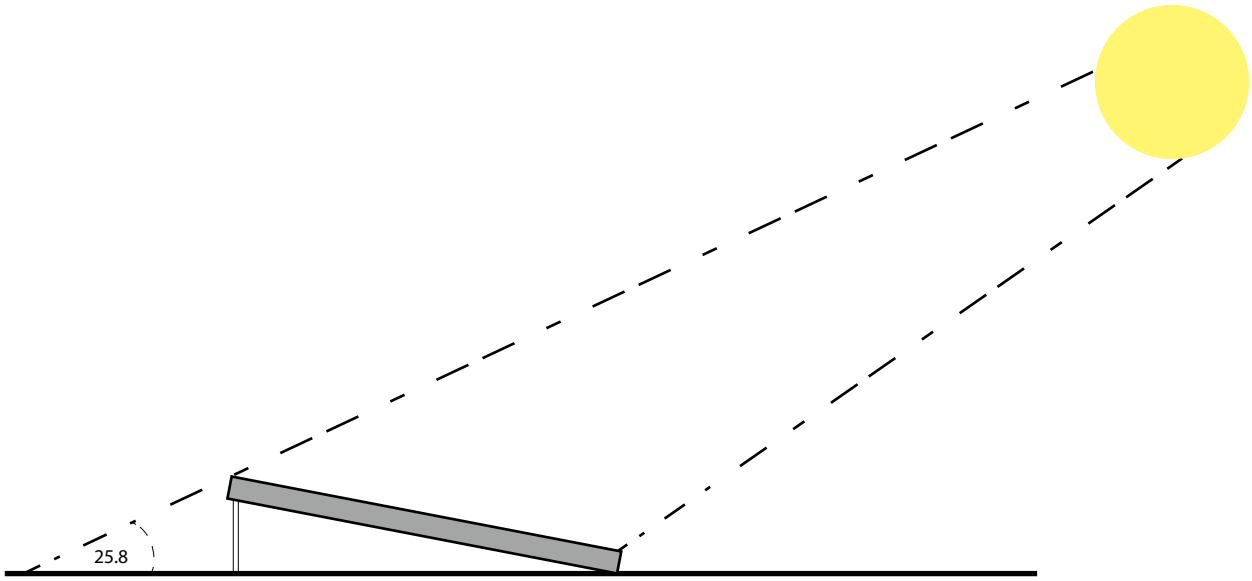


Fig 8.18 An incident angle of 25.8 degrees used for shade calculations – lowest annual incident solar angle for house on the Jersey Coast.

ENERGY ANALYSIS RESULTS AND DISCUSSION

CALCULATING THE YIELD OF THE PHOTOVOLATIC ARRAY

In order to determine the overall amount of power that would need to be generated for SURE House, the team started with the 175 kWh consumption cap for the 8 day energy balance portion of the competition as a baseline. Any consumption greater than 175 kWh would result in point deductions and so all of the systems in the house are designed to – in total – remain below this consumption cap. In order to predict the amount of kW of solar modules the SURE House would require, the team utilized the National Renewable Energy Laboratory's PVwatts program.

TILT ANGLE	0	10	15	20	33.7	40	40.7	50
HEIGHT (IN)	0	.174533	.261799	.349066	.588176	.698132	.710349	.872665
SPACE LENGTH (IN)	1.22	8.04494	11.37849	14.6254	22.8814	26.2668	26.6241	30.9740
SHADE LENGTH (IN)	39.41	38.8112	38.0671	37.0332	32.7873	.698132	.710349	25.3322
SPACE to SHADE	2.523	16.6417	23.5375	30.2541	47.3324	54.3356	55.0746	64.0728
SPACE LENGTH (IN)	15.61	2.33216	1.61729	1.22407	.692703	0.55561	0.54250	0.39536
TOTAL LENGTH (IN)	41.93	55.4530	61.6046	67.2874	80.1197	84.5253	84.9527	89.4050
PANEL AREA (SQFT)	19.20	25.3928	28.2098	30.8120	36.6881	38.7055	38.9012	40.9400
ARRAY AREA (SQFT)	672.07	888.750	987.343	1078.42	1248.08	1354.69	1361.54	1432.90
PV WATTS DATA	PV WATTS DATA CALCULATED AND IMPUT FROM WWW.PVWATTS.NREL.GOV/							
IRVINE,CA OCTOBER								
ROOF SPACE								
NUMBER OF PANELS								

Table 8.3 The table above shows how the required area for a 35 panel array changes as a function of the of the tilt angle. As the tilt angle is increased the significance of the power output increase gets smaller. Small enough that it warrants adding additional panels to increase the yield, rather than further increasing the tilt angle.

Since PVwatts primarily is designed to determine yearly and monthly totals for energy production, the team scaled the amount of energy required for the 8 day competition up to what it would equal for a given month. By dividing the 175 kWh by 8 and then multiplying by 30.5 (the average number of days for the September and October months) the team determined that SURE HOUSE would need to be able to produce around 668 kW for this hybrid month in order to minimally exceed power consumption in normal weather conditions By substituting various system sizes and comparing the yield to the average predicted yield for the hybrid month (weighted toward the first second week in October) an estimated theoretical system size could be determined.Under the assumption of using a transformer less inverter and DC Optimizers the derate breakdown below was estimated using the specifications for a Sunny Boy Inverter and Tigo DC Optimizers.

ENERGY ANALYSIS RESULTS AND DISCUSSION

INVERTER AND STRING CALCS : TEMPERATURE CORRECTIONS

Worst Condition Analysis

In addition to a small factor of safety for overproduction, the SURE House team developed a worst case scenario analysis. It was imperative that the team determine the required array size to meet our consumption requirements – even in the worst weather conditions.

Fig 8.19

ENERGY ANALYSIS RESULTS AND DISCUSSION

INVERTER AND STRING CALCS : TEMPERATURE CORRECTIONS

Irradiance

The most significant impact on the amount of AC electricity produced by a solar array is the amount of incident sunlight that is able to fall upon the solar modules. This is directly affected by the amount of cloud cover and changing weather conditions. In order to analyze the amount of cloud cover and how that would theoretically decrease the SURE House's power yield, the team looked at TMY 3 (Typical Meteorological Year 3) weather data – which is a record of various weather parameter for 1991-2005. Using the past weather conditions, the team was able to predict a likely worst case scenario for the amount of irradiance the solar modules would possibly receive during the competition. In terms of the amount of irradiance received on the best or most clear days, on the worst days (on average over the 15 year period) the solar modules would only receive 15.25% of what they would otherwise receive.

Similarly, on average days, the solar panels would receive 68.6% of what they would receive on a good day. According to the distribution of good irradiance days and bad and by weighting the probability of these conditions occurring, the team developed a worst case model. This worst case model was determined to include four of the worst cloud condition days and four average condition days – over the eight day solar production period. Using the weighted average of these conditions the team was able to determine that the solar array would only be capable of producing 41.94 percent of what it would be able to produce in an eight day competition of perfect irradiance conditions.

Comparing this to the theoretical yield of the solar array according to the National Renewable Energy Laboratory's PV Watts program, the team determined that we would have to oversize the solar array by approximately 28.81 percent in order to account for these possible weather conditions. The NREL's PVwatts system analysis tool also uses TMY3 data to calculate the theoretical yield – however, it does so for average weather conditions at a specified weather station. Using the same weather station data, the sure house team used the difference between the average and the worst case percentages in order to apply a proper factor of safety for inclement weather. The average irradiance of 68.6 percent minus the worst case scenario condition of 41.94 percent results in this 28.81 percent reduction factor in yield.

ENERGY ANALYSIS RESULTS AND DISCUSSION

ENERGY GENERATION VS. CONSUMPTION

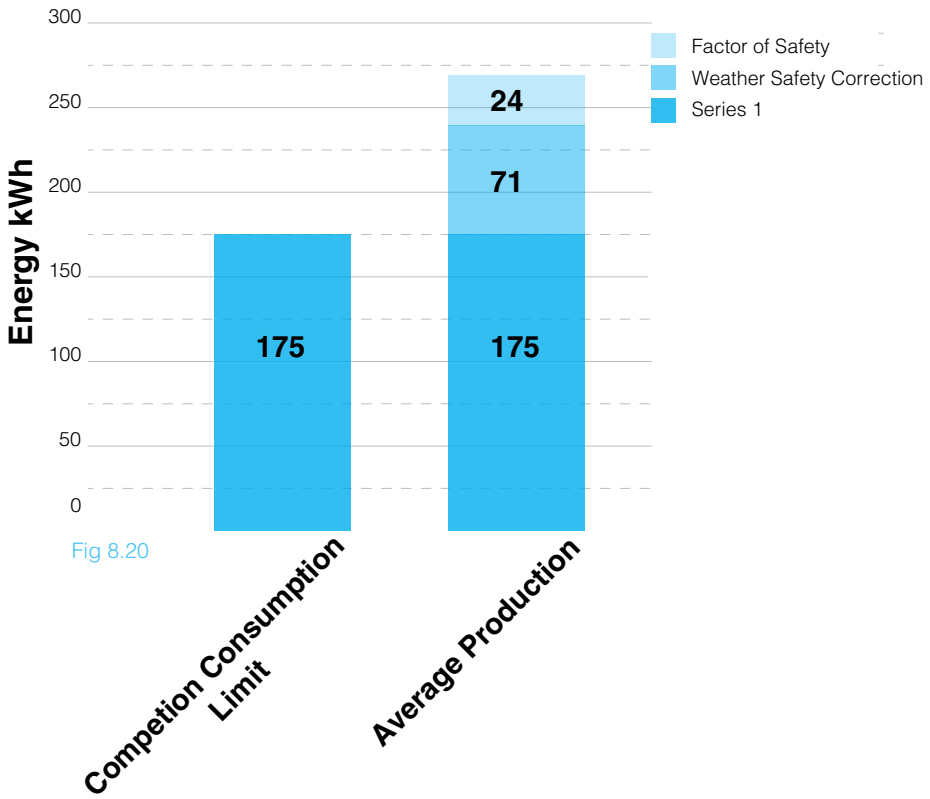


Fig 8.20

The figure above shows the excess energy production capability that is factored in to ensure a net positive energy balance – even in the worst conditions

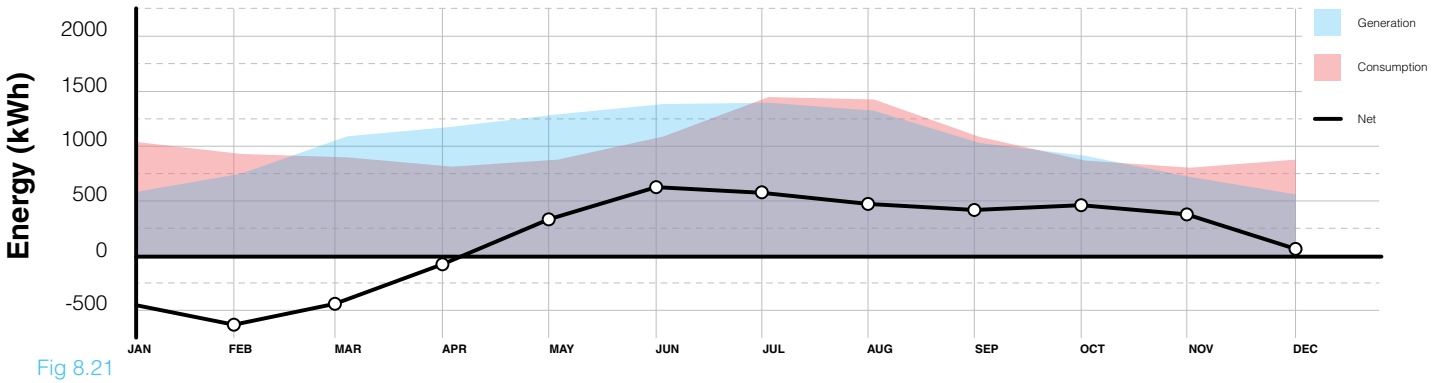


Fig 8.21

Energy Generation vs. Consumption

ENERGY ANALYSIS RESULTS AND DISCUSSION

CALCULATIONS AND MODEL JUSTIFICATIONS

Selecting and sizing the PV heating system for SUREHouse required a very high level of analysis and planning for a couple of reasons – the first being the fact that PV heating devices are not very common and that there is not a lot of performance and sizing data readily available. The second, and perhaps more significant, issue was that almost all the available resources for sizing solar hot water systems assumed a relatively low solar fraction of 50-70 percent. Additionally, the only measurable value of importance in these analyses is yearly performance.

For SURE House, in order to meet our extremely low electrical consumption requirements – the team desired a solar fraction in excess of 80 or 90 percent – which is largely unheard of for domestic solar hot water heating systems.

The biggest difficulty when designing a system with the capability to provide for nearly all, if not all hot water demands is that the solar thermal system must be powerful enough to meet demands in the worst weather conditions, but also have a way to manage excess heat in situations where there is an excess of irradiant energy. It is for this reason that solar thermal systems are rarely designed to cover all of a home's domestic water needs.

The fact that the SURE House team was doing something very different than what has been done traditionally for solar thermal systems meant that the team had to develop our own way to determine the sizing needs of the system. In order to do this, a discrete hot water tank model was developed to track the internal tank temperature of SURE House's domestic hot water tank over the course of the competition.

ENERGY ANALYSIS RESULTS AND DISCUSSION

CALCULATIONS AND MODEL JUSTIFICATIONS

The first step in developing the model was to identify the various inputs and outputs for the system and how these events would impact tank dynamics. In order to track how the internal tank temperature would rise due to solar inputs, the DC output power was calculated from PVwatts for SURE House's particular orientation, latitude, and angle of the mounted solar panels. After accounting for a very small loss in power due to the specified efficiency of the PV heating device the power was converted to British Thermal Units and translated to the temperature rise produced in the hot water in the tank by introducing this amount of energy, taking into account changing specific heats as the internal tank temperature changed.

In addition to the solar inputs into the hot water tank, the backup heat pump needed to be added into the model in order to track any supplemental heat that may or may not be added to the system using a parameterized value for the heat pump.

Next to consider were the various outputs. The first and most important factor that would significantly decrease the temperature of the tank was the water outputs required at various stages during the competition. The hot water draws throughout the competition were modeled as discrete events. The model is designed to calculate the amount of hot water necessary to satisfy a 110 degree water draw (115 for safety factor due to small amount of heat loss through pipes) through use of a thermostatic mixing valve each time during the competition schedule that a specified quantity of hot water is required. This quantity of water is then removed from the tank and replaced with cold domestic water from the water storage tank which is assumed to be a minimum of 65 degrees F. Using the quantity of cold water added to the system along with the quantity and temperature of the domestic hot water previously in the tank, the new temperature of the tank can be calculated.

The second important heat output for the domestic hot water tank model was the effect of heat loss through the sides and bottom of the hot water tank. Taking the surface area of the tank, the internal and external temperature, along with the thermal resistance of the insulation, the heat loss can be calculated for discrete intervals.

ENERGY ANALYSIS RESULTS AND DISCUSSION

Predicted Energy Generation for Irvine, CA: Santa Ana John Wayne Airport

RESULTS **14,316** kWh Per Year

MONTH	SOLAR RADATION ($kWh/m^2/day$)	AC ENERGY (kWh)	ENERGY VALUE ($)
JANUARY	3.74	855	135
FEBRUARY	3.78	781	123
MARCH	5.76	1,306	206
APRIL	6.35	1,394	220
MAY	6.06	1,366	215
JUNE	7.16	1,566	247
JULY	7.33	1,631	257
AUGUST	6.75	1,504	237
SEPTEMBER	5.91	1,269	200
OCTOBER	4.22	952	150
NOVEMBER	4.13	904	143
DECEMBER	3.53	789	124
ANNUAL	**5.39**	**14,316**	**$2,258**

Table 8.4

ENERGY ANALYSIS RESULTS AND DISCUSSION

Predicted Energy Generation for Belmar, NJ

RESULTS 12,283 kWh Per Year

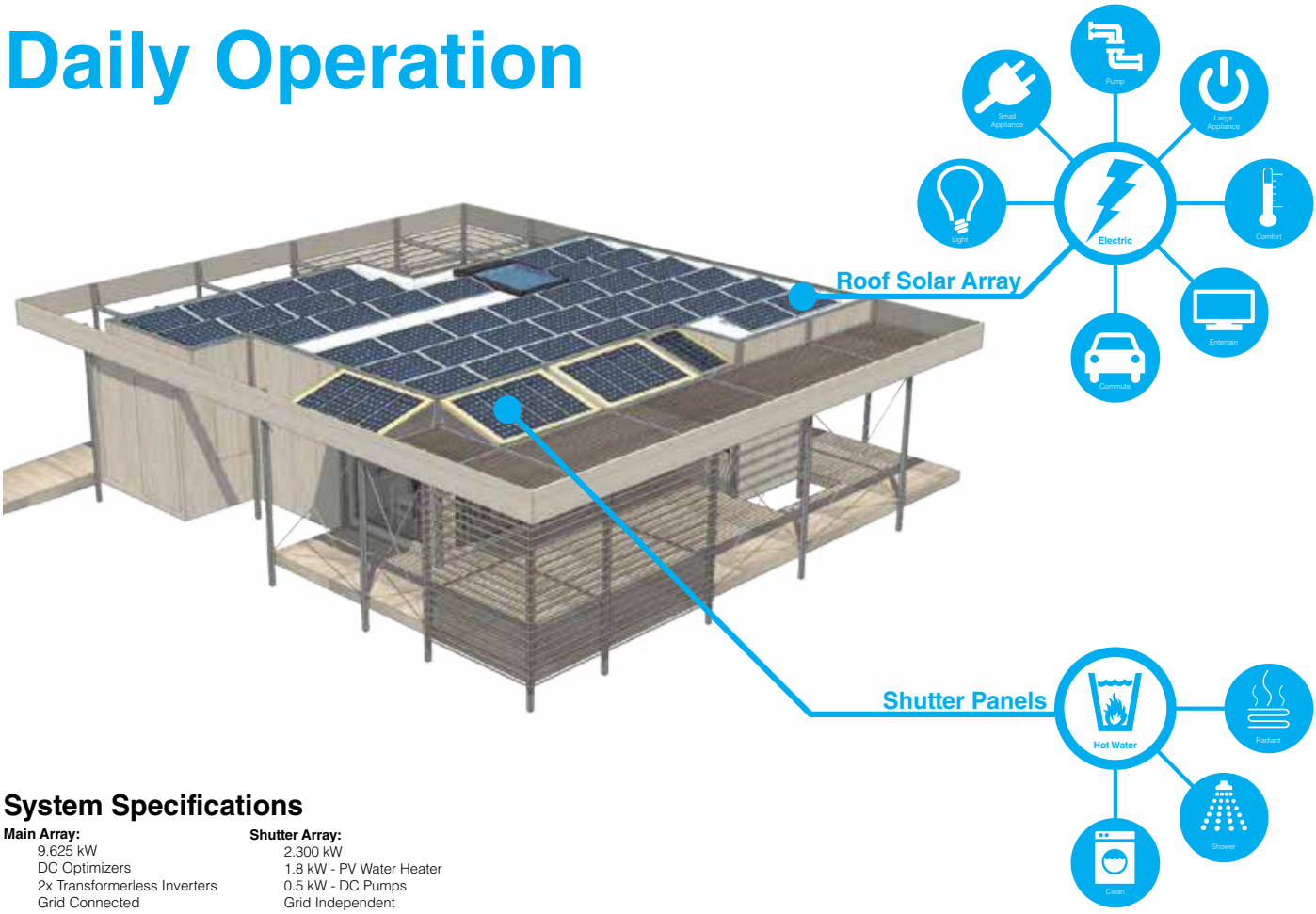
MONTH	SOLAR RADATION ($kWh/m^2/day$)	AC ENERGY (kWh)	ENERGY VALUE ($)
JANUARY	2.39	586	74
FEBRUARY	3.35	754	95
MARCH	4.41	1,096	139
APRIL	5.15	1,184	150
MAY	5.61	1,298	164
JUNE	6.39	1,392	176
JULY	6.34	1,404	177
AUGUST	5.96	1,331	168
SEPTEMBER	4.72	1,035	131
OCTOBER	3.88	918	116
NOVEMBER	3.10	723	91
DECEMBER	2.33	563	71
ANNUAL	**4.47**	**12,283**	**$1,553**

Table 8.5

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOLAR MODES : DAILY OPERATION

Daily Operation



System Specifications

Main Array:
- 9.625 kW
- DC Optimizers
- 2x Transformerless Inverters
- Grid Connected

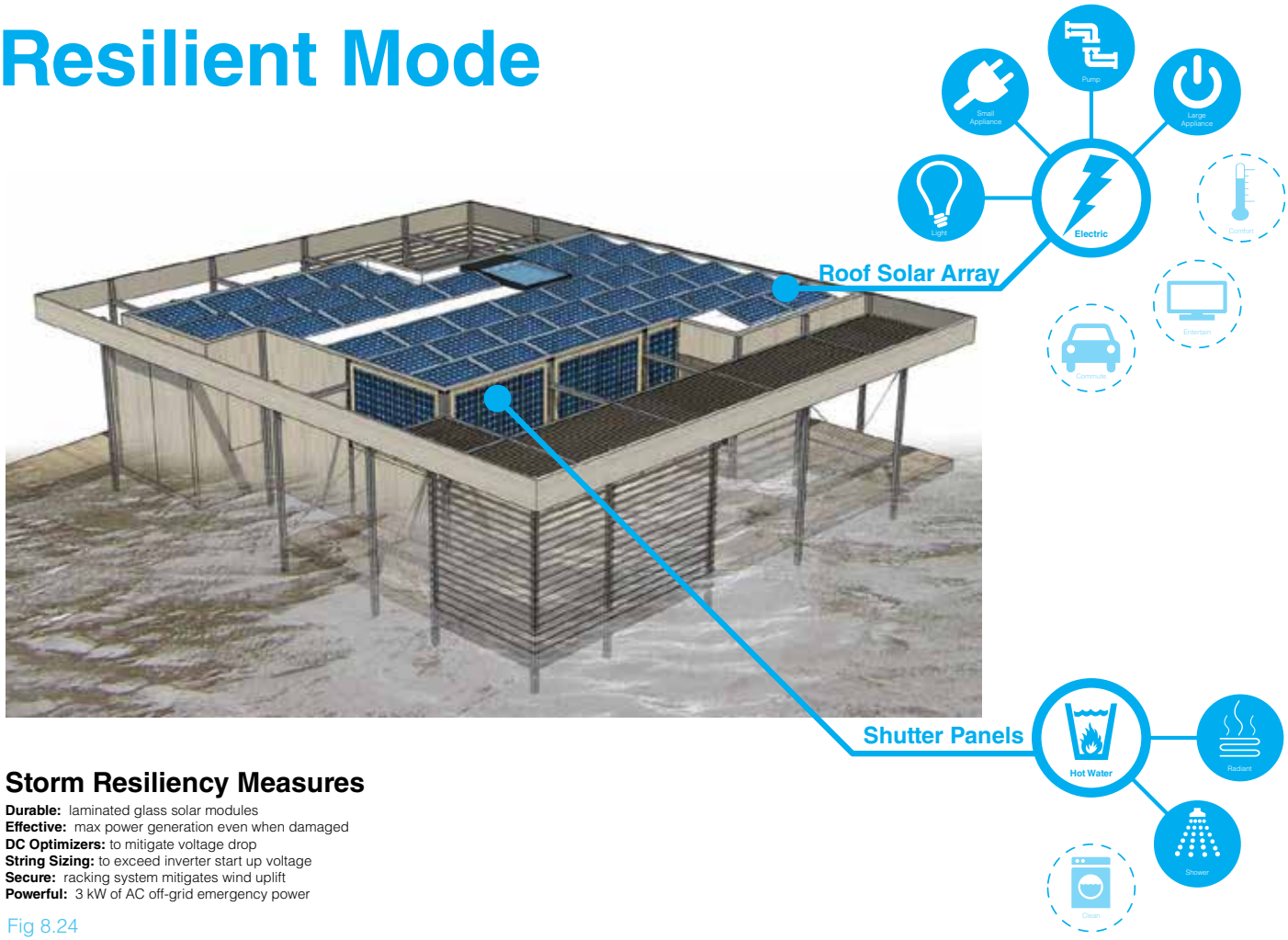
Shutter Array:
- 2.300 kW
- 1.8 kW - PV Water Heater
- 0.5 kW - DC Pumps
- Grid Independent

Fig 8.23

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOLAR MODES : RESILIENT OPERATION

Resilient Mode



Storm Resiliency Measures

Durable: laminated glass solar modules
Effective: max power generation even when damaged
DC Optimizers: to mitigate voltage drop
String Sizing: to exceed inverter start up voltage
Secure: racking system mitigates wind uplift
Powerful: 3 kW of AC off-grid emergency power

Fig 8.24

ENERGY ANALYSIS RESULTS AND DISCUSSION

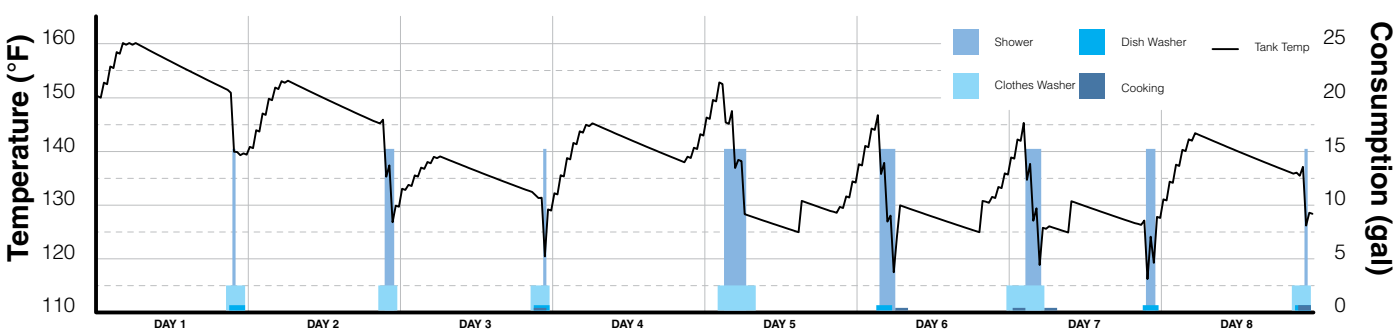
INVERTER AND STRING CALCS : TEMPERATURE CORRECTIONS

Temperature

In an effort to further increase the accuracy of the theoretical decrease in solar generation due to the worst possible weather conditions, the SURE house team also identified air temperature as a possible impactful variable. After confirming that the temperature and the percentage of irradiance are in fact independent from one another, a similar analysis to that conducted for the irradiance was applied to the average temperature conditions over the last 15 years.

First the temperature data for sunlight hours was isolated from the rest of the data set and then the maximum and average temperatures were identified. Again, the PV watts calculations had already determined the effects of average temperature conditions on the yield, and so in order to determine the proper correction factor the team had to determine the difference between the worst and average temperature conditions.

Taking the average temperature for each day the average difference between the hourly temperature and the daily average was determined. After applying the temperature coefficient of -0.45 percent, the SURE house team was able to determine the temperate based derate factor for the worst average day over the last 15 years and the temperature correction for average days (approximately zero). Weighting averages of 4 worst condition day and 4 average condition days – over the 8 solar generation day period – the team determined that in the worst scenario, temperature would decrease the power yield by 2.128 percent.



Hot Water Model

Fig 8.25

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOLAR PV HOT WATER SYSTEM

SUREhouse employs a very unique take on domestic hot water heating compared to traditional methods by utilizing direct DC current from solar panels to run resistance coils in what is known as a photovoltaic water heater. The hot water heating system is based around a PV heating unit that directly converts energy from a system of solar modules to heat energy without any connection to the grid.

The particular heating device that SURE house has selected is Advanced Energy's PV electric heating device. AE's PV heater and the dedicated solar modules that are paired with it is a completely independent electrical system that replaces a more traditional fluid based solar thermal system. Instead of a flat plate or and evacuated tube solar collector, a series of photovoltaic panels is used to harvest the sun's energy. Then, in place of a loop of fluid, the energy is transferred in the form of direct current. And in the place of a heat exchanger, the PV heater exchanges energy by modulating the current through a resistance coil to deliver the required heat to the domestic hot water tank.

Unlike, a traditional electric heat source or heat pump, the energy that is supplied to the PV heater is never in the form of usable AC current or tied to the house or local energy grid. All power generated by the paired solar modules is directly delivered to the PV heating device without any inversion or transformation. Like traditional solar thermal systems, all energy harnessed by the solar collector must be utilized as heat energy. There is no diversion load for excess heat.

However, our system parts ways from traditional solar thermal systems in that excess heat does not need to be dissipated. The solar modules can be thermostatically switched to open circuit when excessively high hot water temperatures are reached. This is especially relevant and beneficial in applications where a very high solar fraction is required.

When achieving a very high solar fraction over a given time period is desired, the heating capacity of the solar thermal heating systems must be substantial even in poor weather conditions. This means that the system is often capable of significantly overproducing heat energy in normal or good operating conditions. In a traditional solar thermal system, there must be a diversion load for the excess heat – otherwise the water temperature will become dangerously high and damage the system.

ENERGY ANALYSIS RESULTS AND DISCUSSION

SOLAR PV HOT WATER SYSTEM

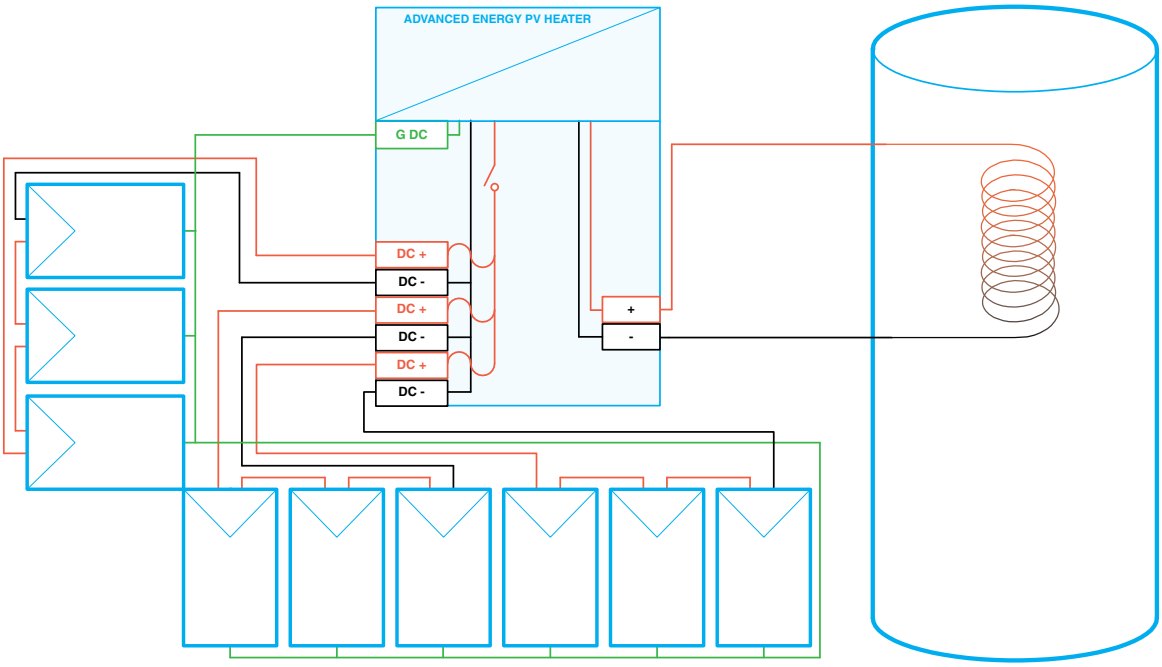


Fig 8.26

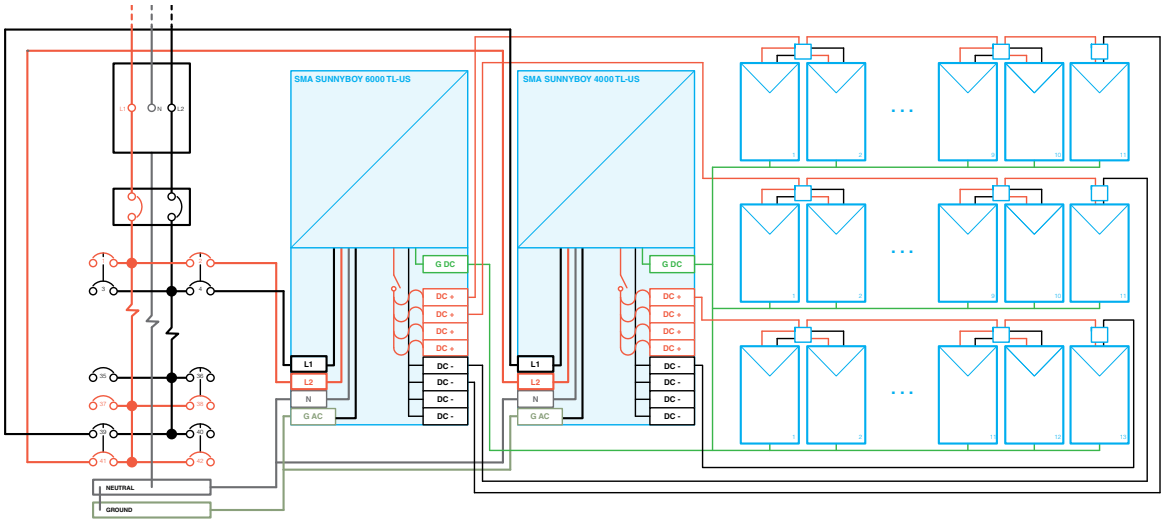


Fig 8.27

09 - Background : Innovative Mechanical Systems

HVAC MODES The HVAC system will operate under four main modes:

NORMAL SUMMER MODE

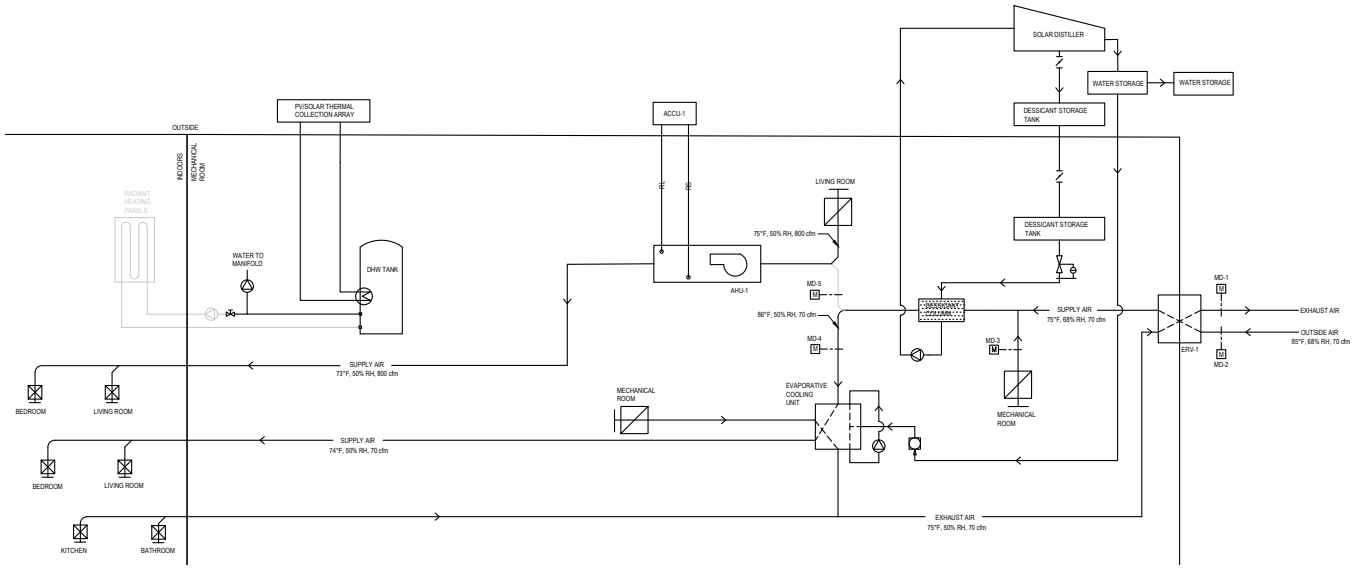


Fig 8.28 Summer HVAC Mode

Ventilation and Dehumidification

The ducts for the ventilation system will be separated from the ducts for the heating and cooling system using motorized dampers. Outside air will be drawn through the energy recovery ventilator and flow through the desiccant system. Fresh, dehumidified air will then enter the living room at 30 cfm and each of the two bedrooms at 20 cfm. Air will be exhausted from the kitchen and bathroom through the energy recovery ventilator. If necessary, to meet pressure balance needs or regenerate the evaporative cooling unit, additional air will be exhausted from the mechanical room.

Heating and Cooling

An air cooled condensing unit outdoors will activate if the temperature sensor system detects that the indoor temperature has gone above a user defined set point. The air handling unit will activate and power up to a nominal 800 cfm. Re-circulated air will be drawn from the living room, cooled, and then brought back into the living room and bedrooms.

HVAC Systems

HVAC MODES

The HVAC system will operate under four main modes:

NORMAL WINTER MODE

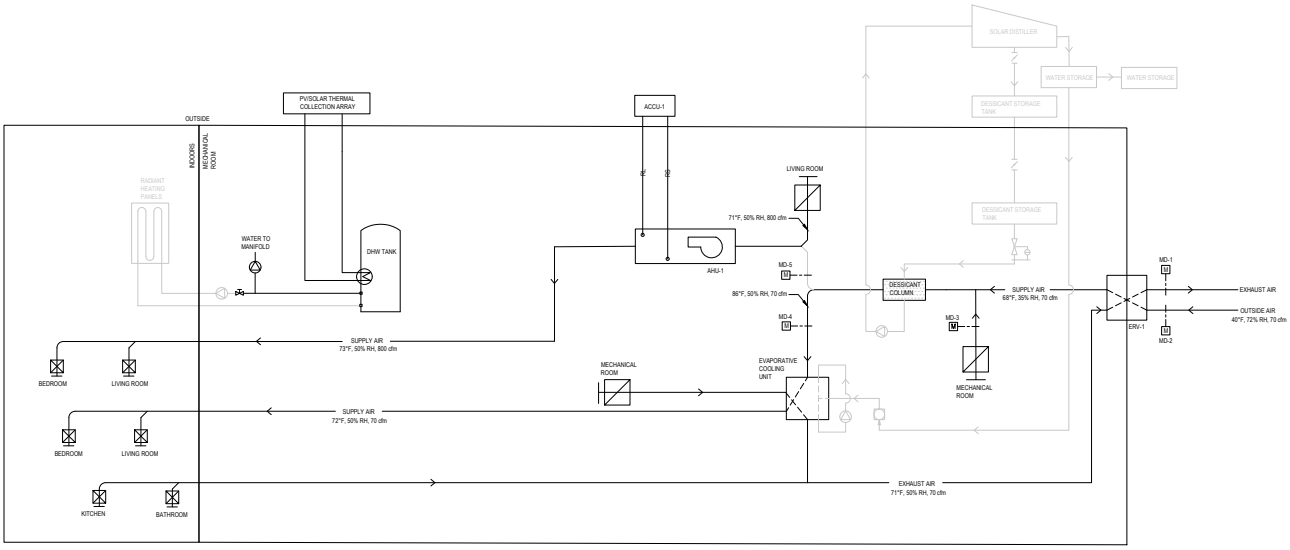


Fig 8.29 Winter HVAC Mode

Ventilation and Dehumidification

The ducts for the ventilation system will be separated from the ducts for the heating and cooling system using motorized dampers. Outside air will be drawn through the energy recovery ventilator and flow through the desiccant system. Whether the desiccant solution is actually running through the column is determined by the relative humidity of the air, since it is less common to dehumidify in the winter. Fresh, dehumidified air will then enter the living room at 30 cfm and each of the two bedrooms at 20 cfm. Air will be exhausted from the kitchen and bathroom through the energy recovery ventilator. If necessary, to meet pressure balance needs or regenerate the evaporative cooling unit, additional air will be exhausted from the mechanical room.

Heating and Cooling

An air cooled condensing unit outdoors will activate if the temperature sensor system detects that the indoor temperature has gone below a user defined set point. The air handling unit will activate and power up to a nominal 800 cfm. Re-circulated air will be drawn from the living room, heated, and then brought back into the living room and bedrooms.

HVAC Systems

HVAC MODES

The HVAC system will operate under four main modes:

SUMMER BOOST MODE

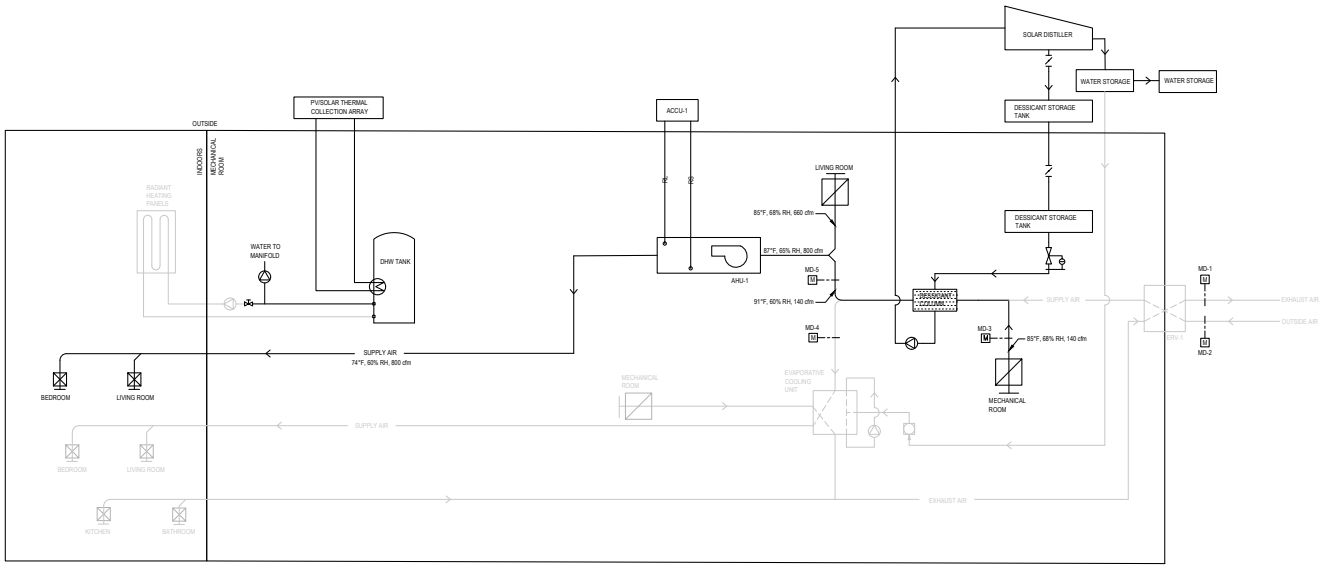


Fig 8.30 Summer Boost HVAC Mode

Combined Heating, Cooling, Ventilation

At the user's signal, the air to the outside will be fully closed utilizing motor dampers and the damper stopping flow from the mechanical room or living room will open. The air handling unit will then pull part of its 800 nominal cfm through the desiccant column, providing about 140 cfm of air draw. This will ensure that the desiccant system will be dealing with some of the latent load present.

The reversible heat pump will also activate so that the air handling unit will be able to cool and dehumidify recirculated air. Both the heat pump and the desiccant system will therefore be dealing with latent load in boost mode. The boost mode can be turned off after a set time or will shut off automatically after a long period of use.

HVAC Systems

HVAC MODES

The HVAC system will operate under four main modes:

EMERGENCY WINTER OPERATION MODE

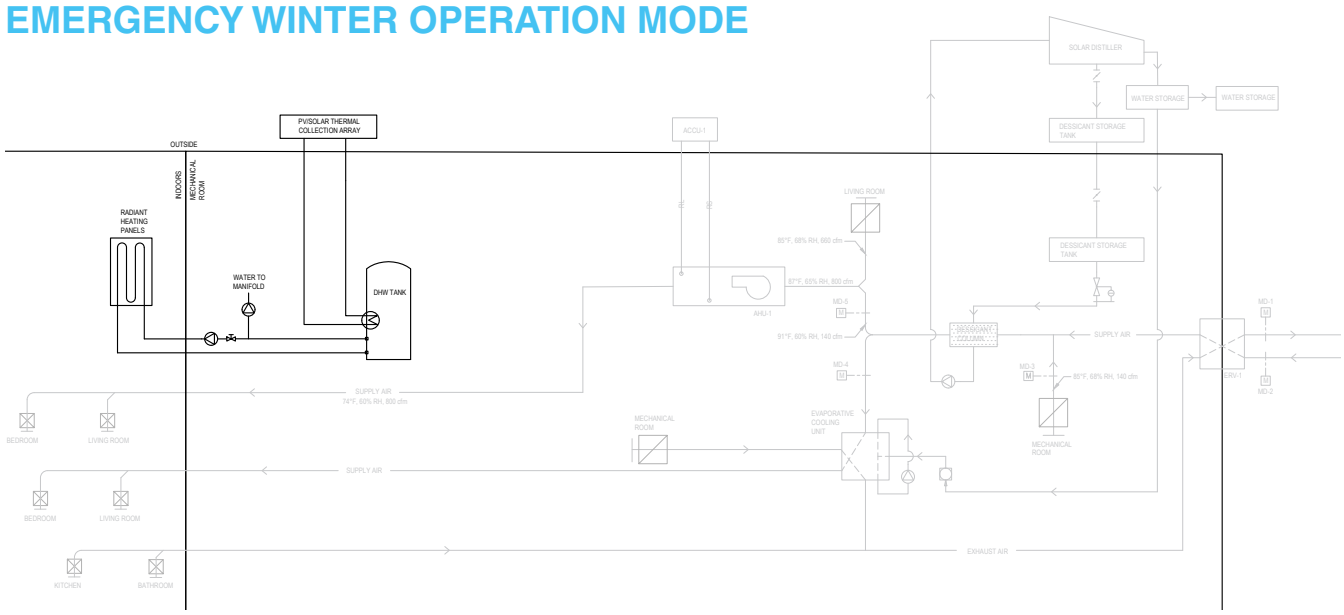


Fig 8.31 Emergency Winter Mode

Heating

The backup radiant system is composed of a section of piping which is normally blocked off from the manifold through a manual valve. The pipes will connect to a few radiant panels which will be installed in an appropriate location in the living room or bedroom. A small solar powered pump must also be turned on, which will provide the low flow needed.

This system is intended for use in case of a power outage, as the DC photovoltaic array will be able to provide thermal energy to store in the insulated hot water tank. This is a possible source of heat for occupants of SURE House to use in the aftermath of a hurricane or other catastrophic event.

HVAC Systems

DETERMINING THE AIR DISTRIBUTION SYSTEM

The main trunk for the HVAC system was sized using the Equal Friction Method. Using an external static pressure of .5” WC and a total equivalent length of approximately 162.5 feet, the friction rate was determined to be 1.2” WC/100 feet.

Using the ASHRAE Air Ducts Friction Loss Diagram with an air volume flow of 800 CFM, the necessary circular duct size was found to be slightly larger than a 12” diameter. However, the maximum amount of space available above the drop ceiling was limited to only a foot; therefore, rectangular ducts were chosen to be employed rather than circular ducts, as this would allow for a decreased duct height with equivalent duct area. A 16” wide by 10” high rectangular duct was selected, as this is a readily available duct size with an area approximately equivalent to a 14” diameter circular duct.

Using the McQuay Air-Conditioning Duct Sizer program to check the feasibility of this design, the velocity was found to be approximately 750 FPM, well below the maximum industry recommended velocity of 900 FPM. The lone return trunk was sized by this method as well and has dimensions of 16” wide by 10” high.

HVAC Systems

DETERMINING THE VENTILATION SYSTEM DESIGN

The first goal was to provide the house with some mechanically forced ventilation. The ventilation system was designed to meet ASHRAE standards regarding outdoor air requirements for the ventilation of residential facilities, which includes adequate exhaust from kitchen and bathroom areas. Based on ASHRAE 62.2, Table 4.1a, residential dwellings comprised of a floor area 1,500 square feet or below, containing 2-3 bedrooms, require a minimum continuous airflow rate of 45 CFM. More specific requirements call for 20 CFM of outdoor air for both the master bedroom and the main body of the home, as well as 10 CFM for smaller, single-individual bedrooms. ASHRAE 62.2 also requires either 50 CFM intermittent or 20 CFM continuous exhaust from bathrooms, as well as 100 CFM intermittent or 25 CFM continuous exhaust from kitchens.

To meet these requirements, the Zehnder Comfoair 200 Energy Recovery Ventilator (ERV) was selected. An ERV was selected for ventilation purposes due to the energy-efficient nature of these systems. By preconditioning the incoming outdoor air with the cooler, less humid, outgoing exhaust air, the ERV reduces the cooling load handled by the HVAC system, thereby reducing energy consumption. This same principle applies in the wintertime as well when the cold incoming air is pre-heated by the outgoing exhaust air. This particular model was selected as it is considered amongst the most energy efficient available today, suggested by both customer testimonials and information available from Zehnder. The Comfoair 200 has been certified at 92% efficiency by the Passive House Institute. This multi-stage model is capable of up to 150 CFM airflow when running at 100%; however, for the purposes of the competition, the unit will be operated at 50%, providing approximately 70 CFM of airflow.

HVAC Systems

DETERMINING THE VENTILATION SYSTEM DESIGN

The 70 CFM airflow rate was chosen due to the fact that the ERV will be running in conjunction with the liquid desiccant system. 70 CFM was calculated as an appropriate airflow to allow for adequate reaction with the desiccant solution while at the same time remaining capable of meeting ASHRAE ventilation requirements. The airflow into and out of the house was broken down as follows:

Fresh air distribution:

- 20 CFM to main body (continuous)
- 20 CFM to the child bedroom (continuous)
- 30 CFM to the master bedroom (continuous)

Exhaust air distribution:

- 30 CFM from the kitchen area (continuous)
- 40 CFM from the bathroom (continuous)

In order to distribute and exhaust air from around the house at the correct flow rates, the equal friction method was utilized in order to size the main supply trunk for the ductwork. First, the Total Effective Length (TEL) or the measured length from the farthest supply outlet and farthest return inlet, plus the equivalent length of all turns and fittings, was calculated. This value was found to be approximately 92.5 feet. Next, the available static pressure for the duct system was calculated using the external static pressure of .120” WC as provided by Zehnder and the cumulative .06” WC pressure drop created by the supply outlet and return grille. The friction loss was calculated by multiplying the available static pressure (.06” WC) by 100 and dividing it by the TEL (92.5 feet), which resulted in a friction rate of approximately .065” WC/100 feet. Using the ASHRAE friction loss diagram, a circular duct with a diameter of 5.5” was selected. In order to accommodate commonly available circular ducts, the diameter was changed to 6”. (This calculation does not take into account the pressure drop created by the desiccant column, as this factor is still under investigation and the duct sizing will be adjusted appropriately, if necessary, when this value is determined).

HVAC Systems

DETERMINING THE VENTILATION SYSTEM DESIGN

The supply branches were chosen to be of 2" lesser diameter than the trunk. In order to ensure that this methodology was appropriate in regards to velocity through the duct, the McQuay Air-Conditioning Duct Sizer program was utilized. At 20 CFM, a 4" diameter duct was determined to have an air velocity of approximately 230 FPM, well below the recommended maximum of 500 FPM.

The return trunk and branches were sized using the same methodology. A 6" diameter circular duct was chosen for the trunk of the return, while a 4" diameter circular duct was chosen for the lone return branch. Utilizing the McQuay Air-Conditioning Duct Sizer program to check the velocity in the branch duct once again, a value of approximately 343 FPM was calculated, also below the maximum industry recommendation of 400 FPM for return ducts.

Overall, circular ducts were chosen for the ventilation system, as ducts of this nature aide in reducing noise produced by moving air. Generally, their larger vertical size combined with reduced ceiling space is the limiting factor when deciding between circular and rectangular ducts. However, due to the lower rate at which ventilation air is being distributed, the necessary size of these ducts was smaller, largely eliminating this as an issue. Additionally, cable-operated dampers will be provided on all branch ducts to aid in controlling air flow.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

LIQUID DESICCANT SYSTEM

Stevens Institute of Technology is seeking to include a Desiccant System V2 as a practical pleasing addition to the school's 2015 submission. This system will use Stevens Institute of Technology's 2013 Solar Decathlon house desiccant system as a precedent in order to progress the efficiency and practicality. Desiccants are attractive for their passive removal of humidity from the house environment.

The school's 2013 submission of a desiccant systems work based on the tendency of water in the atmosphere to condense in salt-laden solutions. The process is driven by the difference of water pressure in the air being greater than that of the brine solution of the desiccant system. The nature of the system, taking water from the house's air and storing it in liquid phase within the system until removal, dilutes the salt solution and subsequently discourages the driving force (water concentration gradient). To counter this inevitable tendency there is also an outside component. In this module, water is evaporated from the desiccant into the surroundings and thus the salt concentration is maintained and humidity can continue to be removed inside the house.

The most popular reason for dehumidifying an interior space is to increase the comfort level. Doing so also reduces operational costs in that it requires less energy to heat and cool the home. Air with a lower moisture content takes less energy to heat and cool because the specific heat of water is much higher than that of pure air. The system may be optimized by increasing the surface area interaction between the brine solution and humid air. To optimize space in the house, Stevens Institute of Technology is developing a design that will feature several small columns located in the mechanical room. To further improve the desiccant's performance, humidity sensors will be utilized connected to a relay Arduino board that will vary air flow rate through the columns depending on the amount of humidity removal required. The "Arduino Uno" will also control pumps to the outside component when the salt concentration may drop too low.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

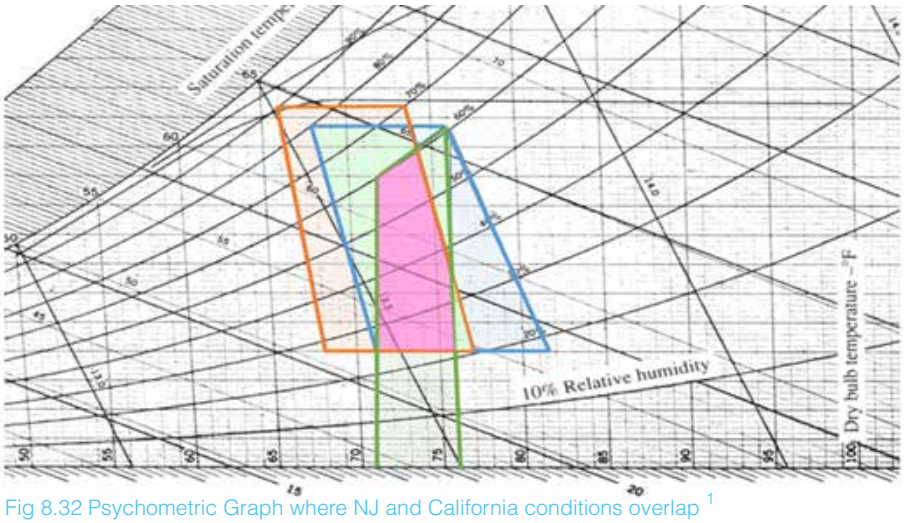


Fig 8.32 Psychometric Graph where NJ and California conditions overlap [1]

One of the requirements when building a house is to ensure that the conditions within the house are both livable and comfortable. In the Solar Decathlon it is our goal to satisfy all the conditions of the competition while also maintaining the appropriate comfort level. Our team congruently decided to build a sustainable and resilient house that meets all the Solar Decathlon competition requirements, while drawing inspiration from our experiences during Hurricane Sandy and the relief efforts. The Stevens team began to design a house following Passivhaus standards and resiliency in mind with our main methods of regulating this interior comfort level being a liquid desiccant dehumidification system which would consider the two very different climates of the New Jersey shore and Californian coastline.

To define this comfort zone the team examined the climates of the Jersey Shore, the home's ultimate destination, and Southern California as the competition location. Looking at both typical meteorological year (TMY3) data from the past thirty years and the psychometric data for the regions, we combined the information to narrow our goal performance region to fit within both climates and the restrictions of the Solar Decathlon. We created the above psychometric chart with these constraints in mind. The orange region shows the comfort zone for the New Jersey Shore, the blue region shows the comfort zone for Irvine, California, and the green region shows the conditions for the Solar Decathlon Competition. The pink shaded section in the middle shows the overlap of all three boxes. This pink region will reflect our goal for the competition. The zones were created by using TMY3 visualized in Weather Tool 2011 by Autodesk. The TMY3 data for New Jersey was taken from the McGuire Air Force Base. The Irvine California TMY3 data was from CA climate zone 8.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

The main trunk for the HVAC system was sized using the Equal Friction Method. Using an external static pressure of .5" WC and a total equivalent length of approximately 162.5 feet, the friction rate was determined to be 1.2" WC/100 feet. Using the ASHRAE Air Ducts Friction Loss Diagram with an air volume flow of 800 CFM, the necessary circular duct size was found to be slightly larger than a 12" diameter. However, the maximum amount of space available above the drop ceiling was limited to only a foot; therefore, rectangular ducts were chosen to be employed rather than circular ducts, as this would allow for a decreased duct height with equivalent duct area. A 16" wide by 10" high rectangular duct was selected, as this is a readily available duct size with an area approximately equivalent to a 14" diameter circular duct. Using the McQuay Air-Conditioning Duct Sizer program to check the feasibility of this design, the velocity was found to be approximately 750 FPM, well below the maximum industry recommended velocity of 900 FPM. The lone return trunk was sized by this method as well and has dimensions of 16" wide by 10" high.

The dehumidification system is the first complete desiccant cooling and heating system meant for residential use, and can save homeowners as much as $50 a month in utility bills with impressive interior air quality. It strives to provide consumers with an energy-efficient, economical, and effective means to dehumidify their homes and condition the air. While large-scale passive desiccant dehumidification systems exist for commercial applications, no such system is readily available in the residential sector. Our product is intended for homeowners in the southern New Jersey area, where summertime humidity is a constant and expensive to regulate discomfort. Using a combination of passive dehumidification methods running on solar power, our product will simultaneously improve interior comfort conditions while decreasing utility costs for consumers.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

To determine if a desiccant system was needed for the New Jersey climate and the California climate during the competition we looked at TMY3 data. Below is the visualization of the TMY3 data obtained from the AutoDesk Weather Tool. These graphs show the temperature and relative humidity throughout the course of a year. The big take away from these graphs is that there is a need for a dehumidification system in order to remove the latent load from the HVAC system. As a general rule of thumb, a relative humidity between 40-60% is comfortable.

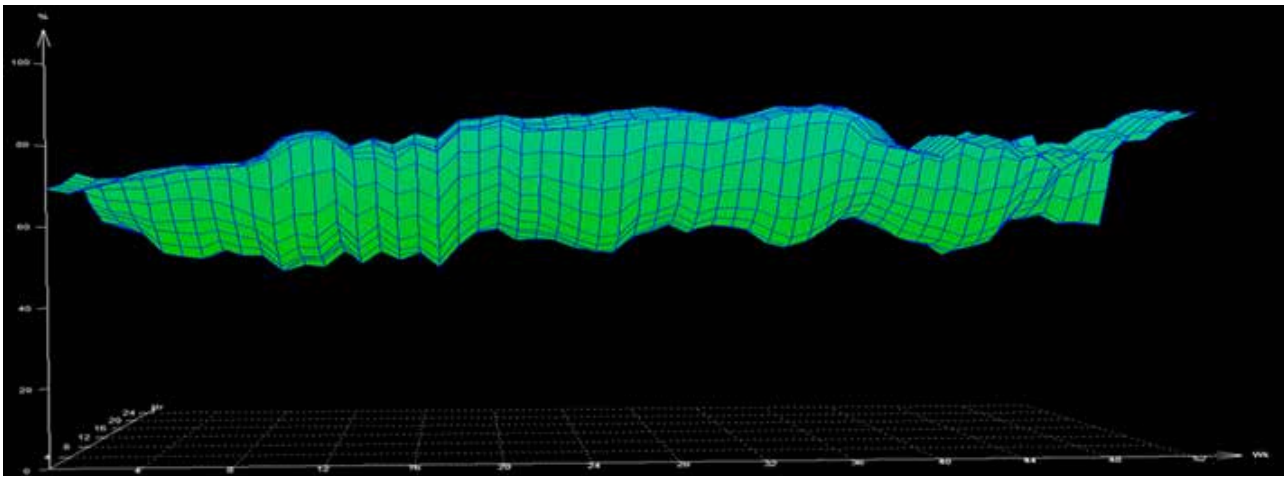


Fig 8.33 Relative humidity versus weeks; NJ Shore

This graph displays relative humidity in the y-axis and weeks in a year in the x-axis for the NJ Shore area. This data clearly shows that for most of the year the relative humidity is above 60%. However, the above graph is not very reliable since the relative humidity is dependent on temperature. If someone considers outside air during the winter and heats it up to comfort zone conditions, the relative humidity drops to around 30% which is quite dry. The opposite is true during the summer. When the outside air is brought in and cooled the relative humidity jumps up to a higher value. To get a better picture of what will happen when the outside air is brought inside, the same graph can be used with temperature replacing relative humidity in the y-axis.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

The graph at right displays relative humidity versus hours in a day for the NJ Shore area. There are some very important takeaways from looking at how the relative humidity changes with the hour of the day. We can see that during the middle of the day, the relative humidity is within the comfort zone, but spikes during the night time hours. This is because the amount of water in the air stays approximately constant, but the temperature changes and the relative humidity is dependent on temperature. This shows that a dehumidification system will only need to run around 12 hours a day with the majority of those hours occurring during the night.

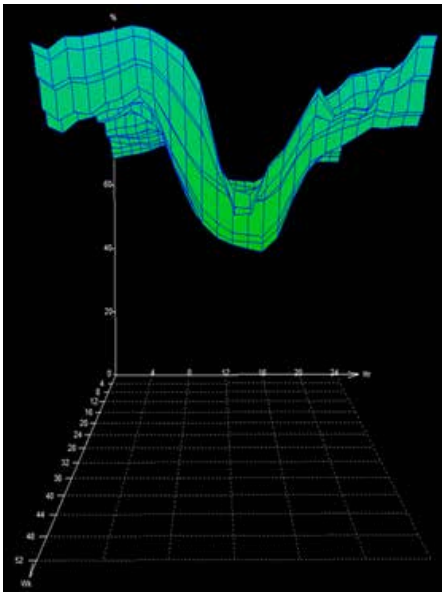


Fig 8.34 Rel. Humidity versus Hours; NJ Shore

The graph below displays temperature versus weeks in a year for the NJ Shore area. It shows that the summer months of the year are hot with an average temperature of around 25 degrees Celsius. Meanwhile, the winter months of the year are fairly cold with an average temperature of around 5 degrees Celsius. When you couple this information with the previous data you see the summer months place a large latent load on the HVAC system of the house. The winter months for the New Jersey climate do not need a dehumidification system because there is not any extra latent load on the HVAC system. This means that the desiccant system would only have to run for approximately half the year in the NJ shore area.

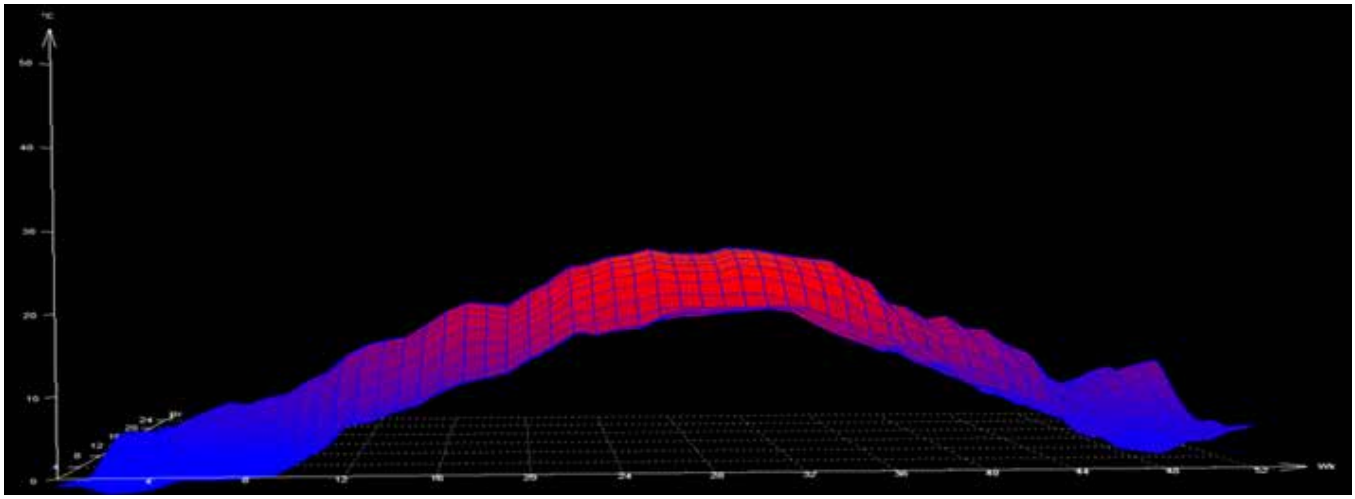


Fig 8.35 Temperature versus Weeks; NJ Shore

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

The graph at right displays temperature versus hours in a day for the NJ shore area. The shape of this graph could have been predicted from looking at the previous graph. The hours when the air is the hottest, the relative humidity is the lowest. This is because the temperature and relative humidity are inversely proportional meaning that when one is high, the other will be low as long as the absolute humidity stays constant.

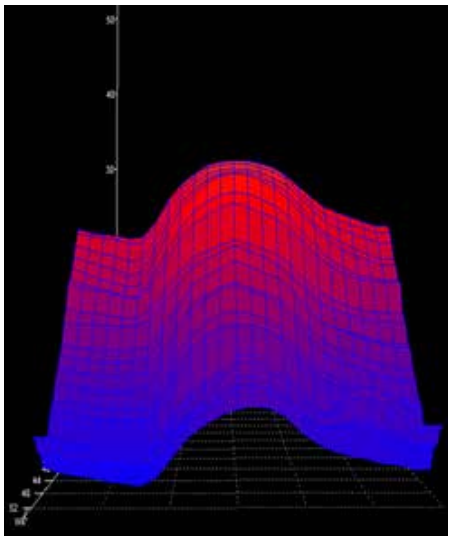


Fig 8.36 Temperature versus Hours; NJ Shore

This graph below displays temperature versus weeks in a year for the California Zone 8 area. This graph shows that the summer months and winter months are very similar in terms of temperature throughout the year. This is very different from the NJ shore area meaning that the demand for dehumidification is greater throughout the year. In other words, a large latent load will be placed on the HVAC system of the house. Finally, a low energy dehumidification system would be very beneficial because it would be running year round.

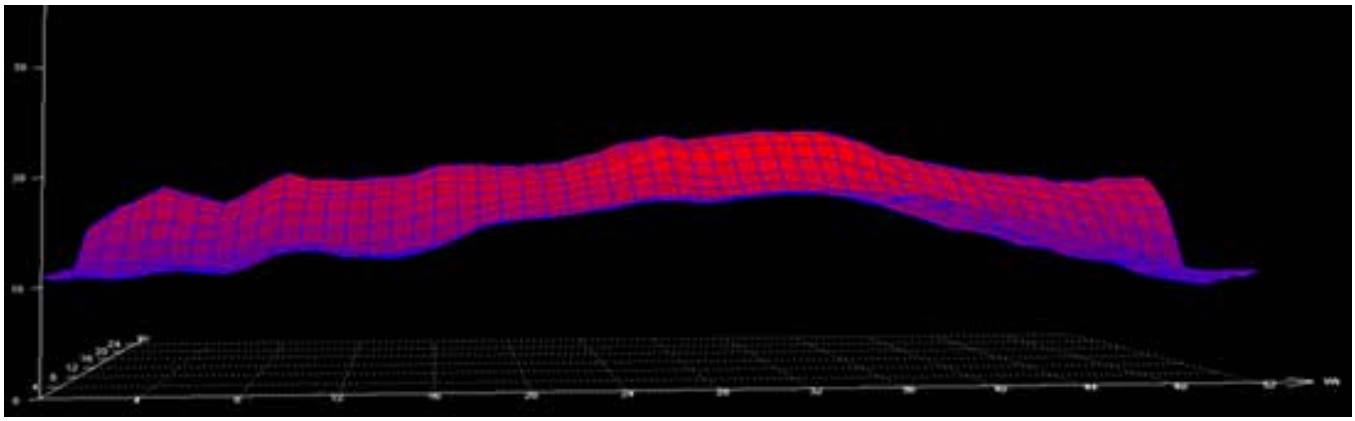


Fig 8.37 Displays Temperature versus Weeks in a Year; California Zone 8; NJ Shore

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

The graph at right displays temperature versus hours in a day for the NJ shore area. The shape of this graph could have been predicted from looking at the previous graph. The hours when the air is the hottest, the relative humidity is the lowest. This is because the temperature and relative humidity are inversely proportional meaning that when one is high, the other will be low as long as the absolute humidity stays constant.

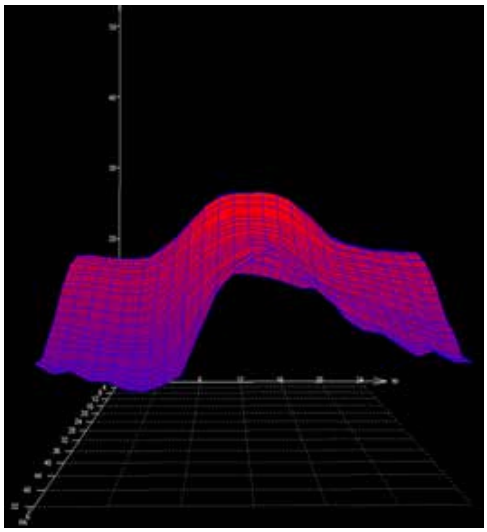


Fig 8.38 Temperature versus Hours; CA Zone 8

This graph below displays relative humidity versus weeks in a year for the California Zone 8 area. This graph shows a very interesting misconception of southern California. Many people think southern California is a dry place, but this graph shows that the relative humidity is above 60% most of the year. The reason for the high humidity in Zone 8 is its location between the Pacific Ocean and a mountain range which traps the moist air over the area.

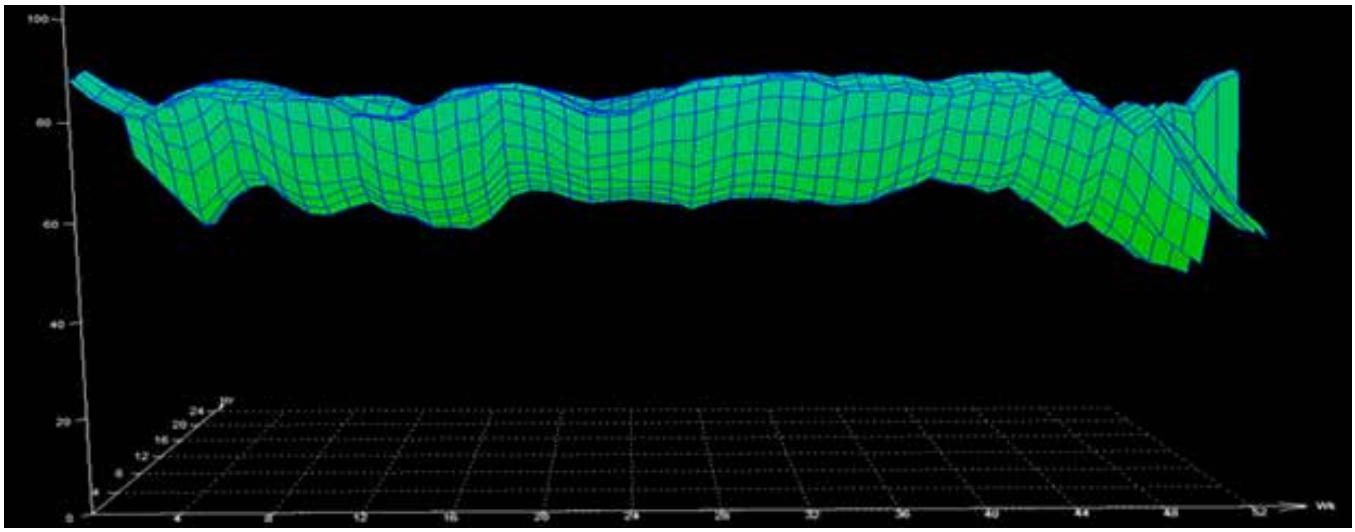


Fig 8.39 Relative Humidity versus Weeks in a Year; CA Zone 8; NJ Shore

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

The graph at right displays relative humidity versus hours in a day for the California Zone 8 area. It also has a similar shape to the New Jersey shore.

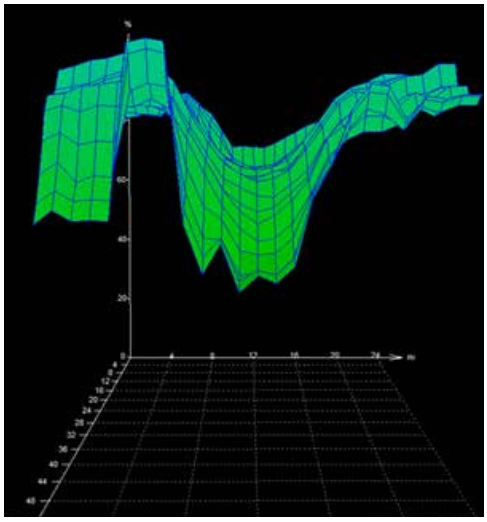


Fig 8.40 Temperature versus Hours; CA Zone 8

NECESSITY FOR SYSTEM

If the goal is to minimize energy usage, the need for a dehumidification system in the New Jersey climate is essential according to the research conducted. The summer time in the New Jersey climate causes a large latent load to be placed on the HVAC system. Although the latent load is not as large, the spring and fall seasons also benefit from the use of a desiccant system since the temperature is within the comfort zone, but the relative humidity is not. Running a low energy dehumidification system during these seasons instead of running the entire HVAC system will provide significant savings for the homeowner. The California climate data shows that year round dehumidification will be needed to remove the latent load from the HVAC system. Generally speaking, both climates only need to dehumidify during the night time hours from around 7pm-7am. It is interesting to note that 7:30pm is when the Solar Decathlon starts to measure the relative humidity during the exhibition days.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

In order to identify if dehumidification is needed, a temperature and humidity sensor is located in the duct work. If there is no need to dehumidify the house, the system will be turned off and the air will be fed through for natural ventilation. If the air entering the house is humid, then the desiccant column will strip the air of moisture using a liquid desiccant solution and the air stream that is pulled from the mechanical room will be used as a secondary air stream for the evaporative cooler. The evaporative cooler will cool the air so warm air is not distributed to the living spaces.

In the case that the house needs to get dehumidified the solar distiller will regenerate liquid desiccant solution by the use of solar energy. A temperature sensor as well as a salinity sensor will be essential to make this work. A butterfly valve will allow the desiccant solution to flow from the solar distiller to the storage tank. The desiccant storage tank acts as a holding tank in the event that the solar distiller regenerates the solution very quickly. The flow control valve provides a constant flow rate of desiccant solution to the desiccant column despite the loss of head. The next assembly includes the desiccant column that dehumidifies the incoming air streams. Finally the storage tank located beneath the desiccant column catches the less concentrated desiccant solution, which goes back to the solar distiller with the help of a small pump once the tank has been filled.

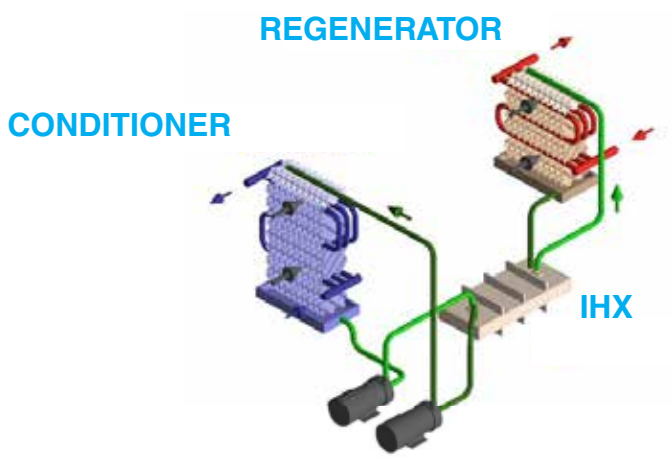


Fig 8.41 Desiccant System Diagram

A bigger storage tank is located on the right of the solar distiller for storage purposes. This tank will overflow into the grey water storage tank. A float valve will later refill the tank that is located beneath the evaporative cooler if needed. This storage tank catches any water that did not evaporate in the evaporative cooler. Finally a small pump will cycle the water back to the top of the evaporative cooler.

LIQUID DESICCANT SYSTEM

DESIGN DEVELOPMENT

Our house is required by code to have a minimum ventilation rate of 60cfm. We have decided to use a slightly higher flow rate of 70cfm for better indoor air quality. Passive houses have a reputation for having poor indoor air quality because of the low ventilation rates they have. We have determined a flow of 30lb of desiccant solution per hour to be an ideal flow rate. This was determined by using ASPEN Plus software. We varied the solution flow rate until the air coming out was in its driest state. The feeding and storage tank are both 15 gallons in size we decided how long we wanted one solution to last us. We came upon 4 hours. We decided four hours per solution because two solutions would take care of dehumidifying the house for an entire night. The solar distiller was sized to be around 36 square feet. This number was determined by research on solar stills and the effect depth has on evaporation rates. This correlates to a depth between one and two inches depending on how much water was adsorbed from the air. The size of the desiccant column and the evaporative cooler have not been determined and we are working on calculations to figure out the best way to model such a unique system.

The curent version tries to solve the shortcomings of the previous versions. The concept is to provide all our cooling through evaporation. We will be taking all the air that we need for cooling from the outside. This air will be dehumidified by our desiccant solution. The air will then go through an evaporative cooling unit, which uses the inside air as the process and a small percentage of the dry incoming air. The reason for using the dry air that we just spent energy dehumidifying is this air can absorb large amounts of water and provide large amounts of cooling.

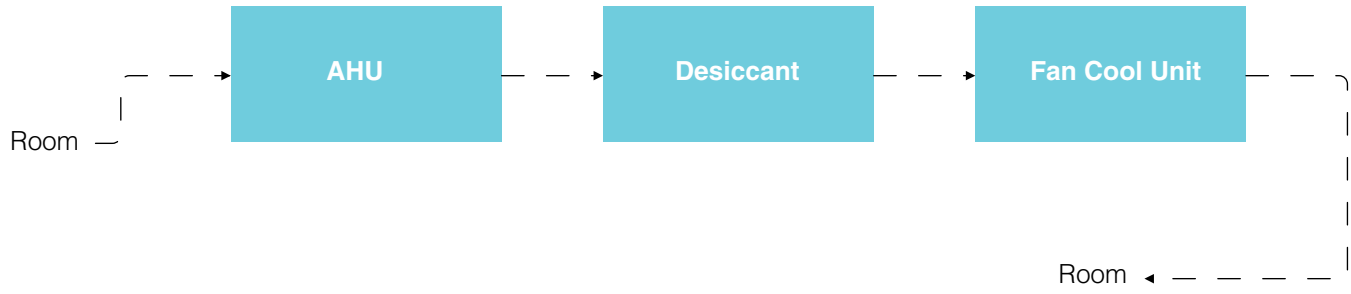


Fig 8.42 Air Circulation Diagram

LIQUID DESICCANT SYSTEM

SOLUTION RESEARCH

After deciding that the we would be using a desiccant dehumidification the team next needed to select which chemical desiccant. The team created a selection criteria chart for screening the solutions in order to make a decision. The main factors that the team felt they needed to consider were the vapor pressure, toxicity, cost, ease of procurement, solubility and corrosiveness. Once the team created a list of selection criteria, they ranked them according to their relative importance and created the following matrix in order to compare the solutions at a more precise level. Essentially, the solution scores are determined by the weighted sum of the ratings.
When assigning the weights for the selection criteria, the team felt that the most important factors were that vapor pressure and toxicity. The team scored the solutions on a scale of 0 to 5 with 0 being the worst of the options and 5 being the best. The Solution Scoring Matrix is shown below.

DESICCANT LIQUID SOLUTIONS						
	Calcium Chloride		Lithium Chloride		Lithium Chloride	
	Rating	Weighted Scoring	Rating	Weighted Scoring	Rating	Weighted Scoring
Vapor Pressure	2.44	0.85	5	1.75	2.27	0.8
Toxicity	2.78	0.69	1.46	0.37	5	1.25
Cost	5	1.25	0.18	0.05	0.09	0.02
Procurement	5	0.5	3	0.03	2	0.2
Solubility	2.44	0.12	2.54	0.13	5	0.25
Corrosiveness	0	0	0	0	0	0
TOTAL	17.66	3.42	12.18	2.59	14.36	2.52
RANK		1		2		3
CONTINUE?		YES				

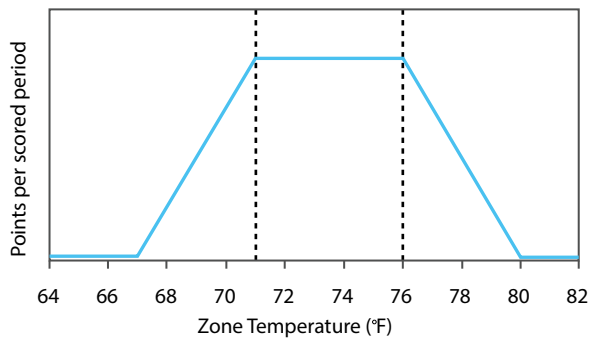
Table 8.6 Solution Scoring Matrix

To calculate the rating each solution received we looked up the different selection criteria and ordered the numbers. If we were looking for a small number, like vapor pressure, we multiplied that number by 5 to give us a normalization factor. Then we took all the data we collected and divided it by that factor to give us a score between 0 and 5. We divided 5 by the best value to obtain the normalization factor then multiplied the normalization factor for all the data to give us a value between 0 and 5. This method always places a value at 5 and compares all the values. The vapor pressure was taken at 25°C and 35wt%. This value should be close to that used for our system. Calcium Chloride can be found in most hardware stores, albeit at a lower purity. Lithium Chloride can be ordered from a U.S. vendor but at a premium cost. The results of the matrix reveal that the Calcium Chloride solution received the highest score.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

SPECIFICATIONS

In coordination with the stipulations of the Solar Decathlon, our selected psychrometric region, and Passivhaus regulations, we created environment specifications based on these goals and established system constraints.



Full Points:	71	F	(22 C)	≤	Temperature	≤	76	F	(24 C)
Reduced Points:	67	F	(19 C)	<	Temperature	<	71	F	(22 C)
or	76	F	(24 C)	<	Temperature	<	80	F	(27 C)
No points:					Temperature	≤	67	F	(19 C)
or					Temperature		80	F	(27 C)

Fig 8.7 Scoring function for the Temperature Subcontest

As established by the Solar Decathlon rules the team must keep the time-averaged interior dry-bulb temperature of the house between 71.0°F (21.7°C) and 76.0°F (24.4°C) during the scored period. Our team has decided to aim for a temperature of 74°F which is within the overlapping comfort zone described above. The graphics above provided by the DOE represent the scoring based on the interior temperature.

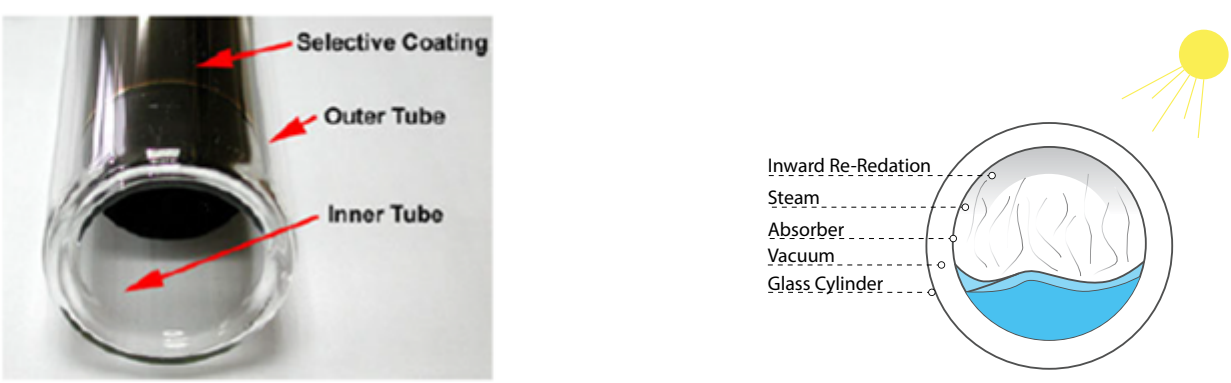
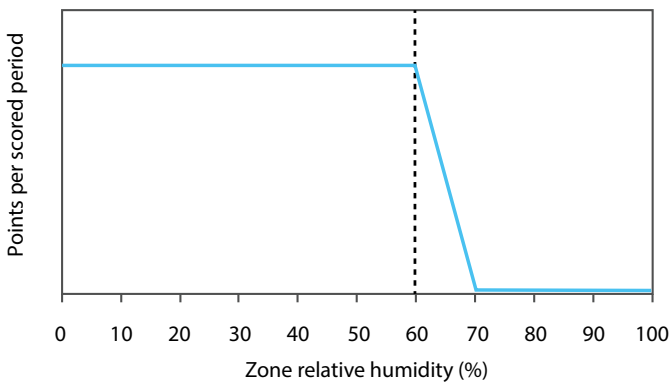


Fig B.16 Output is 100 C steam at one atmosphere P. Steam flows to point of use without a pump.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

SPECIFICATIONS

The Solar Decathlon has added a humidity constraint that most homes in the United States would not encounter, but has a large impact on relative comfort. For the competition we are required to keep the house under 60% relative humidity. Our team has decided to aim for a design relative humidity of 50% to correspond with the 74°F temperature within the pink region. The relative humidity diagrams and their correlation to points are shown below.



Full Points:		Relative Humidity	≤	60 %
Reduced Points:	60 % <	Relative Humidity	<	70 %
No Points:		Relative Humidity	≥	70 %

Fig 8.8 Scoring function for the Humidity Subcontest

In addition the interior comfort specifications like temperature and relative humidity, there are specific energy consumption and sustainability constraints. In addition to creating a fully regenerative desiccant system we also need to ensure that we consume less than 26.25 kWh of electrical energy during the contest week, less than 15% of our total energy allotment. To follow Passive House standards our projected yearly heating and cooling demand must be less than 15 kWh/m2 annually and a peak heating demand under 10 W/m2. Additionally the total projected yearly primary energy must be lower than 120 kWh/m2 per year. We will also be required to bring the internal climate to the specified ranges of temperature and relative humidity in a thirty minute time frame after the house is closed to the public from whatever the elevated temperature and humidity conditions.

REFERENCES

1 Tool 2011 by AutoDesk. The TMY3 data for New Jersey was taken from the McGuire Air Force Base. The Irvine California TMY3 data was from CA climate zone 8.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

DESICCANT SYSTEM VERSION 3.A

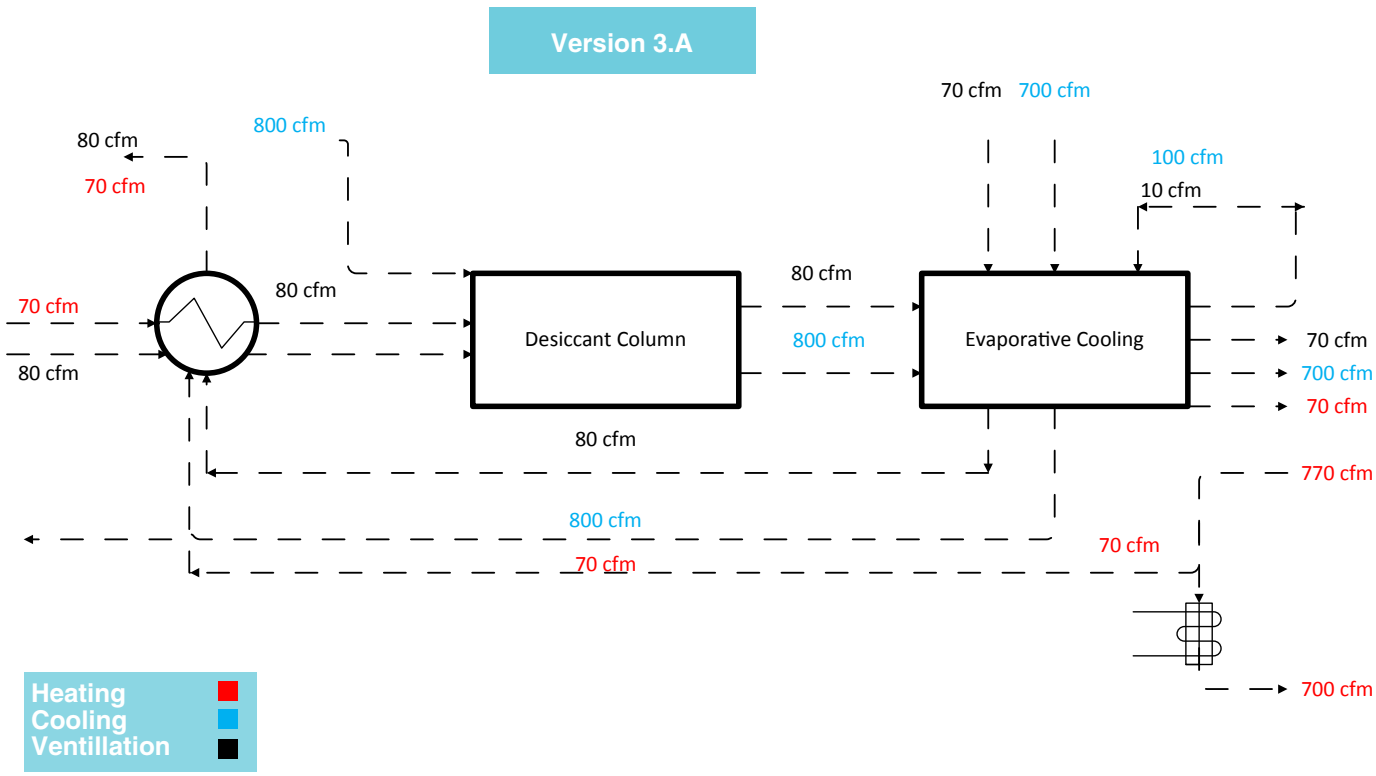


Fig 8.43 Air Circulation Diagram

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

DESICCANT SYSTEM VERSION 3.A

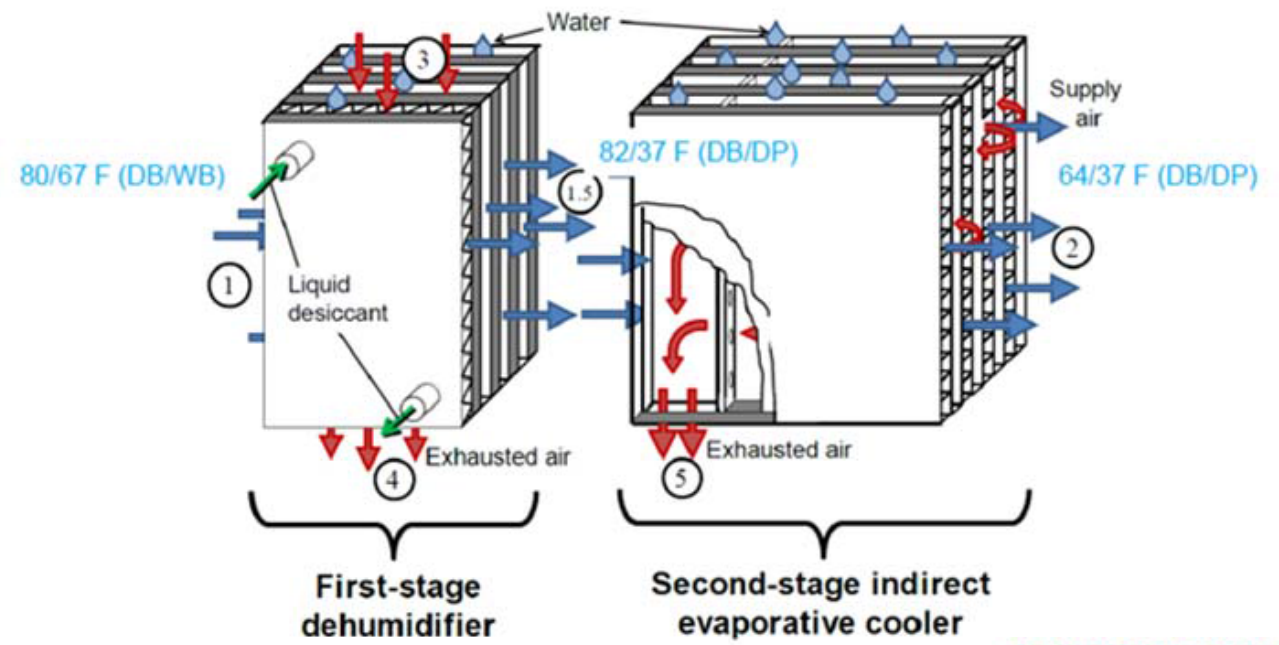


Fig 8.44 Air Circulation Diagram

NREL TP 5500-54755

Liquid desiccant enhanced evaporative cooling. This can provide cooling below the wet bulb temperature and is a two step process: (1) drying the air with liquid desiccant and (2) sending the dry air through an indirect evaporative cooler.

PROS : Can cool the air to temperatures below the wet bulb temperature of the incoming air.

CONS : Wastes some of the air that you spent energy dehumidifying.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

VERSION 2.0 FLOW DIAGRAM

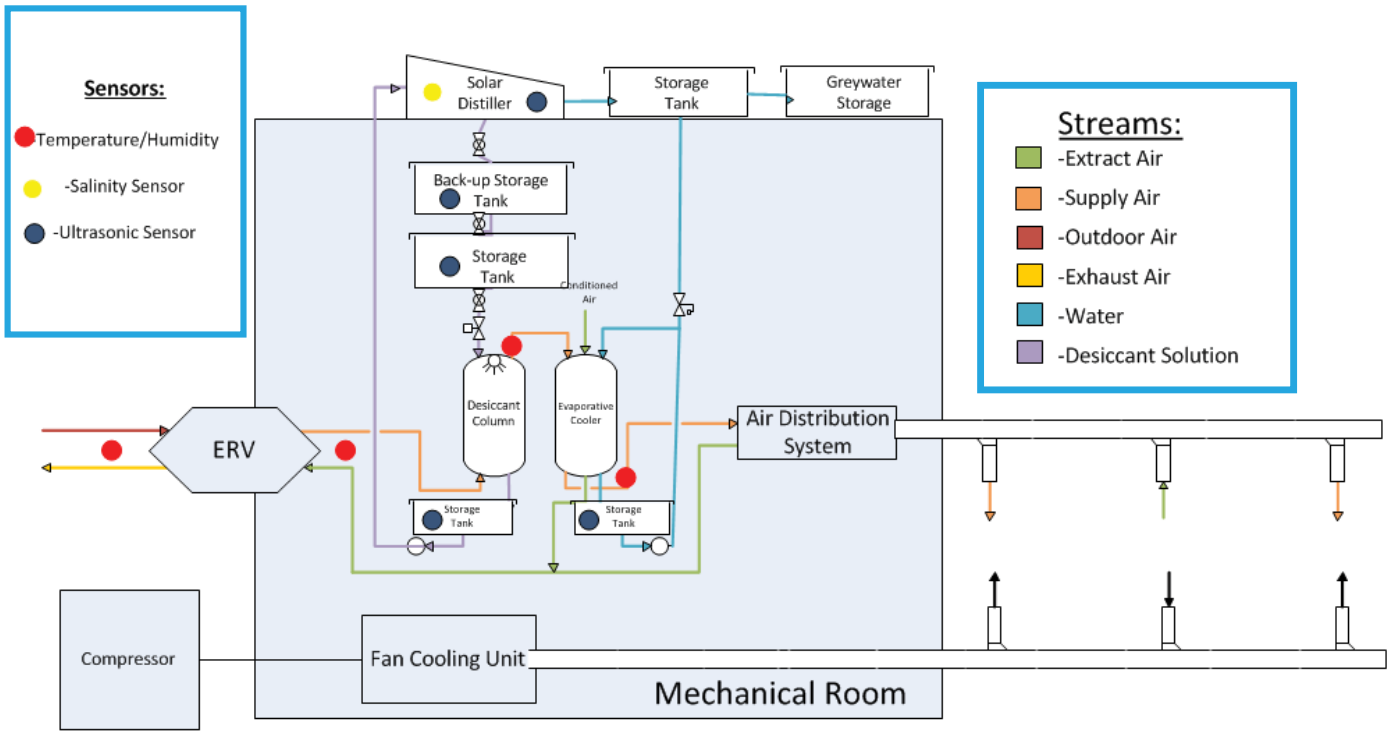


Fig 8.45 Version 2.0 Vision Flow Diagram

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

VERSION 2.0 EVAP COOLER FEATURE

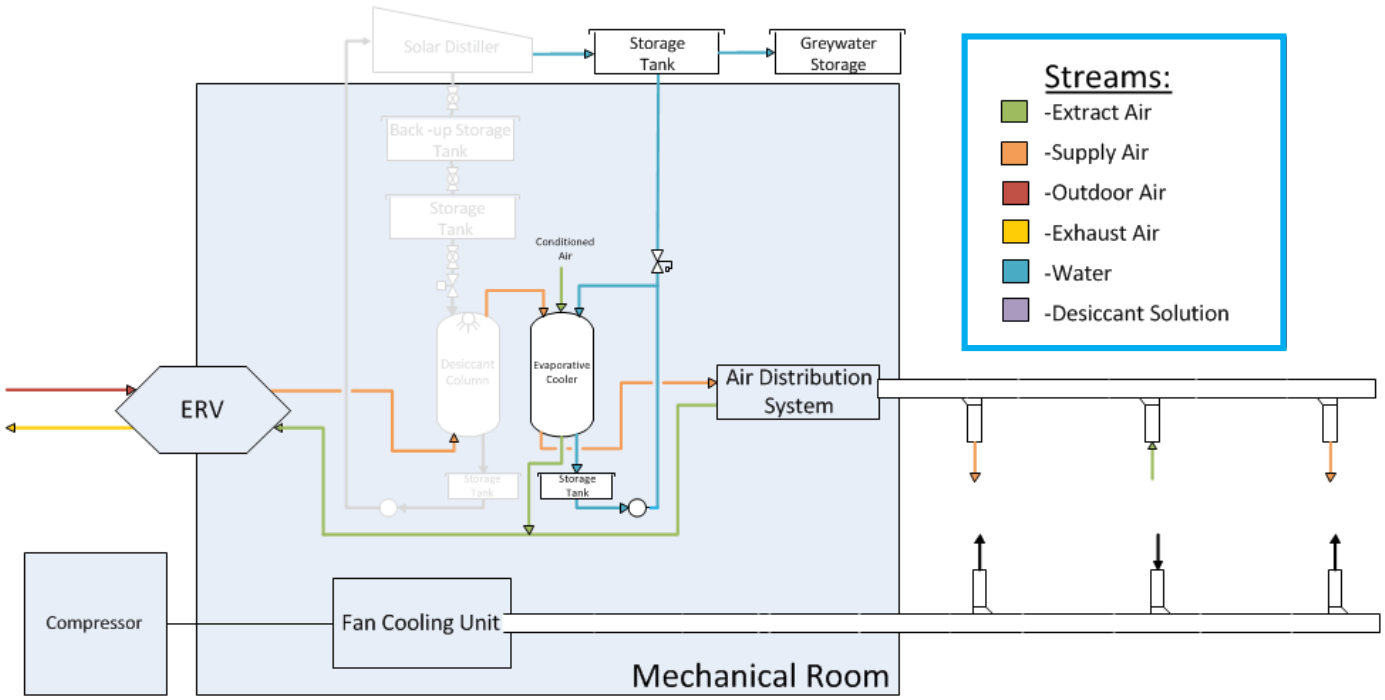


Fig 8.46

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

VERSION 2.0 ERV FEATURE

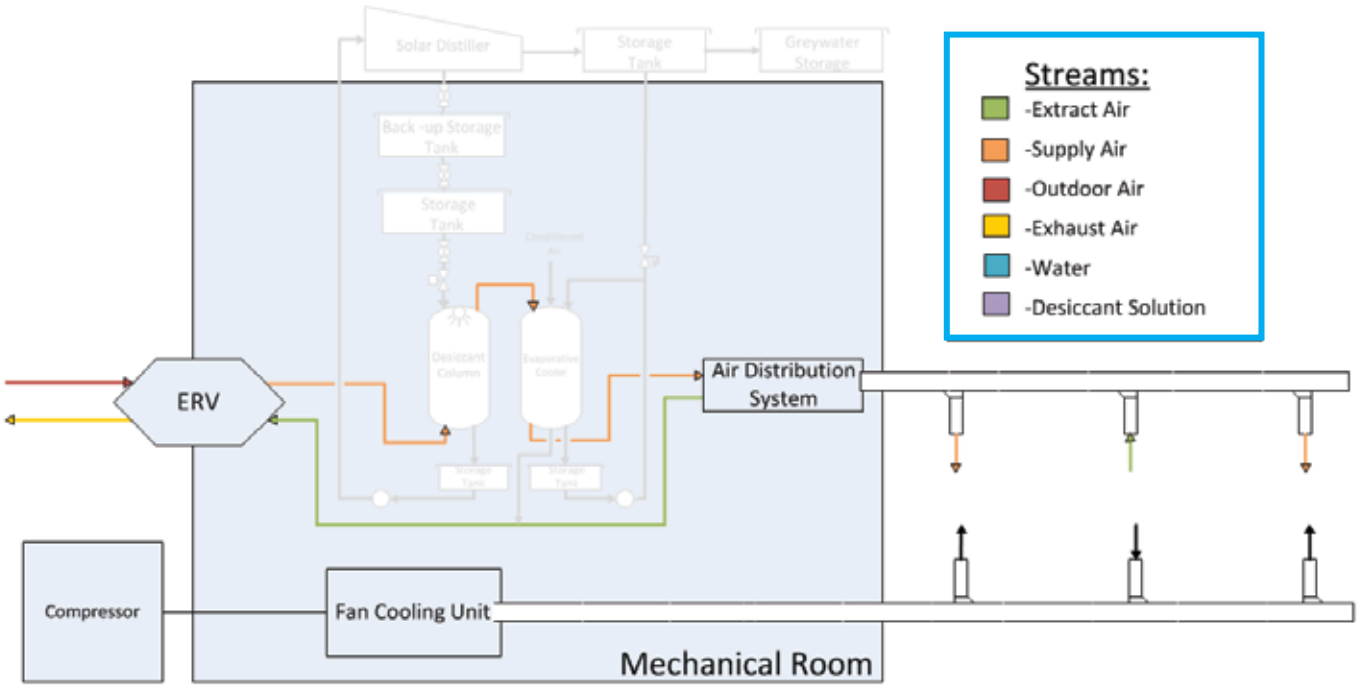


Fig 8.47

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

VERSION 2.0 RECIRCULATION FEATURE

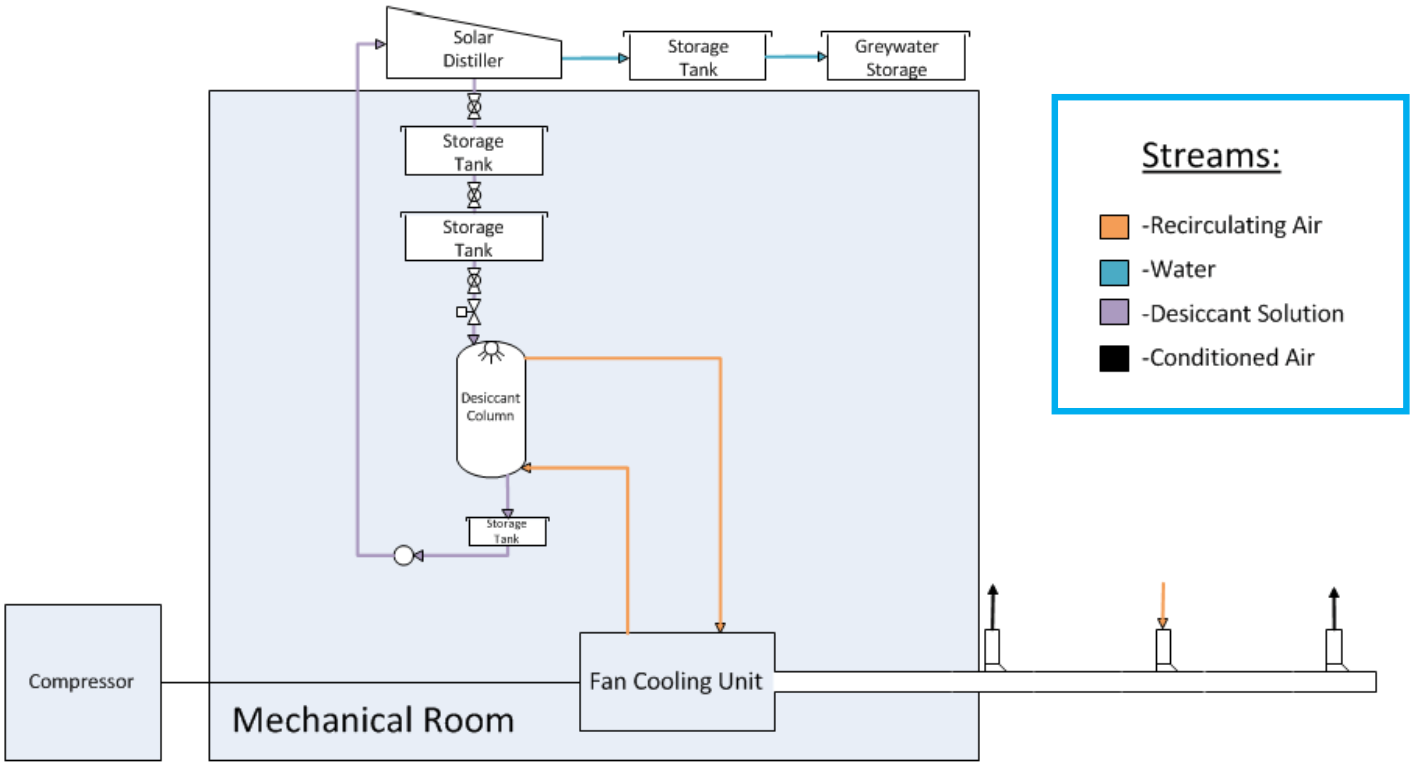


Fig 8.48

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

INDIVIDUAL FLOW DIAGRAMS

DESICCANT SYSTEM

1.) Solar Distiller that regenerates the Liquid Desiccant Solution through the use of solar energy. **Needs a temperature sensor as well as a salinity sensor.**

2.) Butterfly Valve that allows desiccant solution to flow from the Solar Distiller to number 3 storage tank. **Needs to be programmed to open and close.**

3.) Back-up Desiccant Storage tank

4.) Butterfly Valve that allows desiccant solution to flow from the number storage tank to the desiccant column. **Needs to be programmed to open and close.**

5.) Desiccant Storage tank that acts as a holding tank in the event that the Solar Distiller regenerates the solution very quickly.

6.) Butterfly Valve that allows desiccant solution to flow from the Solar Distiller to number 3 storage tank. **Needs to be programmed to open and close.**

7.) Flow Control Valve that will provide a constant flow rate of desiccant solution to the desiccant column despite the loss of head. **Needs to be programmed to dynamically change to always provide a constant flow rate.**

8.) Desiccant Column that will dehumidify the incoming air streams.

9.) Storage tank located beneath the desiccant columns to catch the less concentrated desiccant solution. **Needs to have a level sensor.**

10.) Small pump that will cycle the desiccnt solution from the number 7 storage tank to the solar distiller. **Needs to be programmed to run once the storage tanks contain a certain volume of desiccant solution.**

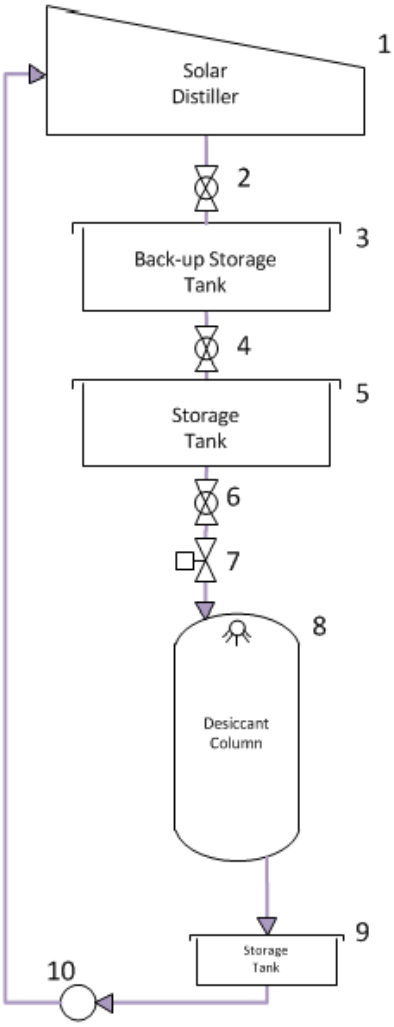


Fig 8.49 Version 2.0 Desiccant System

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

INDIVIDUAL FLOW DIAGRAMS

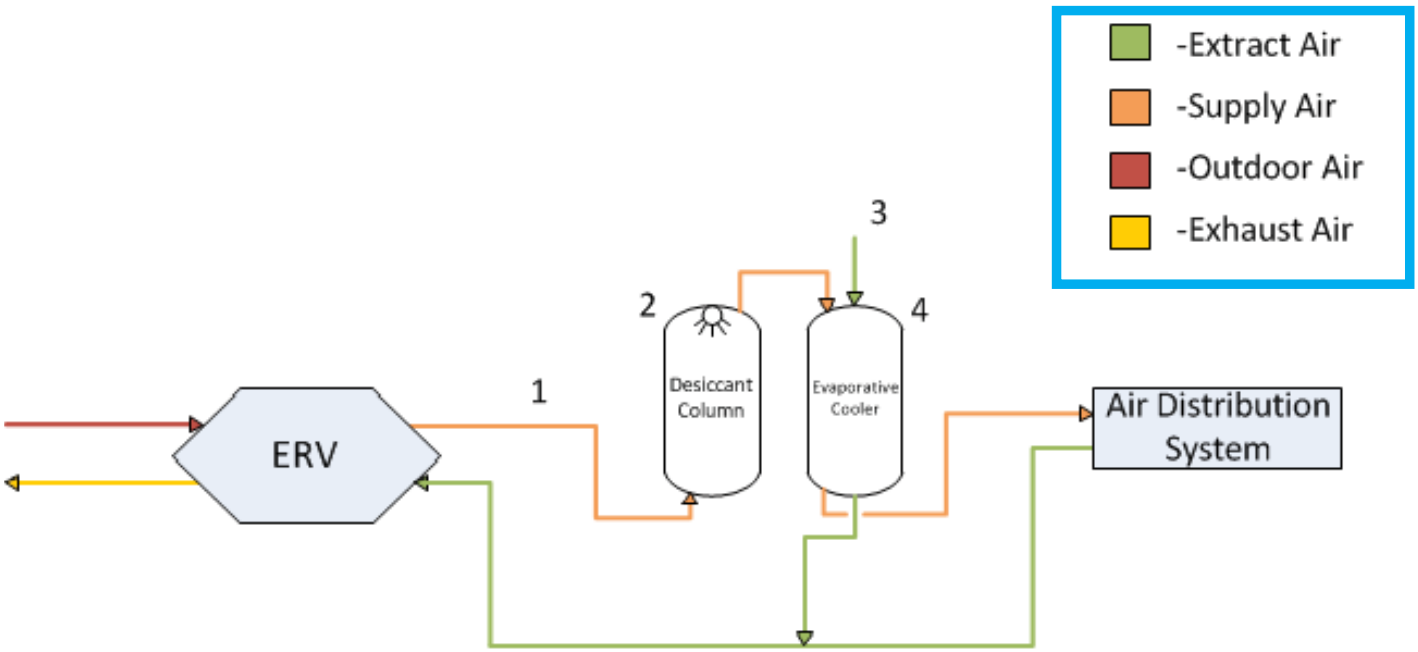


Fig 8.50

VENTILATION SYSTEM

1.) Temperature and humidity sensor that is located in the duct work. If dehumidification is unneeded, the system will be turned off and the air will be fed through. if dehumidification is needed, the system will be turned on.

2.) Desiccant Column that will strip the air moisture using a liquid desiccant solution.

3.) Air stream that is pulled from the mechanical room that will be used as the secondary air stream for the Evaporative Cooler.

4.) Evaporative Cooler that will cool the air so that it can be further dehumidified or fed into the living space through the distribution unit.

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

INDIVIDUAL FLOW DIAGRAMS

WATER SYSTEM

1.) Storage tank for the water that is produced by the Solar Distiller through the regeneration of the liquid Desiccant.

2.) Greywater storage tank that will have excess water fed to it from number 1 storage tank.

3.) Float valve that will refill the number 5 storage tank located beneath the evaporative coolers when need be using the water in the number 1 storage tank.

4.) Evaporative Cooler that is used to cool the desiccant air stream through the use of water evaporation.

5.) Storage tank located beneath the evaporative cooler that will catch any water that did not evaporate.

6.) Small pump that will cycle the water from the number 5 storage tank to the top of the evaporative cooler. **Needs to be programmed to run in 5 minute cycles.**

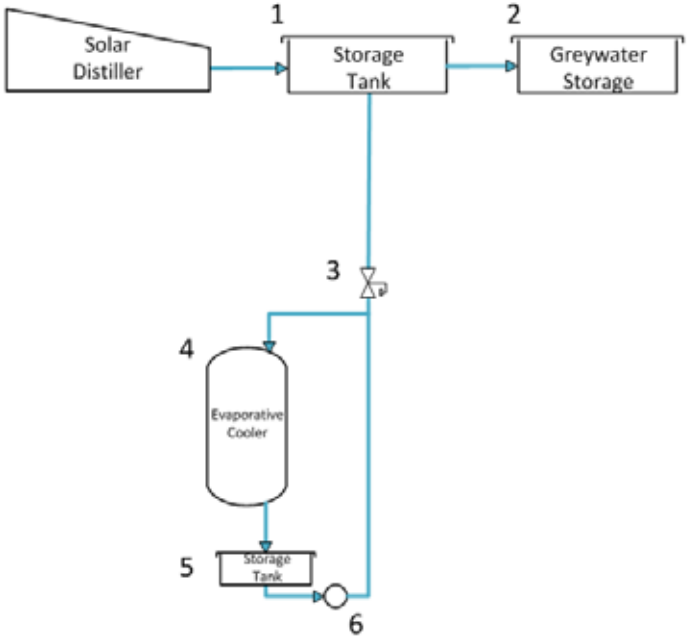


Fig 8.51

SUMMARY OF MECHANICAL INNOVATIVE SYSTEMS

INDIVIDUAL FLOW DIAGRAMS

OVERALL SYSTEM

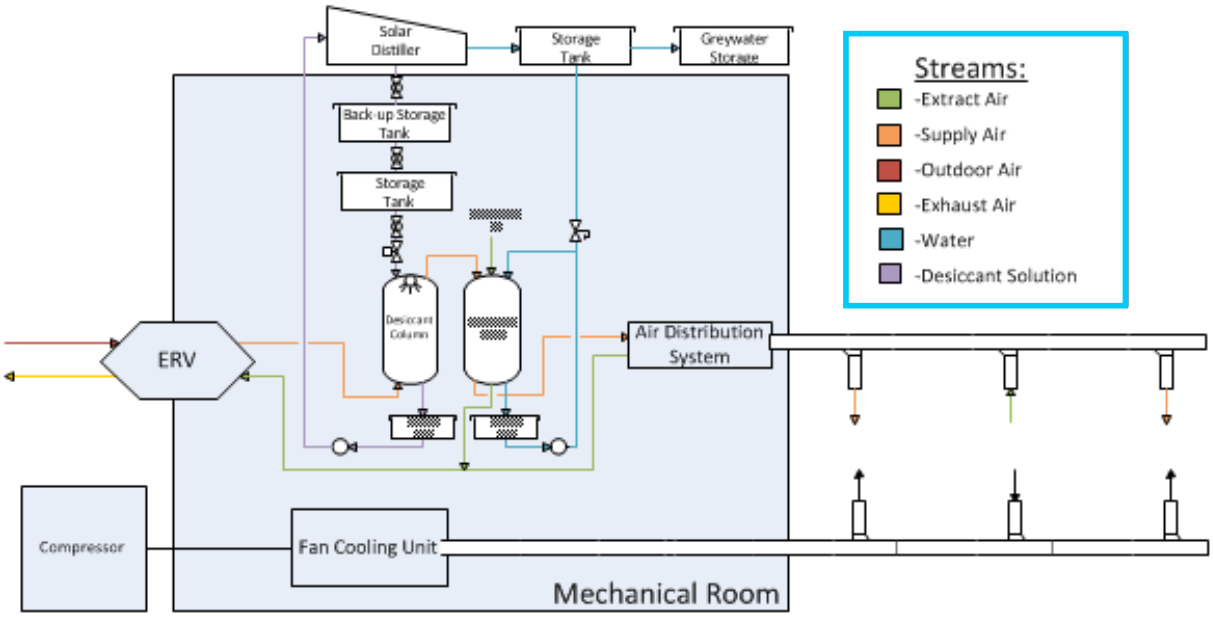


Fig 8.52

VERSION 3.0

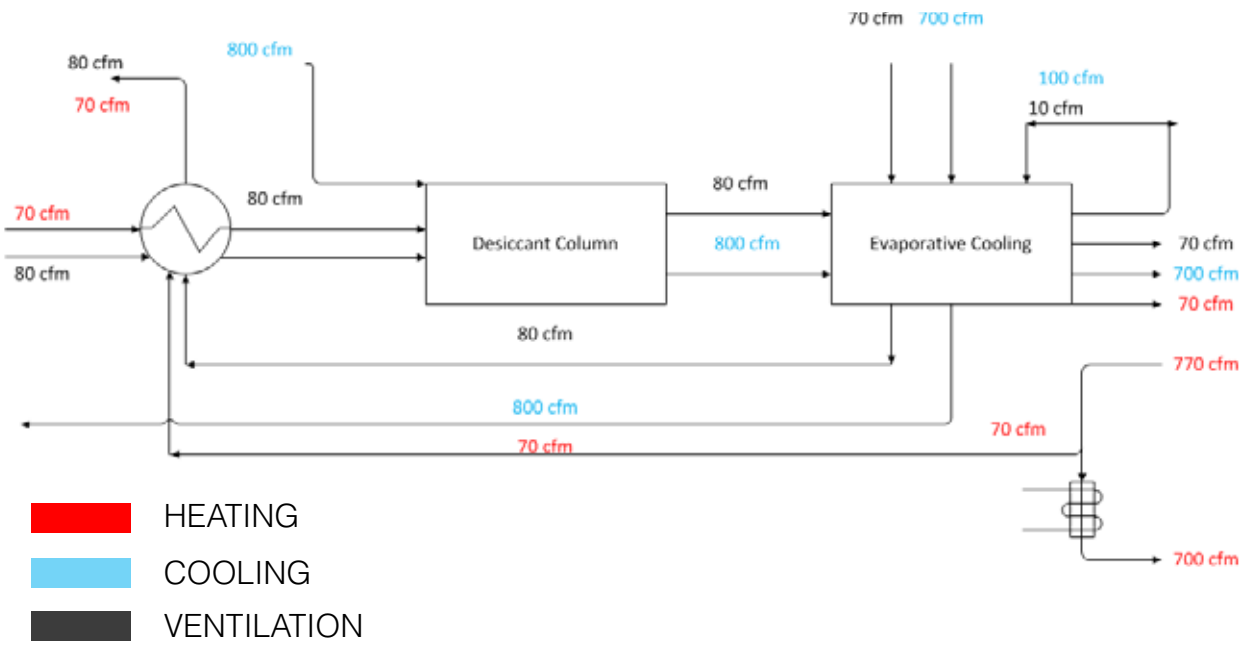


Fig 8.53 Version 3.0 Flow Diagram

09 CONSTRUCTION SPECIFICATIONS

CONSTRUCTION SPECIFICATIONS

DIVISION 01	**GENERAL REQUIREMENTS**
01 25 00	SUBSTITUTION PROCEDURES
01 42 00	REFERENCES
01 50 00	TEMPORARY FACILITIES AND CONTROLS
01 60 00	PRODUCT REQUIREMENTS
01 74 19	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
01 81 13	SUSTAINABLE DESIGN REQUIREMENTS
DIVISION 02	**EXISTING CONDITIONS**
02 43 13.13	BUILDING RELOCATION
DIVISION 06	**WOOD,PLASTICS,AND COMPOSITES**
06 10 00	ROUGH CARPENTRY
06 10 53	MISCELLANEOUS ROUGH CARPENTRY
06 15 33	WOOD PATIO DECKING
06 16 00	SHEATHING
06 29 00	FINISH CARPENTRY
DIVISION 07	**THERMAL AND MOISTURE PROTECTION**
07 21 00	THERMAL INSULATION
07 25 00	WEATHER BARRIERS
07 41 13	METAL ROOF PANELS
07 46 19	STEEL SIDING
07 46 23	WOOD SIDING
DIVISION 08	**OPENINGS**
08 16 13	FIBERGLASS DOORS
08 54 13	FIBERGLASS WINDOWS
08 80 00	GLAZING

CONSTRUCTION SPECIFICATIONS

DIVISION 11	**EQUIPMENT**
11 26 00	UNIT KITCHENS
11 31 00	RESIDENTIAL APPLIANCES
DIVISION 21	**FIRE SUPPRESSION**
21 05 00	COMMON WORK RESULTS FOR FIRE SUPPRESSION
21 10 00	WATER-BASED FIRE-SUPPRESSION SYSTEMS
DIVISION 22	**PLUMBING**
22 05 00	COMMON WORK RESULTS FOR PLUMBING
22 05 13	COMMON MOTOR REQ. FOR PLUMBING EQUIPMENT
22 05 23	GENERAL-DUTY VALVES FOR PLUMBING PIPING
22 13 16	SANITARY WASTE AND VENT PIPING
22 33 00	ELECTRIC DOMESTIC WATER HEATERS
DIVISION 23	**HVAC**
23 05 00	COMMON WORK RESULTS FOR HVAC
23 05 13	COMMON MOTOR REQ. FOR HVAC EQUIPMENT
23 05 23	GENERAL-DUTY VALVES FOR HVAC PIPING
23 07 00	HVAC INSULATION
23 21 13	HYDRONIC PIPING
23 21 23	HYDRONIC PUMPS
23 31 00	HVAC DUCTS AND CASINGS
23 34 23	HVAC POWER VENTILATORS
23 37 13	DIFFUSERS, REGISTERS, AND GRILLES
23 56 13.13	HEATING, FLAT-PLATE, SOLAR COLLECTORS
23 73 13	MODULAR INDOOR CENTRAL AIR-HANDLING UNITS
23 81 46	WATER-SOURCE UNITARY HEAT PUMPS
DIVISION 25	**INTEGRATED AUTOMATION**
25 05 00	COMMON WORK RESULTS FOR INTEGRATED AUTOMATION
25 13 00	INTEGRATED AUTOMATION MONITORING NETWORK

CONSTRUCTION SPECIFICATIONS

DIVISION 26	**ELECTRICAL**
26 09 23	LIGHTING CONTROL DEVICES
26 24 16	PANELBOARDS
26 27 13	ELECTRICITY METERING
26 31 00	PHOTOVOLTAIC COLLECTORS
26 50 00	LIGHTING
DIVISION 26	**ELECTRICAL**
28 31 00	FIRE DETECTION AND ALARM
DIVISION 31	**EARTHWORK**
31 01 00	MAINTENANCE OF EARTHWORK
31 01 62	MAINTENANCE OF DRIVEN PILES
31 06 00	SCHEDULES FOR EARTHWORK
DIVISION 32	**EARTH MOVING**
31 01 30	OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS
31 01 80	OPERATION AND MAINTENANCE OF IRRIGATION
DIVISION 33	**UTILITIES**
33 06 00	SCHEDULES FOR WATER UTILITIES
33 06 40	SCHEDULES FOR STORM DRAINAGE UTILITIES
DIVISION 34	**TRANSPORTATION**

CONSTRUCTION SPECIFICATIONS

DIVISION 35	**WATERWAY AND MARINE CONSTRUCTION**
DIVISION 40	**PROCESS INTEGRATION**
DIVISION 41	**MATERIAL PROCESSING AND HANDLING EQUIP.**
DIVISION 42	**PROCESS HEATING,COOLING,AND DRYING EQUIP.**
DIVISION 43	**PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIP.**
DIVISION 44	**POLLUTION CONTROL EQUIPMENT**
DIVISION 45	**INDUSTRY SPECIFIC MANUFACTURING EQUIP.**
DIVISION 48	**ELECTRICAL POWER GENERATION**
48 19 19	ELECTRICAL POWER GENERATION INVERTER

10 QUANTITY TAKE OFF

COMPETITION PROTOTYPE

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

COLLECTIVE TOTALS

SYSTEM DESCRIPTION		SUB-TOTAL
Electrical	$	60,056.20
Plumbing / Fire Protection	$	26,813.05
Mechanical	$	28,781.25
Foundation Superstructure & Exterior Closure	$	100,738.03
Kitchen / Baths	$	35,534.40
System Total	$	251,922.92
10% Contigency(10% of system total)	$	25,192.29
Construction Cost Total	$	5,521.52
GRAND TOTAL	$	282,636.73

Fig 10.1 Collective Totals

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

ELECTRICAL TOTALS

ELECTRICAL	QTY	UNIT	UNIT COST	EST'D COST	LABOR	LABOR & MATERIAL	SUBTOTAL	TOTAL COST
ELECTRICAL SERVICE & DISTRIBUTION								
200A 120/240V Load Center	1	ea	$275.88	$275.88	$510.00	$785.88		
#1/0 3C	20	lf	$2.74	$54.80	$100.00	$154.80		
SUBTOTAL							$940.68	
LIGHTING & BRANCH WIRING								
Devices								
20A 125V Duplex Receptacle	10	ea	$5.49	$54.90	$100.00	$154.90		
20A 125V Duplex Receptacle - GFCI	15	ea	$14.49	$217.35	$350.00	$567.35		
20A 125V Duplex Receptacle - WP	5	ea	$20.99	$104.95	$200.00	$304.95		
WP Receptacle Housing	5	ea	$8.44	$42.20	$90.00	$132.20		
50A 125/250V Single Receptacle	4	ea	$8.89	$35.56	$70.00	$105.56		
15A 125V Duplex Receptacle - Floor	4	ea	$52.39	$209.56	$400.00	$609.56		
20A 120/277V Switch	8	ea	$8.97	$71.76	$134.00	$205.76		
20A 120/277V 3-Way Switch	4	ea	$3.97	$15.88	$67.00	$82.88		
Branch								
#12/2C Nm-B	500	lf	$0.59	$295.00		$295.00		
#10/3C Nm-B	30	lf	$1.24	$37.20		$37.20		
#8/3C Nm-B	100	lf	$2.39	$239.00		$239.00		
Lighting								
Hampton Bay Sadie Collection 1-Light Hanging Metal Satin Nickel Ceiling Pendant	1	EA	$54.97	$54.97	$329.71	$384.68		
Home Decorators Collection Sydney 3-Light Polished Nickel Bowl Pendant	2	EA	$119.00	$238.00	$329.71	$567.71		
Lithonia Lighting 3 in. Recessed Matte White LED Baffle Kit	2	EA	$44.97	$89.94	$329.71	$419.65		
Lithonia Lighting 4 in. Recessed Matte White LED Baffle Kit	20	EA	$47.97	$959.40	$329.71	$1,289.11		
6" LED Module	6	EA	$29.97	$179.82	$329.71	$509.53		
							$5,905.04	
ELECTRICAL DISTRIBUTION								
Sunmodule Protect SW 275-MONO		ea	$340.00	$13,260.00	$6,630.00	$19,890.00		
LUMOS LSX200 Series		ea	$400.00	$3,600.00	$3,600.00	$7,200.00		
SB 6000TL-US-22		ea	$2,409.00	$2,409.00	$2,409.00	$4,818.00		
SB 3800TL-US-22		ea	$2,060.00	$2,060.00	$2,060.00	$4,120.00		
SnapNrack Series 500		ea	$3,180.00	$3,180.00	$6,360.00	$9,540.00		
Tigo Energy Dual Maximizer - ES (MM-2ES)	18	ea	$99.95	$1,799.10	$1,799.10	$3,598.20		
Tigo Energy Gateway (GTWY)	1	ea	$276.00	$276.00	$0.00	$276.00		
Tigo Energy Maximizer Management Unit (MMU)	1	ea	$499.00	$499.00	$499.00	$998.00		
Advanced Energy PV Heater	1	ea	$1,226.85	$1,226.85	$613.43	$1,840.28		
Wires for Solar Array	930	lf	$1.00	$930.00	$0.00	$930.00		
SUBTOTAL							**$53,210.48**	
TOTAL - ELECTRICAL								**$60,056.20**

Lumos modules used where?

Fig 10.2 Electric Total Costs

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

CONSTRUCTION COSTS

CONTINGENCIES/ESCALATION			SUB-TOTAL	TOTAL
Design and Pricing Contingency	10.00%		#	#
Forklift	1	Week	$1,622.50	$1,622.50
Typical House Crane	2	Days	$1,480.00	$2,960.00
Generator	1	Week	$451.00	$451.00
Night Time Site Lighting	2	Each	$244.01	$488.02
			TOTAL	5521.52

Fig 10.3 Construction Total Costs

PLUMBING + FIRE PROTECTION COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	EST'D COST	LABOR COST	LABOR AND	SUBTOTAL	TOTAL COST
PLUMBING								
DHW Tank - 80 Gallon	1	ea	$3,000	$3,000	$350	$3,350		
Manifold	1	ea	$300	$300	$600	$900		
Rainwater HOGs (1 or 2)	2	ea	$400	$800	$1,600	$2,400		
irrigation system (probably drip piping	1	kit	$144	$144	$288	$432		
supply tank (1500 gallons)	1	ea	$2,600	$2,600	$5,200	$7,800		
wastewater tank (~500 gallons?)	1	ea	$2,235	$2,235	$4,470	$6,705		
sump pump	1	ea	$166	$166	$332	$498		
Pump to manifold	1	ea	$300	$300	$600	$900		
Dual Flush Toilet	1	ea	$330	$330	$660	$990		
Subtotal							$23,975	
Fire Protection								
Sidewall Sprinkler	3	EA	$70.21	$211	$105.32	$316		
Ceiling Sprinkler	1	EA	$70.21	$70	$35.11	$105		
Sprinkler Head	1	EA	$7.00	$7	$3.50	$11		
Sprinkler Cover Plate	4	EA	$26.06	$104	$52.12	$156		
Smoke/CO Detector	5	EA	$64.99	$325	$30.00	$355		
Fire Extinguisher	1	EA	$29.97	$30	$0.00	$30		
Fire Suppression Piping	100	LF	$11.40	$1,140	$570.00	$1,710		
Manual Globe Valves	3	EA	$10.00	$30	$5.00	$35		
Pressure Gauges	2	EA	$50.00	$100	$20.00	$120		
							$2,838	
							TOTAL	$26,813

Fig 10.4 Plumbing + Fire Protection Costs

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

ENCLOSURE COSTS

Exterior Closure						
Exterior Walls						
SIPS composite insulated material 4'X8' 4.5" thick	80	sf	$4.27	$342		
4'x10' 5/8"Drywall	80	SHT	$10.32	$825.60		
4'x10' Green Board	3	SHT	$13.00	$39.00		
Drywall adhesive	2	CS	$52.82	$105.64		
25lb Box of Drywall screws	1	BX	$38.96	$38.96		
5lb Bag of Green Spackle	8	BU	$14.78	$118.24		
5lb Bag of Blue Spackle	6	BU	$14.78	$88.68		
Rapid Mix Spackle	1	BG	$10.25	$10.25		
Drywall Tape	8	RL	$1.75	$14.00		
Flex Tape	1	RL	$9.98	$9.98		
Corner Bead - Outside corner 10'	33	EA	$1.98	$65.34		
J-Bead 8'	50	LF	$1.18	$59.00		
Hardi board 1/2"	4	SHT	$11.77	$47.08		
Hardi board 1/4"	3	SHT	$10.37	$31.11		
Sub Total					1794.48	
Exterior Windows						
Bedroom Windows: Zola Tilt and Turn 3'X5'	30	sf	$35	1050		
Skylights: Fakro Fixed flat roof skylights 2.5'X5'	25	sf	$35	875		
Sub Total					1925	
Exterior Doors						
West and South Sliding Doors: Zola Lift and Slide 9' high by 10' wide	180	sf	$35	6300		
Sub Total					$ 6,335.00	
Total-Exterior Closure						$ 8,260.00
House Roof						
2 x 8 Hangers	30	EA	$2.98	89.4		
Sub Total					89.4	
Module Roof						
Wood Studs (2" x 6" x 12')	33	EA	$8.11	267.63		
Plywood (3/4")	30	EA	$19.97	599.1		
2" x 8" x 14'	30	EA	$11.02	330.6		
2" x 8" x 16' (Wet/Dry Roof Rim)	30	EA	$12.59	377.7		
2" x 6" x 10'	12	EA	$6.45	77.4		
2" x 6" x 12'	33	EA	$7.74	255.42		
6" x 6" x 12' Columns	6	EA	$25.00	150		
6" x 6" x 16' Columns	2	EA	$30.00	60		
6" x 10" x 12'	2	EA	$94.80	189.6		
6" x 10" x 14'	1	EA	$110.60	110.6		
6" x 10" x 24'	1	EA	$189.60	189.6		
LVL Module Connection	2	EA		0		
Sub Total					$2,607.65	
Solar Roofing				0		
1.75 x 11.5 LVL	37	EA	$100.56	3720.72		
2" x 8" x 16'	35	EA	$17.97	628.95		
Plywood Sheathing	36	EA	$19.97	718.92		
Felt Paper	4	RL	$19.20	76.8		
Roofing Staples	5	BX	$12.00	60		
Sub Total					$5,205.39	
Roofing				0		
Asphalt Roof Shingles	14 BD		$26.68	373.52		
Versashield	980 SF		$0.96	940.8		
Sub Total					$1,314.32	
TOTAL:						$9,216.76

Fig 10.5 Enclosure Totals

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

HVAC COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	EST'D COST	LABOR COST	LABOR TOTA	SUBTOTAL	
HVAC								
Compressor/Fan Coil Unit Bundle	1	ea	$3,500.00				$3,500.00	
Refrigerant Piping	TBD	Per 25'	$125.00				$125.00	
Dessicant Black Box	1	ea	$750.00				$750.00	
ERV	1	ea	$2,200.00				$2,200.00	
Ducting	95	L.F.	$45.00	$4,275.00		$2,137.50	$6,412.50	
1-1/2" Duct Thermal Insulation	9025	S.F.	$0.23	2075.75	$1.52	13718	15793.75	
							TOTAL COST	28781.25

Fig 10.5 HVAC Totals

KITCHEN COSTS

	System Description	QTY	UNIT	UNIT COST	LABOR COST	EST'D COST	SUBTOTAL	TOTAL COST
Kitchen								
	Counter tops	25.08	sq ft	$ 0.042	$ 9.15	$ 10.20		
	Backsplash	53	sq ft	$ 4.90	$ 4.70	$ 264.40		
	Cabinets	159	sq ft	$ 5.61	$ 1.32	$ 893.31		
	Selves	30	ea	$ 7.70	$ 1.32	$ 232.32		
	Flooring	459	sq ft	$ 1.99	$ 1.71	$ 915.12		
	Island	55.9	sq ft	$ 0.042	$ 9.15	$ 11.50		
	Dishwasher 24-32"	1	ea	$ 1,499.00	$ 420.00	$ 1,919.00		
	Grill 13"	3	ea	$ 1,550.00	$ 142.00	$ 4,792.00		
	Stove 29-30"	1	ea	$ 799.00	$ 195.00	$ 994.00		
	Cooktop 30-32"	1	ea	$ 599.00	$ 200.00	$ 799.00		
	Range Hood 30-36"	1	ea	$ 749.00	$ 266.00	$ 1,015.00		
	Refrigerator 30-33"	1	ea	$ 7,590.00	$ 274.00	$ 7,864.00		
	Sink	1	ea	$ 746.05	$ 610.00	$ 1,356.05		
							$ 21,065.91	
Bath / Out Shower								
	Shower Tile/ Flooring	145	sq ft	$ 2.39	$ 5.15	$ 351.70		
	Flooring	20	sq ft	$ 4.90	$ 1.71	$ 99.71		
	Cabinets	5.6	sq ft	$ 5.61	$ 1.32	$ 32.74		
	Selves	4	ea	$ 7.70	$ 1.32	$ 32.12		
	Mirror	26	sq ft	$ 5.75	$ 21.50	$ 171.00		
	Shower Head	1	ea	$ 2,158.00	$ 57.00	$ 2,215.00		
	Sink	1	ea	$ 120.00	$ 90.00	$ 210.00		
	Faucet	1	ea	$ 2,924.48	$ 50.00	$ 2,974.48		
	Toilet	1	ea	$ 666.00	$ 156.00	$ 822.00		
	Towel Rack	1	ea	$ 2.99	$ 0.67	$ 3.66		
							$ 6,912.41	
Out Shower								
	Wood Paneling	84	sq ft	$ 6.30	$ 15.33	$ 544.53		
	Wood Surface	105	sq ft	$ 1.99	$ 1.71	$ 210.66		
	Shower Head	1	ea	$ 2,158.00	$ 57.00	$ 2,215.00		
							$ 2,970.19	
Miscellaneous								
	Interior Paint-Walls	2000	sq ft	$ 0.13	$ 134.40	$ 394.40		
	Interior Paint-Ceilings	750	sq ft	$ 0.13		$ 97.50		
	Interior Paint-Base&Trim	200	sq ft	$ 0.13		$ 26.00		
	Washer	1	ea	$ 1,575.00	$ 305.00	$ 1,880.00		
	Dryer	1	ea	$ 1,900.00	$ 224.00	$ 2,124.00		
	Dryer Vent Kit	1	ea	$ 38.50	$ 25.50	$ 64.00		
							$ 4,585.90	
TOTAL								$ 35,534.40

Fig 10.6 Kitchen Totals

QUANTITY TAKEOFF OF COMPETITION PROTOTYPE

FOUNDATION COSTS

Description	QTY	Unit	Unit Cost	Estimated Cost	Sub Total	Tot Cost		
Foundations							TOTAL	$100,738.03
Special Foundations								
CP selsmic pier on 24" X 24" bearing pad 7" tall	31	ea	$169.00	$5,239.00				
CP selsmic pier on 24"X24" bearing pad 10" tall	18	ea	$169.00	$3,042.00				
CP anchor pier 7' tall	2	ea						
CP anchor pier 10' tall	2	ea						
Concrete padding 1ft diamater 4-6" tall	19	ea						
4"X4" posts on 3-ply plywood base	78	ea	$24.00	$1,872.00				
Sub Total					$10,153.00			
Total- Foundations						$10,153.00		
Superstructure								
Floor Construction								
Steel Support A500 Grade B steel hss 4X4X 1/4	600	lf	$17	10200				
wood joist 2X10"	600	ea	$1.49	$894.00				
Sub Total					11094			
Structural Framing								
2'X4' 12ft long	1982.73	lf	$6.08	1004.5832				
HHS 3X3X3/16	475.93	lf	$17	8090.81				
HHS 4X3X1/4	591.125	lf	$17	10049.125				
HHS 12X3X3/16	204.04	lf	$17	3468.68				
Sub Total					22613.1982			
Structural Column								
HHS 3X3X3/16	1593.71	lf	$17	27093.07				
Sub Total					27093.07			
Roof Construction								
Steel Support A500 Grade B steel hss 4X4X 3/8	486.5	lf	$17	8270.5				
Steel Support A500 Grade B steel hss 12X3X3/16	205.5	lf	$17	3493.5				
Steel Support A500 Grade B steel hss 4X4X 3/8 - columns 12'5.5"	32	ea	$17	544				
Sub Total					$ 12,308.00			
Total- Superstructure						$ 73,108.27		

Fig 10.7 Foundation Totals

11 PRODUCT CUT SHEETS

Division 00

Procurement and Contracting Requirements

Division 01

General Requirements

Division 02

Existing Conditions

Division 03
Concrete

Division 04
Masonry

Division 05
Metals

CSI #: 05 05 23

WITTEN FASTENERS

150 SERIES - "SPIRAL RIB"
THREADED INSERT, BLIND, REGULAR HEAD STYLE
HEAVY DUTY, "HIGH PERFORMANCE"

TABLE I

CODE NO.	T THREAD	A DIA ±.010	B SELF-LK ±.06	C DIA ±.010	INSTL HOLE +.010/-.000
632	6-32 UNC	.490	.12	.460	.500
832	8-32 UNC	.490	.12	.460	.500
1032	10-32 UNF	.520	.12	.490	.530
420	1/4-20 UNC	.583	.16	.553	.593
428	1/4-28 UNF	.583	.16	.553	.593
518	5/16-18 UNC	.646	.20	.616	.656
524	5/16-24 UNF	.646	.20	.616	.656
616	3/8-16 UNC	.708	.20	.678	.718
624	3/8-24 UNF	.708	.20	.678	.718
714	7/16-14 UNC	.771	.20	.741	.781
720	7/16-20 UNF	.771	.20	.741	.781
813	1/2-13 UNC	.833	.20	.803	.843
820	1/2-20 UNF	.833	.20	.803	.843

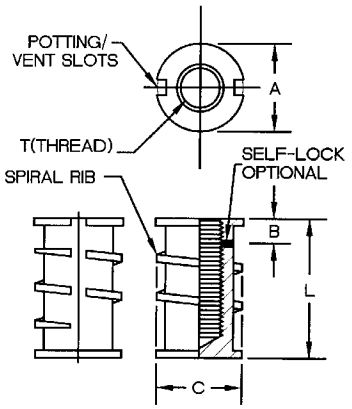


TABLE II

DASH NO.	L ±.03 LENGTH	MINIMUM FULL THREAD DEPTH #6	#8	#10	1/4	5/16	3/8	7/16	1/2
-5	.312	.162	.162	--	--	--	--	--	--
-6	.375	.225	.225	.175	--	--	--	--	--
-7	.437	.276	.287	.237	--	--	--	--	--
-8	.500	.276	.328	.300	.225	--	--	--	--
-10	.625	.276	.328	.375	.350	.350	.350	--	--
-12	.750	.276	.328	.375	.475	.475	.475	.400	.400
-14	.875	.276	.328	.375	.500	.600	.600	.525	.525
-16	1.000	.276	.328	.375	.500	.625	.725	.650	.650
-18	1.125	.276	.328	.375	.500	.625	.750	.775	.775
-20	1.250	.276	.328	.375	.500	.625	.750	.874	.900
-22	1.375	.276	.328	.375	.500	.625	.750	.874	1.000
-24	1.500	.276	.328	.375	.500	.625	.750	.874	1.000

EXAMPLE: PART NUMBERING SYSTEM

150 — 428 — L — 12 — SS

- Series Prefix
- Thread Code No. (Table I)
- Add "LK" for Self-Lock (Nylon)
  Add "L" for Self-Lock (Metallic Crimp)
- Length Dash No. (Table II)
- Material:
  A=Alum Alloy (Chem Film Finish)
  C=Carbon Steel (CAD Plate Finish)
  Z=Carbon Steel (Zinc Plate)
  SS=Stainless Steel (Plain Finish)
  SP=Stainless Steel (Passivate)

WITTEN COMPANY, INC.
918-272-9567

Notes:
1. Threads per MIL-S-7742
2. Patent No. 4,941,785 and 5,082,405
3. No. of Spiral Ribs varies with length
4. Installation tabs are available

CSI #: 05 05 23

WITTEN FASTENERS

METRIC 150 SERIES - "SPIRAL RIB"

THREADED INSERT, BLIND, REGULAR HEAD STYLE
HEAVY DUTY, "HIGH PERFORMANCE"

TABLE I

CODE NO.	T THREAD	A DIA ±.010	B SELF-LK ±.06	C DIA ±.010	INSTL HOLE +.005/-.000
M3.5	M3.5X.6	.490	.12	.460	.500
M4	M4X.7	.490	.12	.460	.500
M5	M5X.8	.520	.12	.490	.530
M6	M6X1	.583	.16	.553	.593
M8	M8X1.25	.646	.20	.616	.656
M10X1.25	M10X1.25	.708	.20	.678	.718
M10X1.5	M10X1.5	.708	.20	.678	.718
M12X1.5	M12X1.5	.833	.20	.803	.843
M12X1.75	M12X1.75	.833	.20	.803	.843
M14X1.5	M14X1.5	.895	.20	.862	.906
M14X2.0	M14X2.0	.895	.20	.862	.906
M16X1.5	M16X1.5	.958	.22	.924	.968
M16X2	M16X2	.958	.22	.924	.968

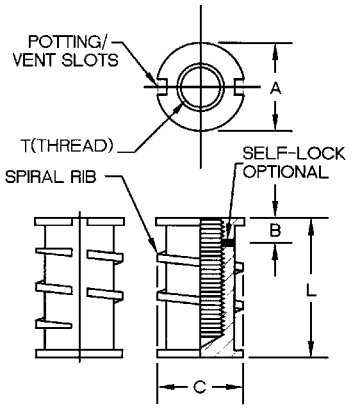


TABLE II

DASH NO.	L ±.03 LENGTH	MINIMUM FULL THREAD DEPTH								
		M3.5	M4	M5	M6	M8	M10	M12	M14	M16
-5	.312	.162	.162	--	--	--	--	--	--	--
-6	.375	.225	.225	.175	--	--	--	--	--	--
-7	.437	.276	.287	.237	--	--	--	--	--	--
-8	.500	.276	.315	.300	.225	--	--	--	--	--
-10	.625	.276	.315	.375	.350	.350	.350	--	--	--
-12	.750	.276	.315	.393	.472	.475	.475	.400	.400	.350
-14	.875	.276	.315	.393	.472	.600	.600	.525	.525	.475
-16	1.000	.276	.315	.393	.472	.625	.725	.650	.650	.600
-18	1.125	.276	.315	.393	.472	.629	.750	.775	.775	.725
-20	1.250	.276	.315	.393	.472	.629	.786	.874	.900	.850
-22	1.375	.276	.315	.393	.472	.629	.786	.944	1.000	.975
-24	1.500	.276	.315	.393	.472	.629	.786	.944	1.100	1.150

EXAMPLE: PART NUMBERING SYSTEM

150 — M5 — L — 12 — SS

Series Prefix
Thread Code No. (Table I)
Add "LK" for Self-Lock (Nylon)
Add "L" for Self-Lock (Metallic Crimp)
Length Dash No. (Table II)
Material:
A=Alum Alloy (Chem Film Finish)
C=Carbon Steel (CAD Plate Finish)
Z=Carbon Steel (Zinc Plate)
SS=Stainless Steel (Plain Finish)
SP=Stainless Steel (Passivate)

WITTEN COMPANY, INC.
918-272-9567

Notes:
1. Threads per MIL-S-7742
2. Patent No. 4,941,785 and 5,082,405
3. No. of Spiral Ribs varies with length
4. Installation tabs are available

CSI #: 05 05 23

WITTEN FASTENERS

151 SERIES - "SPIRAL RIB"
THREADED INSERT, BLIND, SNAP-IN HEAD STYLE
HEAVY DUTY, "HIGH PERFORMANCE"

TABLE I

CODE NO.	T THREAD	A DIA ±.010	B SELF-LK ±.06	C DIA ±.010	INSTL HOLE +.010/-.000
632	6-32 UNC	.500	.12	.427	.468
832	8-32 UNC	.500	.12	.427	.468
1032	10-32 UNF	.531	.12	.458	.500
420	1/4-20 UNC	.594	.16	.521	.562
428	1/4-28 UNF	.594	.16	.521	.562
518	5/16-18 UNC	.656	.20	.583	.625
524	5/16-24 UNF	.656	.20	.583	.625
616	3/8-16 UNC	.719	.20	.646	.687
624	3/8-24 UNF	.719	.20	.646	.687
714	7/16-14 UNC	.781	.20	.708	.750
720	7/16-20 UNF	.781	.20	.708	.750
813	1/2-13 UNC	.844	.20	.771	.812
820	1/2-20 UNF	.844	.20	.771	.812

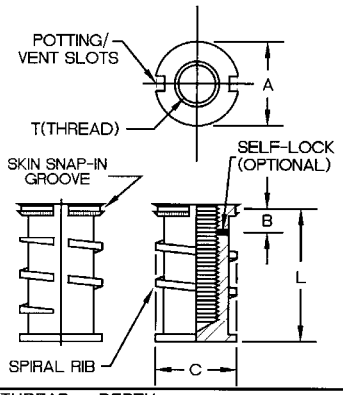


TABLE II

DASH NO.	L ±.03 LENGTH	MINIMUM FULL THREAD DEPTH #6	#8	#10	1/4	5/16	3/8	7/16	1/2
-5	.312	.162	.162	--	--	--	--	--	--
-6	.375	.225	.225	.175	--	--	--	--	--
-7	.437	.276	.287	.237	--	--	--	--	--
-8	.500	.276	.328	.300	.225	--	--	--	--
-10	.625	.276	.328	.375	.350	.350	.350	--	--
-12	.750	.276	.328	.375	.475	.475	.475	.400	.400
-14	.875	.276	.328	.375	.500	.600	.600	.525	.525
-16	1.000	.276	.328	.375	.500	.625	.725	.650	.650
-18	1.125	.276	.328	.375	.500	.625	.750	.775	.775
-20	1.250	.276	.328	.375	.500	.625	.750	.874	.900
-22	1.375	.276	.328	.375	.500	.625	.750	.874	1.000
-24	1.500	.276	.328	.375	.500	.625	.750	.874	1.000

EXAMPLE: PART NUMBERING SYSTEM

151 – 428 – LK – 12 – SS – 1

Series Prefix
Thread Code No. (Table I)
Add "LK" for Self-Lock (Nylon)
Add "L" for Self-Lock (Metallic Crimp)
Length Dash No. (Table II)
Material:
A=Alum Alloy (Chem Film Finish)
C=Carbon Steel (CAD Plate Finish)
Z=Carbon Steel (Zinc Plate)
SS=Stainless Steel (Plain Finish)
SP=Stainless Steel (Passivate)
Skin Thickness (Table III)

TABLE III

DASH NO.	SKIN THICKNESS INSTALL SIDE
-1	.010-.019
-2	.020-.029
-3	.030-.039
-4	.040-.049
-5	.050-.059
-6	.060-.069
-7	.070-.079
-8	.080-.089
-9	.090-.099

Notes:
1. Threads per MIL-S-7742
2. Patent No. 4,941,785 and 5,082,405
3. No. of Spiral Ribs varies with length

WITTEN COMPANY, INC.
918-272-9567

CSI #: 05 05 23

WITTEN FASTENERS

151 SERIES
SHEET 1 OF 1

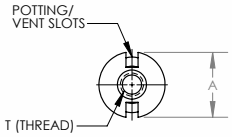
METRIC 151 SERIES - "SPIRAL RIB"

THREADED INSERT, BLIND, SNAP-IN HEAD STYLE

HEAVY DUTY, "HIGH PERFORMANCE"

TABLE I

CODE NO.	T THREAD	A DIA ±.010	B SELF-LOCK ±.06	C DIA ±.010	INSTALLATION HOLE +.010 /-.000
M3.5	M3.5x.6	.500	.12	.427	.468
M4	M4x.7	.500	.12	.427	.468
M5	M5x.8	.531	.12	.458	.500
M6	M6x1	.594	.16	.521	.562
M8x1	M8x1	.656	.20	.583	.625
M8x1.25	M8x1.25	.656	.20	.583	.625
M10x1.25	M10x1.25	.719	.20	.646	.687
M10x1.5	M10x1.5	.719	.20	.646	.687
M12x1.5	M12x1.5	.844	.20	.771	.812
M12x1.75	M12x1.75	.844	.20	.771	.812



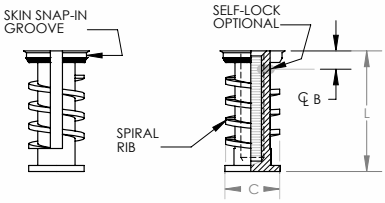


TABLE II

DASH NO.	L ±.03 LENGTH	MINIMUM FULL THREAD DEPTH						
		M 3.5	M 4	M 5	M 6	M 8	M 10	M 12
-5	.312	.162	.162	-	-	-	-	-
-6	.375	.225	.225	.175	-	-	-	-
-7	.437	.276	.287	.237	-	-	-	-
-8	.500	.276	.328	.300	.225	-	-	-
-10	.625	.276	.328	.375	.350	.350	.350	-
-12	.750	.276	.328	.375	.475	.475	.475	.400
-14	.875	.276	.328	.375	.500	.600	.600	.525
-16	1.000	.276	.328	.375	.500	.625	.725	.650
-18	1.125	.276	.328	.375	.500	.625	.750	.775
-20	1.250	.276	.328	.375	.500	.625	.750	.900
-22	1.375	.276	.328	.375	.500	.625	.750	1.000
-24	1.500	.276	.328	.375	.500	.625	.750	1.000

EXAMPLE: PART NUMBERING SYSTEM

151-M5-LK-12-SS-1

- SERIES PREFIX
- THREAD CODE NO. (TABLE I)
- ADD "LK" FOR SELF LOCK (NYLON)
  ADD "L" FOR SELF-LOCK (METALLIC CRIMP)
- LENGTH DASH NO. (TABLE II)
- MATERIAL:
  A=ALUMINUM ALLOY (CHEM FILM FINISH)
  C=CARBON STEEL (CAD PLATE FINISH)
  Z=CARBON STEEL (ZINC PLATED)
  SS=STAINLESS STEEL (PLAIN FINISH)
  SP=STAINLESS STEEL (PASSIVATED)
- SKIN THICKNESS (TABLE III)

TABLE III

DASH NO.	SKIN THICKNESS INSTALLATION SIDE
-1	.010 - .019
-2	.020 - .029
-3	.030 - .039
-4	.040 - .049
-5	.050 - .059
-6	.060 - .069
-7	.070 - .079
-8	.080 - .089
-9	.090 - .099

NOTES:
1.THREADS PER MIL-S-7742
2.PATENT NO. 4,941,785 & 5,082,405
3.NO. OF SPIRAL RIBS VARY WITH LENGTH

WITTEN COMPANY
918-272-9567
REV-A 8/17/09

CSI #: 05 12 13

8735 N Harborgate ST
Portland, OR 97203

EVRAZ

Office: 503-737-1200
Fax: 503-737-1201

ASTM A500 Square & Rectangular Structural Tubing
Weight per Foot (lb) & Standard Bundle Sizes

			20 and 40 ft Lengths			24 and 48 ft Lengths		
Size	Wall (nominal)	Weight per Foot	Pieces per Bundle	Bundle Footage (40 ft)	Bundle Weight (40 ft)	Pieces per Bundle	Bundle Footage (48 ft)	Bundle Weight (48 ft)
2 1/2" x 2 1/2"	0.125	3.90	25	1,000	3,900	25	1,200	4,680
2 1/2" x 2 1/2"	0.188	5.59	25	1,000	5,590	25	1,200	6,708
2 1/2" x 2 1/2"	0.250	7.10	20	800	5,680	20	960	6,816
3" x 3"	0.125	4.75	25	1,000	4,750	25	1,200	5,700
3" x 3"	0.188	6.87	20	800	5,496	20	960	6,595
3" x 3"	0.250	8.80	15	600	5,280	15	720	6,336
3" x 3"	0.313	10.57	15	600	6,342	15	720	7,610
3 1/2" x 3 1/2"	0.125	5.60	16	640	3,584	16	768	4,301
3 1/2" x 3 1/2"	0.188	8.14	16	640	5,210	16	768	6,252
3 1/2" x 3 1/2"	0.250	10.51	12	480	5,045	12	576	6,054
3 1/2" x 3 1/2"	0.313	12.69	12	480	6,091	8	384	4,873
3 1/2" x 3 1/2"	0.375	14.71	8	320	4,707	8	384	5,649
4" x 4"	0.125	6.46	16	640	4,134	16	768	4,961
4" x 4"	0.188	9.42	16	640	6,029	12	576	5,426
4" x 4"	0.250	12.21	12	480	5,861	8	384	4,689
4" x 4"	0.313	14.82	8	320	4,742	8	384	5,691
4" x 4"	0.375	17.26	8	320	5,523	8	384	6,628
5" x 5"	0.125	8.16	9	360	2,938	9	432	3,525
5" x 5"	0.188	11.97	9	360	4,309	9	432	5,171
5" x 5"	0.250	15.61	9	360	5,620	9	432	6,744
5" x 5"	0.313	19.08	9	360	6,869	9	432	8,243
5" x 5"	0.375	22.36	6	240	5,366	6	288	6,440
5" x 5"	0.500	28.41	6	240	6,818	6	288	8,182
6" x 6"	0.188	14.52	9	360	5,227	9	432	6,273
6" x 6"	0.250	19.01	9	360	6,844	6	288	5,475
6" x 6"	0.313	23.33	6	240	5,599	6	288	6,719
6" x 6"	0.375	27.47	6	240	6,593	6	288	7,911
6" x 6"	0.500	35.22	6	240	8,453	6	288	10,143
7" x 7"	0.188	17.08	4	160	2,733	4	192	3,279
7" x 7"	0.250	22.42	4	160	3,587	4	192	4,305
7" x 7"	0.313	27.58	4	160	4,413	4	192	5,295
7" x 7"	0.375	32.57	4	160	5,211	4	192	6,253
7" x 7"	0.500	42.03	4	160	6,725	4	192	8,070
8" x 8"	0.188	19.63	4	160	3,141	4	192	3,769
8" x 8"	0.250	25.82	4	160	4,131	4	192	4,957
8" x 8"	0.313	31.84	4	160	5,094	4	192	6,113
8" x 8"	0.375	37.68	4	160	6,029	4	192	7,235
8" x 8"	0.500	48.83	4	160	7,813	4	192	9,375
10" x 10"	0.250	32.63	4	160	5,221	4	192	6,265
10" x 10"	0.313	40.35	4	160	6,456	4	192	7,747
10" x 10"	0.375	47.89	4	160	7,662	4	192	9,195
10" x 10"	0.500	62.45	4	160	9,992	4	192	11,990

Alternate bundle sizes may be available, please contact the Sales Dept. for information.
For sizes, gauges, lengths and grades not listed above, please contact the Sales Dept.

Rev 10/20/03

CSI #: 05 12 13

8735 N Harborgate ST
Portland, OR 97203

EVRAZ

Office: 503-737-1200
Fax: 503-737-1201

ASTM A500 Square & Rectangular Structural Tubing
Weight per Foot (lb) & Standard Bundle Sizes

			20 and 40 ft Lengths			24 and 48 ft Lengths		
Size	Wall (nominal)	Weight per Foot	Pieces per Bundle	Bundle Footage (40 ft)	Bundle Weight (40 ft)	Pieces per Bundle	Bundle Footage (48 ft)	Bundle Weight (48 ft)
3" x 2"	0.125	3.90	30	1,200	4,680	30	1,440	5,616
3" x 2"	0.188	5.59	30	1,200	6,708	25	1,200	6,708
3" x 2"	0.250	7.10	25	1,000	7,100	20	960	6,816
3 1/2" x 2 1/2"	0.125	4.75	20	800	3,800	20	960	4,560
3 1/2" x 2 1/2"	0.188	6.87	20	800	5,496	20	960	6,595
3 1/2" x 2 1/2"	0.250	8.80	16	640	5,632	16	768	6,758
4" x 2"	0.125	4.75	20	800	3,800	20	960	4,560
4" x 2"	0.188	6.87	16	640	4,397	16	768	5,276
4" x 2"	0.250	8.80	16	640	5,632	16	768	6,758
4" x 2"	0.313	10.57	16	640	6,765	16	768	8,118
4" x 3"	0.125	5.60	12	480	2,688	12	576	3,226
4" x 3"	0.188	8.14	12	480	3,907	12	576	4,689
4" x 3"	0.250	10.51	12	480	5,045	12	576	6,054
4" x 3"	0.313	12.69	12	480	6,091	9	432	5,482
4" x 3"	0.375	14.71	9	360	5,296	9	432	6,355
5" x 2"	0.125	5.60	21	840	4,704	21	1,008	5,645
5" x 2"	0.188	8.14	18	720	5,861	18	864	7,033
5" x 2"	0.250	10.51	15	600	6,306	15	720	7,567
5" x 2"	0.313	12.69	15	600	7,614	12	576	7,309
5" x 2"	0.375	14.71	15	600	8,826	12	576	8,473
5" x 3"	0.125	6.46	15	600	3,876	15	720	4,651
5" x 3"	0.188	9.42	15	600	5,652	12	576	5,426
5" x 3"	0.250	12.21	12	480	5,861	12	576	7,033
5" x 3"	0.313	14.82	9	360	5,335	9	432	6,402
5" x 3"	0.375	17.26	9	360	6,214	9	432	7,456
5" x 4"	0.125	7.31	9	360	2,632	9	432	3,158
5" x 4"	0.188	10.70	9	360	3,852	9	432	4,622
5" x 4"	0.250	13.91	9	360	5,008	9	432	6,009
5" x 4"	0.313	16.95	9	360	6,102	6	288	4,882
5" x 4"	0.375	19.81	6	240	4,754	6	288	5,705
6" x 2"	0.125	6.46	12	480	3,101	12	576	3,721
6" x 2"	0.188	9.42	12	480	4,522	12	576	5,426
6" x 2"	0.250	12.21	12	480	5,861	12	576	7,033
6" x 2"	0.313	14.82	10	400	5,928	10	480	7,114
6" x 2"	0.375	17.26	10	400	6,904	8	384	6,628
6" x 3"	0.125	7.31	8	320	2,339	8	384	2,807
6" x 3"	0.188	10.70	8	320	3,424	8	384	4,109
6" x 3"	0.250	13.91	8	320	4,451	8	384	5,341
6" x 3"	0.313	16.95	6	240	4,068	6	288	4,882
6" x 3"	0.375	19.81	6	240	4,754	6	288	5,705

Alternate bundle sizes may be available, please contact the Sales Dept. for information.
For sizes, gauges, lengths and grades not listed above, please contact the Sales Dept.

Rev 10/20/03

CSI #: 05 12 13

8735 N Harborgate ST
Portland, OR 97203

EVRAZ

Office: 503-737-1200
Fax: 503-737-1201

ASTM A500 Square & Rectangular Structural Tubing
Weight per Foot (lb) & Standard Bundle Sizes

			20 and 40 ft Lengths			24 and 48 ft Lengths		
Size	Wall (nominal)	Weight per Foot	Pieces per Bundle	Bundle Footage (40 ft)	Bundle Weight (40 ft)	Pieces per Bundle	Bundle Footage (48 ft)	Bundle Weight (48 ft)
6" x 4"	0.125	8.16	12	480	3,917	12	576	4,700
6" x 4"	0.188	11.97	9	360	4,309	9	432	5,171
6" x 4"	0.250	15.61	9	360	5,620	6	288	4,496
6" x 4"	0.313	19.08	6	240	4,579	6	288	5,495
6" x 4"	0.375	22.36	6	240	5,366	6	288	6,440
6" x 4"	0.500	28.41	6	240	6,818	6	288	8,182
6" x 5"	0.188	13.25	9	360	4,770	9	432	5,724
6" x 5"	0.250	17.31	9	360	6,232	6	288	4,985
6" x 5"	0.313	21.20	6	240	5,088	6	288	6,106
6" x 5"	0.375	24.92	6	240	5,981	6	288	7,177
7" x 3"	0.188	11.97	10	400	4,788	10	480	5,746
7" x 3"	0.250	15.61	10	400	6,244	8	384	5,994
7" x 3"	0.313	19.08	8	320	6,106	6	288	5,495
7" x 3"	0.375	22.36	6	240	5,366	6	288	6,440
7" x 4"	0.188	13.25	8	320	4,240	8	384	5,088
7" x 4"	0.250	17.31	8	320	5,539	8	384	6,647
7" x 4"	0.313	21.20	8	320	6,784	6	288	6,106
7" x 4"	0.375	24.92	6	240	5,981	4	192	4,785
7" x 5"	0.188	14.52	12	480	6,970	9	432	6,273
7" x 5"	0.250	19.01	9	360	6,844	6	288	5,475
7" x 5"	0.313	23.33	6	240	5,599	6	288	6,719
7" x 5"	0.375	27.47	6	240	6,593	6	288	7,911
7" x 5"	0.500	35.22	6	240	8,453	6	288	10,143
8" x 2"	0.188	11.97	14	560	6,703	12	576	6,895
8" x 2"	0.250	15.61	10	400	6,244	8	384	5,994
8" x 3"	0.188	13.25	10	400	5,300	10	480	6,360
8" x 3"	0.250	17.31	10	400	6,924	10	480	8,309
8" x 3"	0.313	21.20	8	320	6,784	6	288	6,106
8" x 3"	0.375	24.92	6	240	5,981	6	288	7,177
8" x 4"	0.188	14.52	8	320	4,646	8	384	5,576
8" x 4"	0.250	19.01	8	320	6,083	6	288	5,475
8" x 4"	0.313	23.33	6	240	5,599	6	288	6,719
8" x 4"	0.375	27.47	6	240	6,593	4	192	5,274
8" x 4"	0.500	35.22	4	160	5,635	4	192	6,762
8" x 6"	0.188	17.08	8	320	5,466	8	384	6,559
8" x 6"	0.250	22.42	6	240	5,381	6	288	6,457
8" x 6"	0.313	27.58	6	240	6,619	4	192	5,295
8" x 6"	0.375	32.57	4	160	5,211	4	192	6,253
8" x 6"	0.500	42.03	4	160	6,725	4	192	8,070
10" x 2"	0.188	14.52	10	400	5,808	8	384	5,576
10" x 2"	0.250	19.01	8	320	6,083	8	384	7,300

Alternate bundle sizes may be available, please contact the Sales Dept. for information.
For sizes, gauges, lengths and grades not listed above, please contact the Sales Dept.

Rev 10/20/03

CSI #: 05 12 13

8735 N Harborgate ST
Portland, OR 97203

EVRAZ

Office: 503-737-1200
Fax: 503-737-1201

ASTM A500 Square & Rectangular Structural Tubing
Weight per Foot (lb) & Standard Bundle Sizes

			20 and 40 ft Lengths			24 and 48 ft Lengths		
Size	Wall (nominal)	Weight per Foot	Pieces per Bundle	Bundle Footage (40 ft)	Bundle Weight (40 ft)	Pieces per Bundle	Bundle Footage (48 ft)	Bundle Weight (48 ft)
10" x 4"	0.188	17.08	6	240	4,099	6	288	4,919
10" x 4"	0.250	22.42	6	240	5,381	6	288	6,457
10" x 4"	0.313	27.58	4	160	4,413	4	192	5,295
10" x 4"	0.375	32.57	4	160	5,211	4	192	6,253
10" x 4"	0.500	42.03	4	160	6,725	4	192	8,070
10" x 6"	0.188	19.63	4	160	3,141	4	192	3,769
10" x 6"	0.250	25.82	4	160	4,131	4	192	4,957
10" x 6"	0.313	31.84	4	160	5,094	4	192	6,113
10" x 6"	0.375	37.68	4	160	6,029	4	192	7,235
10" x 6"	0.500	48.83	4	160	7,813	4	192	9,375
10" x 8"	0.250	29.22	4	160	4,675	4	192	5,610
10" x 8"	0.313	36.09	4	160	5,774	4	192	6,929
10" x 8"	0.375	42.78	4	160	6,845	4	192	8,214
10" x 8"	0.500	55.64	4	160	8,902	4	192	10,683
12" x 4"	0.250	25.82	6	240	6,197	4	192	4,957
12" x 4"	0.313	31.84	4	160	5,094	4	192	6,113
12" x 4"	0.375	37.68	4	160	6,029	4	192	7,235
12" x 4"	0.500	48.83	4	160	7,813	4	192	9,375
12" x 6"	0.250	29.22	4	160	4,675	4	192	5,610
12" x 6"	0.313	36.09	4	160	5,774	4	192	6,929
12" x 6"	0.375	42.78	4	160	6,845	4	192	8,214
12" x 6"	0.500	55.64	4	160	8,902	4	192	10,683
12" x 8"	0.250	32.63	4	160	5,221	4	192	6,265
12" x 8"	0.313	40.35	4	160	6,456	4	192	7,747
12" x 8"	0.375	47.89	4	160	7,662	4	192	9,195
12" x 8"	0.500	62.45	4	160	9,992	4	192	11,990

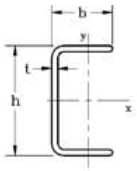
Alternate bundle sizes may be available, please contact the Sales Dept. for information.
For sizes, gauges, lengths and grades not listed above, please contact the Sales Dept.

Rev 10/20/03

Division 06

Woods, Plastics, and Composites

CSI #: 06 51 00



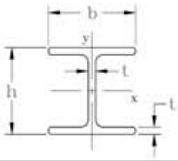
Pultex® Channels

Part Number	Depth(h)	Width(b)	Thick-ness(t)	Area	Weight	X-X axis			Y-Y axis		
						I	S	r	I	S	r
	in	in	in	in^2	lb/ft	in^4	in^3	in	in^4	in^3	in
CH130	1.50	1.00	.1875	0.55	0.49	0.167	0.222	0.551	0.048	0.076	0.297
CH222	2.00	0.56	.125	0.34	0.30	0.164	0.164	0.692	0.007	0.018	0.147
CH230	2.31	1.00	0.16	0.60	0.42	0.433	0.375	0.852	0.051	0.071	0.291
CH224	2.75	1.00	.125	0.56	0.45	0.586	0.426	1.024	0.046	0.061	0.286
CH340	3.00	.875	.25	1.00	0.78	1.018	0.678	1.011	0.050	0.080	0.223
CH330	3.00	1.00	.1875	0.83	0.63	0.945	0.630	1.068	0.062	0.086	0.275
CH342	3.00	1.50	.25	1.31	1.02	1.611	1.074	1.110	0.255	0.248	0.441
CH420	4.00	1.06	.125	0.71	0.58	1.456	0.728	1.431	0.060	0.072	0.290
CH434	4.00	1.75	.1875	1.10	0.87	2.850	1.425	1.607	0.333	0.275	0.550
CH440	4.00	1.13	.25	1.37	1.07	2.628	1.314	1.384	0.118	0.142	0.293
CH540	5.00	1.38	.25	1.75	1.36	5.385	2.154	1.756	0.231	0.223	0.364
CH640	6.00	1.63	.25	2.12	1.65	9.611	3.204	2.129	0.402	0.323	0.435
CH662	6.00	1.69	.375	3.10	2.64	13.427	4.476	2.081	0.621	0.503	0.447
CH740	7.00	2.00	.25	2.57	2.10	16.420	4.692	2.530	0.794	0.517	0.556
CH840	8.00	2.19	.25	2.91	2.30	24.300	6.075	2.890	1.068	0.628	0.606
CH860	8.00	2.19	.375	4.23	3.30	33.751	8.437	2.826	1.470	0.890	0.590
CH922	10.00	2.75	.125	1.88	1.47	25.885	5.177	3.706	1.180	0.534	0.791
CH980	10.00	2.75	0.50	7.01	5.95	86.876	17.375	3.519	3.828	1.855	0.739
CH995	11.50	2.75	0.50	7.78	6.35	124.581	21.666	4.001	4.054	1.930	0.722
CH800	14.00	6.00	0.50	12.17	10.44	349.085	49.869	5.357	40.762	9.273	1.831
CH810	18.00	2.50	0.25	5.56	4.86	204.772	22.752	6.070	1.840	0.865	0.575
CH990	24.00	3.00	.25	7.33	5.66	475.404	39.617	8.054	3.374	1.300	0.679
CH994	24.00	4.00	0.47	14.52	11.21	985.090	82.090	8.237	13.710	4.143	0.972

Pultex® Solid Round Rods

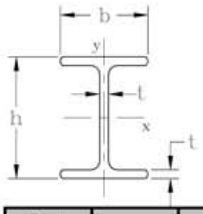
Part Number	Diameter(d)	Area	Weight	X-X axis or Y-Y axis		
				I	S	r
	in	in^2	lb/ft	in^4	in^3	in
SO004	.25	0.049	0.043	<0.001	0.002	0.063
SO006	.375	0.110	0.096	0.001	0.005	0.094
SO008	.50	0.196	0.173	0.003	0.012	0.125
SO010	.625	0.307	0.275	0.008	0.024	0.156
SO012	.75	0.442	0.397	0.016	0.041	0.188
SO016	1.00	0.785	0.685	0.049	0.098	0.250
SO020	1.25	1.227	1.100	0.120	0.192	0.313
SO024	1.50	1.767	1.535	0.249	0.331	0.375
SO032	2.00	3.142	2.560	0.785	0.785	0.500

CSI #: 06 51 00



Pultex® Wide Flange Sections

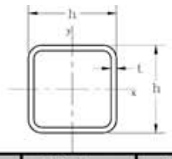
Part Number	Depth(h)	Width(b)	Thick-ness(t)	Area	Weight	X-X axis			Y-Y axis			Design	
						I	S	r	I	S	r	J	C_w
	in	in	in	in^2	lb/ft	in^4	in^3	in	in^4	in^3	in	in^4	in^6
IW340	3.00	3.00	.25	2.17	1.84	3.23	2.15	1.22	1.11	0.74	0.71	0.047	2.49
IW440	4.00	4.00	.25	2.92	2.44	8.05	4.03	1.66	2.63	1.32	0.95	0.063	10.52
IW640	6.00	6.00	.25	4.42	3.64	28.58	9.53	2.54	8.91	4.46	1.42	0.094	80.21
IW660	6.00	6.00	.375	6.57	5.53	40.76	13.59	2.49	13.32	4.44	1.42	0.316	119.84
IW860	8.00	8.00	.375	8.82	7.26	100.35	25.09	3.37	31.65	7.91	1.90	0.422	506.46
IW880	8.00	8.00	.50	11.67	9.99	128.81	32.20	3.32	42.09	10.52	1.90	1.000	673.41
IW960	10.00	10.00	.375	11.07	9.07	200.45	40.09	4.26	61.94	12.39	2.37	0.527	1548.59
IW980	10.00	10.00	.50	14.67	12.03	259.36	51.87	4.20	82.38	16.48	2.37	1.250	2059.52
IW982	12.00	12.00	.50	17.67	14.92	457.26	76.21	5.09	142.59	23.77	2.84	1.500	5133.35



Pultex® I-Sections

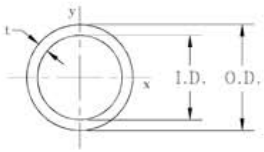
Part Number	Depth(h)	Width(b)	Thick-ness(t)	Area	Weight	X-X axis			Y-Y axis			Design	
						I	S	r	I	S	r	J	C_w
	in	in	in	in^2	lb/ft	in^4	in^3	in	in^4	in^3	in	in^4	in^6
IB340	3.00	1.50	.25	1.42	1.01	1.803	1.202	1.178	0.140	0.186	0.314	0.031	0.315
IB440	4.00	2.00	.25	1.92	1.63	4.530	2.265	1.537	0.329	0.329	0.414	0.042	1.316
IB640	6.00	3.00	.25	2.92	2.39	16.17	5.39	2.35	1.11	0.74	0.62	0.063	9.99
IB660	6.00	3.00	.375	4.32	3.78	22.93	7.64	2.31	1.67	1.11	0.62	0.211	15.00
IB860	8.00	4.00	.375	5.82	4.74	56.71	14.18	3.12	3.95	1.97	0.82	0.281	63.12
IB880	8.00	4.00	.50	7.67	6.45	72.48	18.12	3.07	5.27	2.63	0.82	0.667	84.26
IB960	10.00	5.00	.375	7.32	6.06	113.55	22.71	3.94	7.71	3.08	1.03	0.352	192.80
IB980	10.00	5.00	.50	9.67	7.93	146.45	29.29	3.89	10.27	4.11	1.03	0.833	256.84
IB982	12.00	6.00	.50	11.67	9.83	258.76	43.13	4.71	17.76	5.92	1.23	1.000	639.33

CSI #: 06 51 00



Pultex® Square Tubes

Part Number	Width or Depth(h)	Thick-ness(t)	Area	Weight	X-X axis or Y-Y axis		
					I	S	r
	in	in	in^2	lb/ft	in^4	in^3	in
TQ120	1.00	0.125	0.42	0.33	0.05	0.11	0.36
TQ140	1.25	0.250	0.93	0.76	0.16	0.26	0.42
TQ124	1.50	0.125	0.67	0.48	0.21	0.28	0.56
TQ142	1.50	0.250	1.24	0.92	0.33	0.44	0.52
TQ126	1.75	0.125	0.80	0.54	0.35	0.40	0.66
TQ144	1.75	0.250	1.48	1.12	0.57	0.67	0.62
TQ220	2.00	0.125	0.92	0.69	0.53	0.53	0.76
TQ230	2.11	0.190	1.44	1.08	0.89	0.84	0.78
TQ240	2.00	0.250	1.73	1.40	0.89	0.89	0.72
TQ242	2.50	0.250	2.24	1.79	1.90	1.52	0.92
TQ340	3.00	0.250	2.74	2.16	3.47	2.31	1.13
TQ360	3.5	.375	4.68	3.70	7.71	4.40	1.28
TQ440	4.00	0.250	3.73	2.96	8.75	4.37	1.53
CT045	5.20	0.375	7.00	5.82	26.73	10.28	1.95
TQ660	6.00	0.375	8.48	7.47	44.93	14.98	2.30

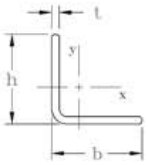


Pultex® Round Tubes

Part Number	Outside Diameter (D)	Inside Diameter (d)	Thick-ness(t)	Area	Weight	X-X axis		
						I	S	r
	in	in	in	in^2	lb/ft	in^4	in^3	in
TU005	.75	0.56	.0937	0.19	0.17	0.01	0.03	0.23
TU120	1.00	0.75	.125	0.34	0.28	0.03	0.07	0.31
TU122	1.25	1.00	.125	0.44	0.34	0.07	0.11	0.40
TU118	1.25	1.00	.0937	0.34	0.27	0.06	0.09	0.41
TU143	1.50	1.00	.25	0.98	0.77	0.20	0.27	0.45
TU124	1.50	1.25	.125	0.54	0.42	0.13	0.17	0.49
TU142	1.75	1.25	.25	0.91	0.64	0.34	0.39	0.54
TU126	1.75	1.50	.125	0.64	0.50	0.21	0.24	0.58
TU240	2.00	1.50	.25	1.37	1.08	0.54	0.54	0.63
TU220	2.00	1.75	.125	0.73	0.64	0.33	0.33	0.66
TU242	2.50	2.00	.25	1.77	1.32	1.13	0.91	0.80
TU222	2.50	2.25	.125	0.93	0.62	0.66	0.53	0.84
TU340	3.00	2.50	.25	2.16	1.66	2.06	1.37	0.98
TU410	4.02	3.46	0.28	3.24	2.79	5.69	2.84	1.33

CSI #: 06 51 00

Elements of Sections



Pultex® Equal Leg Angles

Part Number	Depth(h)	Width(b)	Thick-ness(t)	Area	Weight	X-X axis or Y-Y axis			
						I	S	r	r_z
	in	in	in	in^2	lb/ft	in^4	in^3	in	in
AE120	1.00	1.00	0.125	0.22	0.17	0.021	0.030	0.304	0.182
AE140	1.00	1.00	0.250	0.42	0.31	0.035	0.053	0.286	0.183
AE122	1.50	1.50	0.125	0.35	0.25	0.075	0.071	0.465	0.284
AE130	1.50	1.50	0.1875	0.51	0.38	0.106	0.101	0.455	0.282
AE142	1.50	1.50	0.250	0.67	0.51	0.133	0.129	0.445	0.281
AE220	2.00	2.00	0.125	0.47	0.35	0.186	0.129	0.626	0.386
AE230	2.00	2.00	0.1875	0.70	0.53	0.266	0.187	0.616	0.383
AE240	2.00	2.00	0.250	0.92	0.68	0.338	0.241	0.606	0.381
AE320	3.00	3.00	0.125	0.72	0.56	0.651	0.297	0.949	0.590
AE330	3.00	3.00	0.1875	1.08	0.78	0.947	0.435	0.938	0.587
AE340	3.00	3.00	0.250	1.42	1.06	1.223	0.568	0.927	0.584
AE360	3.00	3.00	0.375	2.09	1.74	1.721	0.815	0.908	0.578
AE440	4.00	4.00	0.250	1.92	1.59	3.002	1.034	1.250	0.787
AE460	4.00	4.00	0.375	2.84	2.28	4.290	1.499	1.230	0.780
AE480	4.00	4.00	0.500	3.72	3.01	5.451	1.934	1.211	0.774
AE640	6.00	6.00	0.250	2.92	2.29	10.491	2.382	1.895	1.194
AE660	6.00	6.00	0.375	4.34	3.57	15.230	3.492	1.874	1.185
AE680	6.00	6.00	0.500	5.72	4.66	19.654	4.552	1.854	1.177

CSI #: 06 71 00

PROPERTIES					
DESCRIPTION	Extremely Strong Non-Shrinking Permanent Bond	Flexible Non-Shrinking General Purpose	Extremely Strong Non-Shrinking Permanent Bond	Flexible UV-Resistant Weatherproof	Flexible Non-Sagging Mildew Resistant
APPLICATION TEMPERATURE	40º–100ºF (5º–38ºC)	40º–100ºF (5º–38ºC)	40º–100ºF (5º–38ºC)	40º–100ºF (5º–38ºC)	40º–100ºF (5º–38ºC)
CONSISTENCY	Medium Paste	Medium Paste	Medium Paste	Medium Paste	Non-Sagging Paste
COLOR	White Black Mahogany Tan	White Black	White	White	White Clear
TACK-FREE*	48 Hours	1–2 Hours	1–2 Hours	<2 Hours	20 Minutes
CURE***	7–14 Days	24–48 Hours	24–48 Hours	24–48 Hours	24–48 Hours
TENSILE STRENGTH	700psi	300psi	600psi	300psi	220psi
% ELONGATION BEFORE BREAK	1350%	900%	925%	800%	350%
SANDABLE	Yes	Yes	Yes	Yes	No
DISCOLORATION RESISTANCE	Better	Good	Better	Excellent	Excellent
GELCOAT	H	G	H	G	B
FIBERGLASS	H	G	H	G	B
WOOD	H	G	H	G	B
METAL	H**	G**	H**	H	B
RUBBER	G	G	G	B	B
PLASTICS	G/B	G/B	G/B	B	B

Protect from direct sunlight and rain until cured. H=High Strength Bonding G=General Bonding B=Bedding Sealing
*at 75ºF/50% RH **Primer recommended ***at 1/4″ depth

APPLICATIONS QUESTIONS

- Am I making a structural, general, bedding or sealing bond?
- Will I ever have to disassemble?
- Have I cleaned and/or scuffed the surfaces to be bonded/sealed?
- How soon do I need the adhesive sealant to skin over? cure?
- Do I need to apply a primer?
- How much do I need? (Hint: a 1/10th gallon container provides 30 linear feet @ 1/4″ bead, 120 feet @ 1/8″ bead)

CSI #: 06 71 00

3M™ Marine Adhesive Sealant Fast Cure 4000 UV

This one-part sealant cures to form a firm, rubbery waterproof seal. Its flexibility allows for the dissipation of stress caused by shock, vibration, swelling or shrinking. Designed for marine applications above and below the waterline. Its superior UV resistance properties make this an ideal cosmetic sealant.

FLEX PACK-400ML SIZE		
Part Number	Color	Units/Case
051135-06586	White	12

CARTRIDGES-1/10 GALLON SIZE		
Part Number	Color	Units/Case
051135-06580	White	12

TUBES-CARDED		
Part Number	Color	Units/Case
051135-05280	White	6

3M™ Marine Adhesive Sealant Fast Cure 4200

A one-part, general all-purpose polyurethane that chemically reacts with moisture to deliver flexible bonds with good adhesion to wood, fiberglass, gelcoat, plastics and metals. Forms watertight, weather-resistant seals on joints and boat hardware above or below the waterline. This product is approximately half the strength of 3M™ Marine Adhesive Sealant 5200, which allows for disassembly of parts.

TUBES-CARDED			
Part Number	Color	Size	Units/Case
051135-05260	White	3 oz.	12

CARTRIDGES-1/10 GALLON SIZE		
Part Number	Color	Units/Case
051135-06560	White	12
051135-06564	Black	12

3M™ Marine Adhesive Sealant 5200

This high-performance polyurethane adhesive sealant becomes tack-free in 24-48 hours, and completely cures in 5-7 days with no shrinking. The seal is extremely strong, retaining its strength above or below the waterline. Stays flexible–allows for structural movement. Stress caused by shock, vibration, swelling or shrinking is effectively absorbed. Has excellent resistance to weathering and salt water. Check the bonding and sealing jobs this product can handle for you:

CSI #: 06 71 00

3M™ Marine Adhesive Sealant Fast Cure 5200

This fast cure version of 3M™ Marine Adhesive Sealant 5200 becomes tack-free in one hour and completely cures within 24 hours. Delivering strong, flexible seals, 3M Marine Adhesive Fast Cure 5200 is ideal for applications where a fast, long-term seal is needed above or below the waterline, such as hull to deck seams, wood to fiberglass, marine hardware, and hull and stern joints. Remains flexible, allowing structural movement, and has excellent resistance to weathering and the marine environment. Available in tubes and cartridges.

TUBES-CARDED			
Part Number	Color	Size	Units/Case
051135-05220	White	3 oz.	12

CARTRIDGES-1/10 GALLON SIZE		
Part Number	Color	Units/Case
051135-06520	White	12

3M™ Marine Grade Silicone Sealant

A mildew resistant non-sagging, moisture-curing silicone rubber sealant. Remains flexible with excellent resistance to the marine environment. Adheres to bare and painted metal, fiberglass, glass, non-oily woods and many plastics and abraded rubbers.

Ideal for head sealing applications. Also excellent gasket adhesive and formed-in-place gasket material.

TUBES-CARDED			
Part Number	Color	Size	Units/Case
051135-08016	Clear	1 oz.	12
051135-08017	White	3 oz.	12
051135-08019	Clear	3 oz.	12

CARTRIDGES-1/10 GALLON SIZE		
Part Number	Color	Units/Case
051135-08027	White	12
051135-08028	Black	12
051135-08029	Clear	12

fiberglass deck to fiberglass hull, wood to fiberglass, portholes and deck fittings, under mouldings, hull seams above or below waterline, center board trunk joints, between struts and planking, stern joints, deck housing, etc. Easy to apply with manual caulking gun. Remains workable with trowel or spatula up to four hours after application. Won't sag or flow in vertical or horizontal seams. Available in tubes, cartridges and 5-gallon pails.

TUBES-CARDED			
Part Number	Color	Size	Units/Case
051135-05207	Black	1 oz.	12
051135-05206	White	1 oz.	12
051135-05203	White	3 oz.	12
051135-05205	Black	3 oz.	12

CARTRIDGES-1/10 GALLON SIZE		
Part Number	Color	Units/Case
051135-06500	White	12
051135-06501	Tan	12
051135-06502	Mahogany	12
051135-06504	Black	12

PAILS-5 GALLON			
Part Number	Color	Size	Units/Case
021200-21463	White	5 gallon	1
021200-21450	Tan	5 gallon	1
021200-21456	Mahogany	5 gallon	1

Clean Up Tips

For uncured adhesive sealant, use 3M™ General Purpose Adhesive Cleaner PN 08984 or 3M™ Citrus Cleaner PN 08889 or PN 76394.

CSI #: 06 71 00

Coverage Charts for Adhesive Sealant Products

Given the desired diameter of a bead or the dimensions of a seam, the coverage obtained from a cartridge or flex pack can be looked up in the following charts. Note that the values are calculated for "no waste." The actual coverage will be based on application technique and overfill.

Bead Diameter (inch) *fractional*	*decimal*	**Length of Bead** (lineal feet) *for 10 fl.oz.*	*for 400 ml*
1/8	0.1250	126.2	165.7
3/16	0.1875	56.1	73.7
1/4	0.2500	31.6	41.4
5/16	0.3125	20.2	26.5
3/8	0.3750	14.0	18.4
7/16	0.4375	10.3	13.5
1/2	0.5000	7.9	10.4

Lineal Feet of Seam

Seam Depth (inch)	*Seam Width (inch)* 1/8	1/4	3/8	1/2
1/8	96.2 (130.1)	48.1 (65.1)	32.1 (43.4)	24.1 (32.5)
3/16	64.2 (86.8)	32.1 (43.4)	21.4 (28.9)	16.0 (21.7)
1/4	48.1 (65.1)	24.1 (32.5)	16.0 (21.7)	12.0 (16.3)
5/16	38.5 (52.1)	19.2 (26.0)	12.8 (17.4)	9.6 (13.0)
3/8	32.1 (43.4)	16.0 (21.7)	10.7 (14.5)	8.0 (10.8)
7/16	27.5 (37.5)	13.8 (18.6)	9.2 (12.4)	6.9 (9.3)
1/2	24.1 (32.5)	12.0 (16.3)	8.0 (10.8)	6.0 (8.1)

Values given for 10 fl. oz. cartridge and 400 ml (in parentheses).

Lineal Meters of Seam

Seam Depth (mm)	*Seam Width (millimeters)* 4	6	8	10	12
4	18.4 (25.0)	12.3 (16.7)	9.2 (12.5)	7.4 (10.0)	6.1 (8.3)
5	14.8 (20.0)	9.8 (16.3)	7.4 (10.0)	5.9 (8.0)	4.9 (6.7)
6	12.3 (16.7)	8.2 (11.1)	6.1 (8.3)	4.9 (6.7)	4.1 (5.6)
7	10.5 (14.3)	7.0 (9.5)	5.3 (7.1)	4.2 (5.7)	3.5 (4.8)
8	9.2 (12.5)	6.1 (8.3)	4.6 (6.3)	3.7 (5.0)	3.1 (4.2)
10	7.4 (10.0)	4.9 (6.7)	3.7 (5.0)	3.0 (4.0)	2.5 (3.3)
12	6.1 (8.3)	4.1 (5.6)	3.1 (4.2)	1.5 (3.3)	2.0 (2.8)

Area Coverage

Should it be necessary to cover an area with the adhesive sealant, the material should be dispensed from the container and spread with a trowel. Most trowels for spreading adhesives will have a notched edge to facilitate control of the thickness being applied. When the notch depth is known or can be measured the coverage area can be determined from the following tables. Should it be necessary to apply a solid layer of a specific thickness, take the value given in the following table and divide the area by two.

Square Foot Coverage

Package Size	*Notch Depth (inch)* 1/16	1/8	3/16	1/4
3 oz. tube	1.2	0.6	0.4	0.3
10 oz. cartridge	4.0	2.0	1.3	1.0
400 ml flex pack	5.4	2.7	1.8	1.4
5 gallon pail	257	128	86	64

Square Meter Coverage

Package Size	*Notch Depth (centimeters)* 0.30	0.40	0.50	0.60
3 oz. tube	0.06	0.04	0.04	0.03
10 oz. cartridge	0.20	0.15	0.12	0.10
400 ml flex pack	0.27	0.20	0.16	0.13
5 gallon pail	12.62	9.46	7.57	6.31

For further information: **1-877-3M-MARINE**
(1-877-366-2746)

www.3M.com/marine

3M

Marine

3M Center, Building 223-6S-06
St. Paul, MN 55144-1000

Minimum 10% Post-Consumer Fiber

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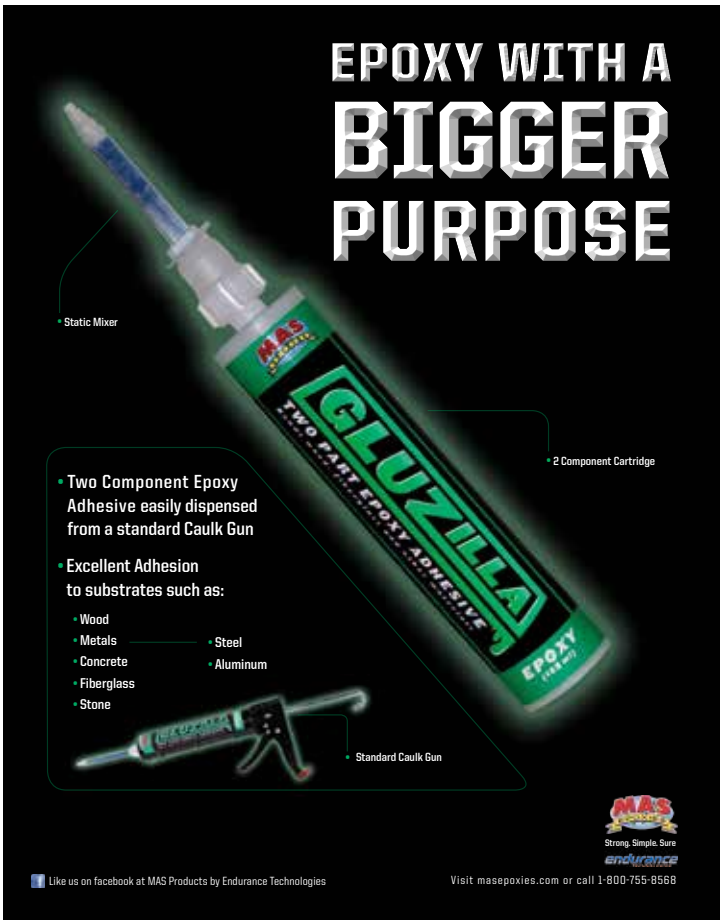

Strong. Simple. Sure

PHYSICAL PROPERTIES	Value	Test Method
Color	Buff	Visual
Hardness, Shore D	80	ASTM D2240
Tensile Strength, psi	6,000	ASTM D638
Tensile Modulus, psi	325,000	ASTM D638
Tensile Elongation, %	8.5	ASTM D638
HDT, Post Cured, °F	122	ASTM D648
Compressive Strength, psi	9,000	ASTM D695
Flexural Strength, psi	10,500	ASTM D790
Flexural Modulus, psi	307,000	ASTM D790
Tensile Adhesion, Wood, psi	1,420	ASTM D4541
Tensile Adhesion, Aluminum, psi	1,840	ASTM D4541
Tensile Adhesion, G-10, Laminate, psi	2,090	ASTM D4541

HANDLING PROPERTIES	Value	Test Method
Resin Density at 25°C,lb/gal	9.6	ASTM D1475
Hardener Density at 25°C,lb/gal	8.8	ASTM D1475
Resin Color-A	Buff	Visual
Hardener Color-B	Amber	Visual
Thixotropic Index, 1/10 RPM	7.5	
Mix Ratio by Weight	100A:46B	Calculated
Mix Ratio by Volume	2A:1B	Calculated
Gel Time at 25°C, 150g mass, min.	30-35	ASTM D2471
Vertical Sag Resistance, in.	1-2	ASTM D2471

PRICES	Case	Price
Gluzilla	24	$20.99
Mixers (2 pack)	1	$3.69
Mixers (6 pack)	1	$9.99

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TRANSONITE® FEATURES AND BENEFITS

The 3-D through-thickness fibers in TRANSONITE® provide greater durability than conventional sandwich panels. Delamination, a common problem in traditional sandwich materials, is virtually eliminated with the 3-D reinforcements that tie the face sheets together. Additionally, TRANSONITE® is one of the only panel products available which can be produced at any length, and width up to 8.5 feet. This provides large clean surfaces with no edges or seams. TRANSONITE® can be manufactured using a wide variety of core materials, reinforcements, fabrics, and resins.

TRANSONITE® Delivers:

- Extremely High Strength
- Very Lightweight
- Corrosion Resistance
- Extreme Durability
- Large Panel Size
- Acoustic Dampening
- Insulative Properties
- High Volume Production
- Fire Resistant Properties
- Reduced Labor

TRANSONITE® MECHANICAL AND PHYSICAL PROPERTIES

Mechanical and physical properties vary depending on the resin type, FIPSI pattern, skin thickness, fiber orientation, core material and shear web configuration when applicable. Typical FRP face sheet properties are presented below.

TYPICAL SKIN PROPERTIES

Test	Imperial Units	Metric Units
Tensile Strength Lengthwise ASTM D638	24,000 psi	165 Mpa
Tensile Strength Crosswise ASTM D638	22,000 psi	152 Mpa
Tensile Modulus Lengthwise ASTM D638	2.8E6 psi	19.3 Gpa
Tensile Modulus Crosswise ASTM D638	2.3E6 psi	15.9 Gpa
Compressive Strength Lengthwise ASTM D695	8,600 psi	59.2 Mpa
Compressive Strength Crosswise ASTM D695	8,600 psi	59.2 Mpa
Compressive Modulus Lengthwise ASTM D695	2.8E6 psi	19.3 Gpa
Compressive Modulus Crosswise ASTM D695	2.8E6 psi	19.3 Gpa
In-Plane Shear Strength Lengthwise ASTM D2344	5,000 psi	34.4 Gpa

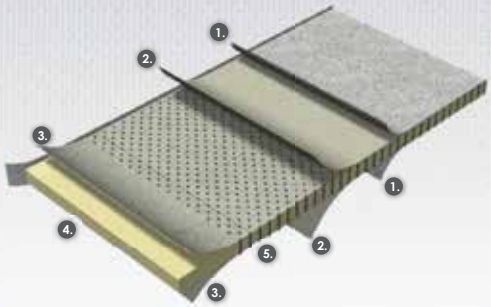
The perpendicular compression strength of the finished panel, depending on the number of FIPSI and shear webs, ranges from 100 to 1200 psi.

The shear strength ranges from 20 psi to 400 psi.

Note: CPI can custom-design a TRANSONITE® panel to meet a customer's mechanical and physical properties.

TYPICAL TRANSONITE® PANEL SYSTEMS

1.0" Thick 4.0 FIPSI 0.070" FRP Face Sheets (PA510)



TYPICAL FIBER ARCHITECTURE:

1. **10 MIL NYLON VEIL**
2. **E/E_{CR} GLASS -CONTINUOUS FILAMENT MAT**
3. **E/E_{CR} GLASS -GLASS WOVEN ROVING FABRIC**
4. **2 PCF POLYISOCYANURATE FOAM CORE**
5. **E/E_{CR} FIBER INSERTS**

E/E_{CR} =

E = E-glass (Electrical Grade Fiberglass)
E_{CR} = E-glass Corrosion (Boron Free)

Typical Physical Properties
Thickness: 1.0" (25.4mm)
Face Skin Thickness: 0.07" (1.8mm)
FIPSI: 4.0 Staggered Pattern
Weight: 2.0 psf (9.77 kg/m2)
Core Material: Polyisocyanurate Foam 2 pcf density
Compressive Strength Crosswise ASTM D695
Compressive Modulus Lengthwise ASTM D695
Compressive Modulus Crosswise ASTM D695
In-Plane Shear Strength Lengthwise ASTM D2344

Typical Panel Mechanical Properties
Flexural Strength: 3,400 psi (23.4 Mpa)
Flexural Modulus: 4.1E5 psi (2.8Gpa)
Shear Strength: 73 psi (503 kpa)
Compression Strength: 260 psi (1.8Mpa)

WHAT IS TRANSONITE®?

TRANSONITE® is a pultruded 3-D Fiber Reinforced Polymer (FRP) "sandwich panel" consisting of thermoset resins, FRP skins, a core, custom designed 3-D insertions known as Fiber Insertions Per Square Inch (FIPSI) and in some cases shear webs for increased shear and compression capacity.

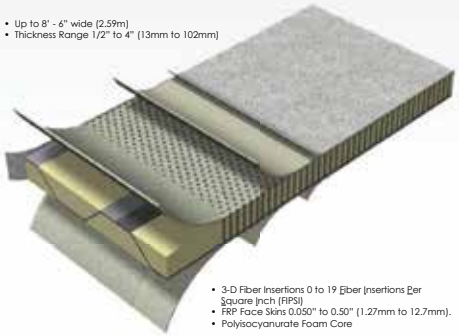
TRANSONITE® can be manufactured with thermoset resins including Vinyl Esters, or Polyesters, with or without fire retardant additives.

Special colors and resins are available where architectural, chemical, temperature, flame, smoke and toxicity may dictate that our standard systems will not meet your criteria. Creative Pultrusions, Inc.'s (CPI) highly skilled engineering team can put together an engineered solution to fit your application.

The top and bottom FRP face skins can be tailored specific for your application. The face skin thickness and fiber volume fractions can also be adjusted to meet your specific design requirements.

The core material can be made of closed cell polyisocyanurate or phenolic foam, or end grain balsa wood depending on the application.

- Up to 8' - 6" wide (2.59m)
- Thickness Range 1/2" to 4" (13mm to 102mm)



- 3-D Fiber Insertions 0 to 19 Fiber Insertions Per Square Inch (FIPSI)
- FRP Face Skins 0.050" to 0.50" (1.27mm to 12.7mm).
- Polyisocyanurate Foam Core

WHAT IS TRANSONITE®? (continued)

Fiber insertions connect the top and bottom skins by means of mechanical FRP pins. The fiber insertion density can range from zero to nineteen FIPSI. The FIPSI pattern density significantly enhances the local compression strength, full section bending strength, as well as, the shear modulus and strength. Unlike traditional FRP panel structures, the patented fiber insertions prevent undesirable delaminations traditionally associated with cored FRP panels.

Shear webs can be incorporated into the TRANSONITE® panel when high shear and localized strength is required. CPI can custom-design the shear webs in terms of the angle, thickness, and pattern depending on your application.

Close Up of the Fiber Insertions with the Core Foam Removed

TRANSONITE® is a lightweight, high strength, extremely durable composite panel. With a wide variety of uses, this patented technology provides an alternative for structural and non-structural flat panel applications. Some examples include:

- Off-road mats
- Heavy truck cabs, floors and sleepers
- Construction panels
- Industrial flooring
- Sound walls/Barriers
- Pallets
- Roadway/Pedestrian Covers
- Air Cargo Containers
- Containment Basing
- Transformer Pads
- Refrigerator Shipping Containers
- RV walls, roofs and floors
- Trailer floors
- Boat bulkheads and flooring
- Tanks
- Wall panels
- Doors
- Customized I-Beams
- Scaffolding Planks
- Insulated Tank Covers
- Privacy Fence
- Blast Panels
- Temporary Shelters

TRANSONITE® can be manufactured in various thicknesses, widths and lengths. The following chart depicts the current range of the TRANSONITE® product.

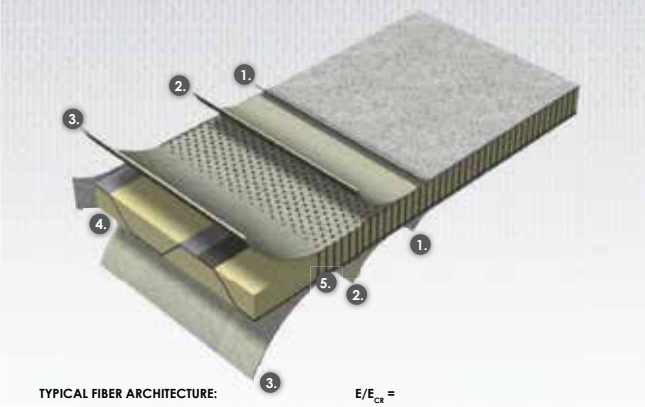
TRANSONITE® PRODUCT RANGE

Parameter	Minimum	Maximum
Width, in (mm)	6 (152)	102 (2591)
Length, in (mm)	1 (25.4)	Limited only by Shipping
Skin Thickness, in (mm)	0.050 (1.27)	0.5 (12.7)
Sandwich Thickness, in (mm)	0.5 (12.7)	4 (102)
3D Fiber Density (FIPSI)	1/2 per sq inch	19 per square inch

CSI #: 06 83 00

TYPICAL TRANSONITE® PANEL SYSTEMS

2.0" Thick 5.33 FIPSI 0.24 and 0.17" FRP Face Sheets (PA521) 6/4



TYPICAL FIBER ARCHITECTURE:

1. 10 MIL NYLON VEIL
2. E/E_{CR} GLASS -CONTINUOUS FILAMENT MAT
3. E/E_{CR} GLASS -GLASS WOVEN ROVING FABRIC
4. 2 PCF POLYISOCYANURATE FOAM CORE
5. E/E_{CR} FIBER INSERTS

E/E_{CR} =

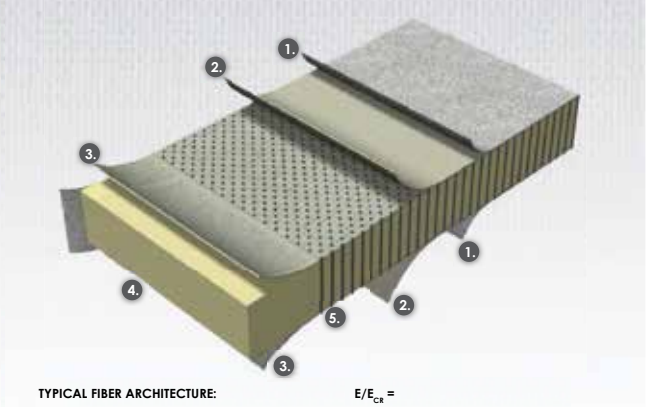
E = E-glass (Electrical Grade Fiberglass)
E_{CR} = E-glass Corrosion (Boron Free)

Typical Physical Properties
Thickness: 2.0" (50.8mm)
Face Skin Thickness: 0.24" and 0.17" (6.1mm&4.3mm)
FIPSI: 5.3 Staggered Pattern
Weight: 6.6 psf (32.2 kg/m2)
Core Material: Polyisocyanurate Foam 2 pcf density

Typical Panel Mechanical Properties (AOC)
Flexural Strength: 18,530 psi (128 Mpa)
Flexural Modulus: 1.95E6 psi (13.4 Gpa)
Shear Strength: 274 psi (1.9 Mpa)
Perp. Compression Strength: 280 psi (1.9 Mpa)

TYPICAL TRANSONITE® PANEL SYSTEMS

3.5" Thick 4.0 FIPSI 0.17" FRP Face Sheets (PA535)



TYPICAL FIBER ARCHITECTURE:

1. 10 MIL NYLON VEIL
2. E/E_{CR} GLASS -CONTINUOUS FILAMENT MAT
3. E/E_{CR} GLASS -GLASS WOVEN ROVING FABRIC
4. 2 PCF POLYISOCYANURATE FOAM CORE
5. E/E_{CR} FIBER INSERTS

E/E_{CR} =

E = E-glass (Electrical Grade Fiberglass)
E_{CR} = E-glass Corrosion (Boron Free)

Typical Physical Properties
Thickness: 3.5" (88.9mm)
Face Skin Thickness: 0.17" (4.3mm)
FIPSI: 4.0 Staggered Pattern
Weight: 5.3 psf (25.9 kg/m2)
Core Material: Polyisocyanurate Foam 2 pcf density
Thermal Resistance: 11.67 hr*ft2**F/BTU

Typical Panel Mechanical Properties (1525)
Flexural Strength: 3,300 psi (23.2 Mpa)
Flexural Modulus: 5.5E5 psi (3.8 Gpa)
Shear Strength: 22 psi (151 kpa)
Perp. Compression Strength: 180 psi (1.2 Mpa)
Pin Bearing: 9,800 psi (67.5 Mpa)
Screw Pull Out (#9 deck screw): 385 lbs (174 kg)

CSI #: 06 83 00

AS COMPOSITE INC.

Sandwich Panels

Buildings

Technical Sheet

Product Description

Structural and insulating sandwich panels, manufactured with glass reinforced thermoplastic skin and expanded Polystyrene (EPS) core, available in various thicknesses.(0.25in.(6.3mm) – 4in.(101mm)) and unlimited lengths.

Applications

Potential uses:

- Mobile homes;
- Temporary homes;
- Permanent homes (Can replace conventional construction because of excellent performance and low cost)
- Industrial buildings;

For many applications including:

- Exterior walls;
- Interior walls;
- Partitions;
- Floors;
- Roofs

Building Panels Technical Sheet July2007

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CSI #: 06 83 00

AS COMPOSITE INC.

Sandwich Panels

Buildings

Technical Sheet

Product Benefits

- Extremely light: A 4in. panel (101mm) thick 4ftx 8ft (1219mm x 2438mm) weighs 57lb (25.85kg);
- Excellent durability: resistant to fatigue, moisture, corrosion and other environmental and chemical factors. Resistant to putrefaction and mould. No maintenance required;
- Non-toxic and entirely recyclable skin;
- Highly resistant to various loads such as wind and seism;
- Excellent impact resistance (no penetration noticed on the skin after undergoing Missile test (FBC TAS 201))
- Very high heat insulation (R20 and more);
- Used in wide temperature variations, from -40°C to 100° C (-40° F to 212° F) ;
- Resisting fire propagation;
- Affordable patent pending panels;
- No adherence of snow and ice;
- Easy and versatile interior and exterior finishing. Can be combined with many types of coatings (stone, gypsum, fire retardant film, etc.);
- Uniform quality in unlimited length, fabricated using a continuous, high speed and fully automated patented process;
- Easy and fast installation and removal.

Technical Data

Physical and mechanical properties of skin material for a .078in. (2mm) thick:

Standard	Test Type	Mean Value
	Glass content	60%
ASTM D 638-96	Young Modulus	1885000psi (13000 Mpa)
	Tension strength	43500psi (300 Mpa)
	Tensile elongation	2,9%
ASTM D 790-96	Flexural Tangent Modulus	1740000psi (12000 Mpa)
	Flexural strength	39875psi (275 Mpa)
ASTM 695-96 (modified)	Compressive strength	20300psi (140 Mpa)
ASTM D 256-93	Notched Izod	29.98 ft-lb /in (1600J/M)
ASTM D 3763-95 (4 layers)	Impact multi-axial 86.61in / sec (2.2 m/sec)	28.76ft-lb (39 J)
	Multi-axial impact 86.61in / sec (2.2 m/sec)	31.72ft-lb (43 J)
ASTM D 792-91	Specific gravity	1,49
ASTM D 2240-97	Shore ' D' hardness	77
ASTM D 3763-95	Heat Deflection	311 ° F (155 °C)
ASTM G26	Ultra-violet Test	no important loss of mechanical and physical properties noticed
ASTM G7-96 et ASTM G24-94	Ultra-violet Test (Onsite test in Arizona)	no important loss of mechanical and physical properties noticed. Very little color change

Building Panels Technical Sheet July2007

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CSI #: 06 83 00

AS COMPOSITE INC.

Sandwich Panels

Buildings

Technical Sheet

Physical and mechanical properties of the core material:

Standards	Test Type	Mean Value
ASTM D C518 C177 For 1in. (25.40mm) thick	Thermal Resistance	R-4.35 (RSI-.74)
ASTM E96 For 1in.(25.4mm) thick	Vapor Permeability	.62 perm (35.0 ng/Pa/s/m²)
ASTM D2126 For 1.5 in. (38mm) thick	Dimensonal Stability	.17%
ASTM D1621 For 1.5 in. (38mm) thick	Compression Strength	30.60psi (210Kpa)
ASTM C203	Flexion Strength	76.30psi (525KPa)
ASTM 2842 For 1.5in.(38mm) thick	Water Absorption	1.00%
ASTM E84 :5 CAN.4-S102.2M:1.40	Flame Propagation	140
Warranty	The thermal resistance of the product is freely 100% guarantied by the supplier for a minimum period of 20 years.	

For all additional information please contact:
AS Composite
Golnaz Shokouhi (514) 697-2828 ext. 223
Golnaz.Shokouhi@ascomposite.com
www.ascomposite.com

Building Panels Technical Sheet july2007

Dimensions

- Available in unlimited lengths, up to 4 feet wide (1219mm);
- Panel Thickness : ¼in.(6.35mm) to 4in.(101mm);

Thermal Properties

- EPS has excellent thermal insulating properties - R4.35/in (R4.35 /25.4mm) so that (a) we conform entirely to Building Code criteria and (b) our product is free of any thermal bridges.
- Insulation core ensures uniform and durable insulation properties for a minimum of 20 years.

Fire

- AS Composite Sandwich Panel skins do not propagate fire nor emit any harmful or toxic gas as per MVSS302/NFPA102 std

Humidity

- The waterproof skin of AS Composite Sandwich Panels prevents the penetration of liquid and humidity in the structure.

Load Tables

Please contact us for any additional information required, such as Load Tables. We will forward it without delay.

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CSI #: 06 71 00

Division 07

Thermal and Moisture Protection

Division 08
Openings

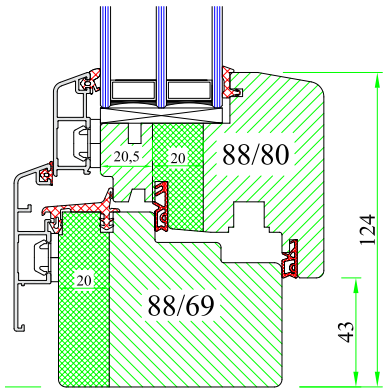
CSI #: 08 14 33

zola European Windows

THERMOPLUS

SPECIFICATIONS

Zola ThermoPlus Clad is the natural choice for Passive Houses and Net-Zero Homes. With R-11 glass standard in an industry-leading 18mm spacer thickness, ThermoPlus can be offered in extremely large sizes. Patented German Purenit insulation creates a thermally broken frame, and the recessed aluminum cladding allows for overinsulation.



ZOLA™ ThermoPlus Clad

1.0 Summary.

Wood window with rain screen aluminum cladding. 88mm wood profile with Purenit™ frame insulation and triple glazing. Overall U-value of 0.123BTU/hr.sqft tested by independent lab.

1.1 Configurations.

Fixed, Tilt&Turn, double (French window) Tilt&Turn, single and double French Doors, Tilt-Slide Doors up to 22', Lift-Slide doors up to 26', Breezepanel™ Folding Glass Walls up to 25'.

1.2 Frame.

Frame to be made from dense, European finger jointed pine. Optionally available woods are clear pine, meranti, or oak. Frame to be manufactured with continuous layer of patented Purenit™ insulation to create thermal break. Frame and sash shall be 88mm deep excl. the cladding.

1.3 Cladding.

Aluminum Cladding shall be rain screen type, attached by manufacturers clip system. Cladding shall be powder coated in specified RAL color as chosen from manufacturers list of standard colors. Full choice of RAL colors available at optional cost. Cladding corners shall be mitered where applicable and invisibly connected with proprietary metal bracket. For locations within one mile of salt water, and where harsh whether conditions are to be expected, welded corners shall be specified at additional cost.

1.4 Glass

Glass shall be triple pane with 18mm spacers and low-e coating on surfaces two and five. Glass assembly shall be 4-18-4-18-4 for assemblies up to 25 ft2, and 6-18-6-18-6 for larger panes, both with a U-value of 0.09BTU/hr.ft2. The glazing unit shall be fully supported by the window frame and not cantilever. Safety glass is available and shall be provided where specified at additional cost. Both tempered and laminated safety glass is available and tested according to CPHC and ASTM standards.

SHGC shall be at least 0.48. Optional high SHGC glass (0.62) available as an upgrade.

1.5 Finish

All units shall be fully factory finished with three layer waterborne finish by Sigma Coatings or Unearthed Paints all natural, no-VOC stand oil paints / stains. All maintenance shall be carried out with materials specified by the original paint / stain supplier.

1.6 Hardware

Hardware shall be premium German tilt&turn, tilt&slide, folding, or lift-slide hardware as applicable to the project, typically manufactured by Roto™.

1.7 Performance

Performance of entire window assembly shall be independently tested and be a minimum of R-8 at a test size of 1.23m x 1.48m. Actual performance will be higher on larger windows and lower on smaller windows, and may vary with selected sill and threshold options.

1.8 Seals

Product shall have three layers of seals, one of them shall have welded corners. Drainage from outer seal shall discharge into the rain screen cladding cavity.

1.9 Warranty

Warranty applies as spelled out in manufacturers standard warranty. Warranty shall be no less than five years on entire assembly.

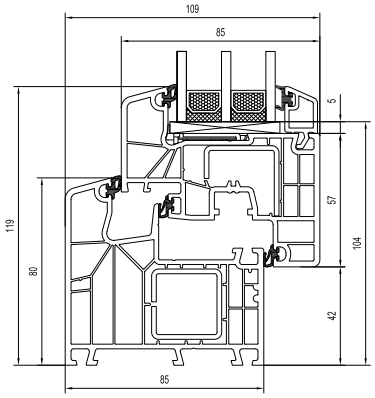
1

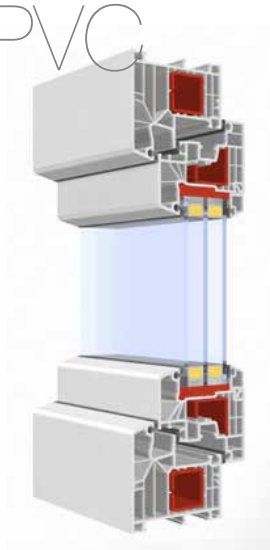
CSI #: 08 52 00

THERMO uPVC

SPECIFICATIONS

Zola Thermo uPVC is the most affordable, Passive House compatible hgh performance window on the U.S. market. It offers the highest r-value available in a uPVC window with clip in rather than glue in glazing for easy glass exchanges. With R-11 glass standard in an industry-leading 18mm spacer thickness, Thermo uPVC can be offered in large sizes.





ZOLA™ Thermo uPVC

1.0 Summary.
uPVC window made from Aluplast profiles with steel reinforcement. Overall U-value of 0.14BTU/hr.sqft for operable units tested by independent lab.

1.1 Configurations.
Fixed, Tilt&Turn, double (French window) Tilt&Turn, single and double French Doors, Tilt-Slide Doors up to 22', Breezepanel™ Folding Glass Walls up to 25'.

1.2 Frame.
Frame to be made from Aluplast Ideal 8000 profiles with steel reinforcement.

1.3 Glass
Glass shall be triple pane with 18/16mm spacers and low-e coating on surfaces two and five. Glass assembly shall be 4-18-4-18-4 for assemblies up to 25 ft2, and 6-16-6-16-6 for larger panes, with a U-value of up to 0.09BTU/hr.ft2. Glass in fixed units may have slightly lower performance. The glazing unit shall not be glued to the frame but easily replaceable via clip system.. Safety glass is available and shall be provided where specified at additional cost. Both tempered and laminated safety glass is available and tested according to CPHC and ASTM standards.
SHGC shall be at least 0.48 for standard glazing. Optional high SHGC glass (0.62) available as an upgrade.

1.4 Finish
Frames shall be white or finished in color or wood look foil.

1.5 Hardware
Hardware shall be premium German tilt&turn, tilt&slide, folding, or lift-slide hardware as applicable to the project, typically manufactured by Roto™.

1.6 Muntins
Muntins shall be provided where specified. Typical width shall be 7/8". Muntin shall be made from uPVC profile on both sides of glazing unit and spacer bars in between glass panes unless otherwise specified.
Where specified lites shall be truly divided. Trtue dividers shall have a width of no less than 2 3/8".

1.7 Performance
Performance of entire window assembly shall be independently tested and be a minimum of R-7 at a test size of 1.23m x 1.48m. Actual performance will be higher on larger windows and lower on smaller windows, and may vary depending on specific sill and threshold requirements.

1.8 Seals
Product shall have three layers of seals.

1.9 Warranty
Warranty applies as spelled out in manufacturers standard warranty. Warranty shall be no less than five years on entire assembly.

Division 09

Finishes

CSI #: 09 29 00

GP TOUGHROCK

Technical Service Hotline 1.800.225.6119 or
www.gpgypsum.com

Manufacturer

Georgia-Pacific Gypsum LLC
133 Peachtree Street
Atlanta, GA 30303

Georgia-Pacific Canada LP
2180 Meadowvale Boulevard, Suite 200
Mississauga, ON L5N 5S3

Technical Service Hotline: 1-800-225-6119

Description

54" (1372 mm) Wide ToughRock® Gypsum Board has a noncombustible (per ASTM E 136), dimensionally stable gypsum core. The surfacings on both faces and on the long edges are 100% recycled paper. The front face (side to be finished) and the long edges are an ivory color; the back face paper is gray. The ends are square cut. ToughRock 54" (1372 mm) Gypsum Board is specifically designed for 9' (2743 mm) ceilings. The use of 54" (1372 mm) Gypsum Board in this application saves labor and time by eliminating the need to use board to fill the gap left from 4' (1219 mm) wide board.

Primary Uses

54" (1372 mm) Wide ToughRock Gypsum Board is a wall covering material for use in new building construction or renovation work. It is designed for direct attachment (screws, nails or adhesive in combination with fasteners) to wood and metal framing or existing surfaces. It may also be used as a covering material for flat or curved structures; the material may be formed to a curve with a short radius.

54" (1372 mm) Wide ToughRock Gypsum Board is manufactured with an ivory colored paper surface designed to receive joint treatment, then paint, wall covering, textured coatings or other finish treatment.

Limitations

54" (1372 mm) Wide ToughRock Gypsum Board is a nonstructural product and should not be used as a nailing base to support heavy wall-mounted objects.

It is intended for interior applications only. Do not use 54" (1372 mm) Wide ToughRock Gypsum Board where there is prolonged exposure to temperatures exceeding 125° F (52° C) and/or continuous exposure to extreme humidity, e.g. located adjacent to wood burning stoves, heating appliances, swimming pools, saunas or steam rooms. Consult manufacturer's literature when water-based textures are to be used.

Applicable Standards

Manufacture to meet ASTM C 1396 Section 5, CSA-A82.27-M; and Federal Specification SS-L-30D, Type III, Grade R.

Building Code Conformity

54" Wide ToughRock Gypsum Board conforms to the requirements of major building codes.

Sizes and Edges

Thickness - nominal	1/2" (12.7 mm)	5/8" (15.9 mm)
Widths - nominal	4'6" (1402 mm)	4'6" (1402 mm)
Lengths - standard	8'-12' (2487–3658 mm)	8'-12' (2487–3658 mm)

Edges

Square, tapered or tapered with round edges.

Supplemental Materials

Fasteners: Nails, screws or adhesive.
Finishing: Tape, ready mixed or setting type joint compound, textures, acoustical sealant.
Trims: Corner bead, edge/casing bead, control joints, floor/ceiling runners and channels.

Technical Data

Flame spread 15 and smoke developed 0, when tested in accordance with ASTM E 84 or CAN/ULC-S102. The core is non-combustible when tested in accordance with ASTM E 136.

5/8" (15.9 mm) 54" (1372 mm) Wide ToughRock Fireguard is UL classified, Type 9 in the following UL assemblies: Design Nos. G501, G520, N501, N502, N505, N602, U017, U032, U204, U301, U302, U305, U309, U329, U332, U338, U339, U341, U342, U354, U357, U358, U379, U411, U418, U420, U421, U425, U434, U436, U442, U460, U465, U473, U502, U504, U505, U510, U512, V419, V450, X508, X516, X517, X525, X526, X527, X528, X602, X604 and ULC classified, Type GF-6 in ULC Designs I509, I514, M500, M514, O501, O502, R804, U301, U302, W301, W404, W409, W415, W449 and Z502.

Sound Control

Sound rated assemblies require caulking at top, bottom, intersections and other penetrations with acoustical sealant to ensure the effectiveness of the assembly and obtain desired STC rating.

Installation—Application Standards

54" (1372 mm) Wide ToughRock Gypsum Board shall be installed according to the Gypsum Association Publication GA-216 "Recommended Specifications for the Application and Finishing of Gypsum Board" and ASTM C 840 "Standard Specification for Application and Finishing of Gypsum Board" for non-fire rated construction. However, to achieve a designated fire resistance rating, installation and details must be consistent with tested assemblies as listed in the Gypsum Association Fire Resistance Design Manual GA-600 and UL/ULC Fire Resistance Directory.

Methods

For non-rated construction, installation methods for single or multi-layer construction involving attachments using mechanical fasteners, adhesive or adhesive with supplemental fasteners are numerous and varied. Refer to Gypsum Association publications for application and installation details.

The installation method selected should be planned carefully to minimize the number of end joints. 54" (1372 mm) Wide ToughRock Gypsum Board can be cut to the necessary size by scoring the face paper with a sharp knife, then snapping away from the cut face. The back paper is then cut or broken by snapping the board in the opposite direction. All cut edges and ends are smoothed by rasping or other suitable methods to form tight-fitting joints when installed.

For rated assemblies, appropriate methods of installation are based on the desired fire resistance rating or specified STC value required. These ratings and values require that details of the tested assemblies be followed. In addition to these details, the installation methods outlined in Gypsum Association Publication GA-216 will facilitate optimum performance through preferred construction practices.

Safety

See *Handling and Use– Caution* section at end of this document.

Handling Precautions

Stack 54" (1372 mm) Wide ToughRock Gypsum Board flat on a level surface. As individual sheets are removed for installation, they should be raised carefully on edge and carried in a vertical position. Appropriate handling is also outlined in Gypsum Association Publications GA-216 and GA-801.

Take care to avoid impact, undue flexing and subsequent damage to board edges, ends and corners. Avoid scuffing the face to be finished.

Material Safety Data Sheet

Material Safety Data Sheet (MSDS) is available upon request or online at www.gpgypsum.com.

CSI #: 09 29 00

GP TOUGHROCK

Technical Service Hotline 1.800.225.6119 or
www.gpgypsum.com

Single-Ply Application[1]
Nails: ASTM C 514, Nails for the Application of Gypsum Board
Screws: ASTM C 1002, Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases

Maximum Framing Spacing (Wood or Metal)

	Single-Ply Thickness	Application	Maximum Framing Members o.c. Spacing
Walls	1/2" (12.7 mm) or 5/8" (15.9 mm)	Right Angles or Parallel	24" (610 mm) o.c.

Nail Applications			Screw Applications	
Wallboard Thickness	Nail Length	Spacing Walls	Screw Length	Spacing Walls[2]
1/2" (12.7 mm)	1-3/8" (35 mm)	8" (203 mm)	1" (25 mm)	16" (406 mm)
5/8" (15.9 mm)	1-1/2" (38 mm)	8" (203 mm)	1-1/4" (32 mm)	16" (406 mm)

[1] *Also refer to local code requirements.*
[2] *Where framing members are spaced 24" (610 mm) o.c., screw spacing of 12" (305 mm) o.c.*

Physical properties

Properties[1]	1/2" (12.7 mm) 54" (1372 mm) Wide ToughRock® Gypsum Board	5/8" (15.9 mm) 54" (1372 mm) Wide ToughRock® Fireguard® Gypsum Board
Thickness, nominal	1/2" (12.7 mm), ± 1/64" (0.4 mm)	5/8" (15.9 mm), ± 1/64" (0.4 mm)
Width, nominal	54" (1370 mm)	54" (1370 mm)
Length, standard	8' (2400 mm) to 12' (3658 mm) ± 1/4" (6 mm)	8' (2400 mm) to 12' (3658 mm) ± 1/4" (6.4 mm)
Weight, lbs./sq. ft., nominal (kg/m²)	1.75 (7.8)	2.4 (10.9)
Edges	Tapered, square and tapered with round edges	Tapered, square and tapered with round edges
Surfacing	100% recycled paper face, back and long edges	100% recycled paper face, back and long edges
Flexural Strength spacing, min.		
Parallel, lbs. (N)	≥40 (178)	≥50 (222)
Perpendicular (N)	≥110 (489)	≥150 (666)
R Value[2] °F•ft²•hr/BTU (K•m²/W)	.45 (0.08)	.56 (0.10)
Nail Pull Resistance, minimum, lbs. force (N)	≥80 (356)	≥90 (400)
Hardness, lbs. force (core, edges and ends)	≥15	≥15

Special lengths and types may be available on special order. For ordering and sales information, call 1-800-947-4497.
[1] *Tested in accordance with ASTM C 473.*
[2] *Tested in accordance with ASTM C 518, Heat Flow Meter*
Note: Specified minimum or maximum values are as in ASTM C 36 and C 1396.

CSI #: 09 29 00

Georgia-Pacific
Gypsum

U.S.A. – Georgia-Pacific Gypsum LLC
Canada – Georgia-Pacific Canada LP

SALES INFORMATION AND ORDER PLACEMENT

U.S.A. Midwest: **1-800-876-4746** West: **1-800-824-7503**
South: **1-800-327-2344** Northeast: **1-800-947-4497**

CANADA Canada Toll Free: **1-800-387-6823**
Quebec Toll Free: **1-800-361-0486**

TECHNICAL INFORMATION

U.S.A. and Canada: **1-800-225-6119**
www.gpgypsum.com

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WARRANTIES, REMEDIES AND TERMS OF SALE For current warranty information for this product, please go to www.gpgypsum.com and select the product for warranty information. All sales of this product by Georgia-Pacific are subject to our Terms of Sale available at www.gpgypsum.com.

UPDATES AND CURRENT INFORMATION The information in this document may change without notice. Visit our website at www.gpgypsum.com for updates and current information.

CAUTION For product fire, safety and use information, go to www.gp.com/safetyinfo or call 1-800-225-6119.

HANDLING AND USE–CAUTION This product may contain fiberglass which may cause skin irritation. Dust and fibers produced during the handling and installation of the product may cause skin, eye and respiratory tract irritation. Avoid breathing dust and minimize contact with skin and eyes. Wear long sleeve shirts, long pants and eye protection. Always maintain adequate ventilation. Use a dust mask or NIOSH/MSHA approved respirator as appropriate in dusty or poorly ventilated areas.

FIRE SAFETY CAUTION Passing a fire test in a controlled laboratory setting and/or certifying or labeling a product as having a one-hour, two-hour, or any other fire resistance or protection rating and, therefore, as acceptable for use in certain fire rated assemblies/systems, does not mean that either a particular assembly/system incorporating the product, or any given piece of the product itself, will necessarily provide one-hour fire resistance, two-hour fire resistance, or any other specified fire resistance or protection in an actual fire. In the event of an actual fire, you should immediately take any and all actions necessary for your safety and the safety of others without regard for any fire rating of any product or assembly/system.

CSI #: 09 29 00

Benjamin Moore®

REGAL® CLASSIC
PREMIUM INTERIOR 100% ACRYLIC
EGGSHELL FINISH N319

Features
- Eggshell, low lustre finish with high durability
- Painted surfaces can be washed after two weeks
- Easy application
- Self priming on most surfaces
- Provides a mildew resistant coating
- Easy clean-up
- Premium hide and leveling
- No unpleasant odor

General Description
A premium quality, 100% acrylic paint that combines the decorative beauty of an eggshell finish with very good durability. A beautiful and durable low lustre, eggshell finish that is easy to apply

Recommended For
Ideal for applications where a fast drying, high hiding, durable coating is required. Recommended for new or previously painted wallboard, plaster, masonry, and primed or previously painted wood or metal. Use on interior walls and ceilings.

Limitations
- Do not apply when air and surface temperatures are below 50°F (10°C)

Product Information

Colors: —Standard:
White and a range of ready-mixed off-white colors

—Tint Bases:
Benjamin Moore® Color Preview® Bases 1B, 2B, 3B & 4B

—Special Colors:
Contact your Benjamin Moore representative

Certification:

VOC Compliant in all regulated areas except the South Coast and areas of California that follow the 2007 Suggested Control Measures.

Master Painters Institute MPI # 44, 52, 139

Class A (0-25) over non-combustible surfaces when tested in accordance with ASTM E-84

Qualifies for LEED® Credit (INTERIOR NON-FLAT)

Technical Assistance
Available through your local authorized Benjamin Moore® retailer. For the location of the retailer nearest you, call 1-800-826-2623, see www.benjaminoore.com, or consult your local Yellow Pages

Technical Data◊		Pastel Base
Vehicle Type		Proprietary Acrylic Latex
Pigment Type		Titanium Dioxide
Volume Solids		36%
Coverage per Gallon at Recommended Film Thickness		400 – 450 Sq. Ft.
Recommended Film Thickness	– Wet	3.8 mils
	– Dry	1.4 mils
Depending on surface texture and porosity. Be sure to estimate the right amount of paint for the job. This will ensure color uniformity and minimize the disposal of excess paint.		
Dry Time @ 77°F (25°C) @ 50% RH	– To Touch	1 Hour
	– To Recoat	1 to 2 Hours
Painted surfaces can be washed after two weeks. High humidity and cool temperatures will result in longer dry, recoat and service times.		
Dries By		Evaporation, Coalescence
Viscosity		100 ± 2 KU
Flash Point		None
Gloss / Sheen		Eggshell
Surface Temperature at Application	– Min.	50°F
	– Max.	90°F
Thin With		See Chart
Clean Up Thinner		Clean Water
Weight Per Gallon		11.3 lbs
Storage Temperature	– Min.	40°F
	– Max.	90°F

Volatile Organic Compounds (VOC)

83 Grams / Liter .69 LBS / Gallon

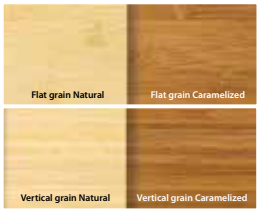
◊Reported values are for Pastel Base. Contact Benjamin Moore for values of other bases or colors.

Benjamin Moore & Co., 101 Paragon Drive, Montvale, NJ 07645 Tel: (201) 573-9600 Fax: (201) 573-9046 www.benjaminmoore.com M72 N319 US 100411

CSI #: 09 64 00

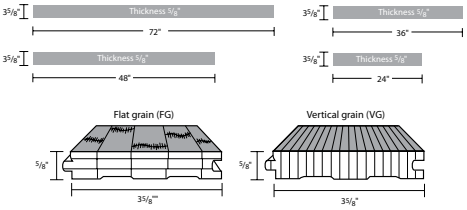
SIGNATURE NATURALS, Traditional solid-strip, prefinished, 3-5/8" x 5/8" x 24", 36", 48" and 72"

The width and lengths are comparable to any traditional hardwood floor and work beautifully with any design. Signature Naturals is 25% harder than red oak - ideal for any room in the home or workplace.



-Micro-bevel on all four sides
-Tongue and groove
-Nail, staple, or glue down

(92mm x 15mm x 620mm, 920mm, 1220mm, 1840mm)

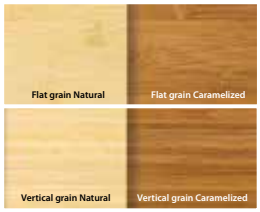


SIGNATURE NATURALS flat grain Caramelized

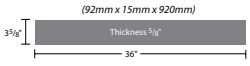
ELEMENTS, Solid-strip bamboo flooring in 3' lengths, 3-5/8" x 5/8" x 36"

ELEMENTS vertical grain Caramelized

Elements is designed to provide optimal affordability to homeowners as well as builders and developers. Wide color variation within and between planks highlights the natural contrast.



(92mm x 15mm x 920mm)



-Micro-bevel on all four sides
-Tongue and groove
-Each box contains all 36" lengths
-Nail, staple, or glue down

With a 16-year track record of providing high-quality bamboo products, Teragren is clearly the industry leader when it comes to bamboo flooring, panels and countertops.
– Keith Rosen, Gensler Architects (NYC)

CSI #: 09 64 00

PRODUCTS FOR COMPARISON

STRAND BAMBOO

PRODUCT	Portfolio Colors	Portfolio Naturals	Synergy® Wide Plank	Synergy® MPL	Synergy® 72
Length	72-1/2"	72-1/2"	72"	24", 36", 48", 72" in one carton	72"
Width	5"	5"	7-11/16"	3-3/4"	3-3/4"
Thickness	1/2"	1/2"	9/16"	1/2"	3/8"
Installation Method	Float	Float	Float	Nail/Glue	Glue
Construction	Solid Strand	Solid Strand	Cross-ply engineered strand	Solid Strand	Solid Strand
Milling	Micro-bevel	Micro-bevel	Square-edge	Micro-bevel	Micro-bevel
Profile	Fold-Down Locking	Fold-Down Locking	Self-locking	Tongue + Groove	Tongue + Groove
*Hardness Rating**	3271	3271	3271	3271	3271
3-part CSI Spec	✓	✓	✓	✓	✓
LEED	MR6; IEQ 4.3	MR6; IEQ 4.3	MR6; IEQ 4.3	MR6; IEQ 4.3	MR6; IEQ 4.3
Coordinating Stair Parts	✓	✓	✓	✓	✓
Finish Warranty	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial

TRADITIONAL BAMBOO

PRODUCT	Studio	Craftsman II	Signature Colors	Signature Naturals	Elements
Length	75"	75-1/2"	24", 36", 48", 72" in one carton	24", 36", 48", 72" in one carton	36"
Width	7-11/16"	5-1/2"	3-5/8"	3-5/8"	3-5/8"
Thickness	9/16"	5/8"	5/8"	5/8"	5/8"
Installation Method	Float	Nail/Staple/Glue or Float	Nail/Staple/Glue	Nail/Staple/Glue	Nail/Staple/Glue
Construction	Cross-ply engineered traditional	Solid Traditional	Solid Traditional	Solid Traditional	Solid Traditional
Milling	Square-edge	Micro-bevel	Micro-bevel	Micro-bevel	Micro-bevel
Profile	Self-locking	Tongue + Groove	Tongue + Groove	Tongue + Groove	Tongue + Groove
*Hardness Rating**	1492	1876	1876	1876	1876
3-part CSI Spec	✓	✓	✓	✓	✓
LEED	MR6; IEQ 4.3	MR6; MR7; IEQ 4.3	MR6; MR7; IEQ 4.3	MR6; MR7; IEQ 4.3	MR6; IEQ 4.3
Coordinating Stair Parts	✓	✓	✓	✓	✓
Finish Warranty	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	25-yr residential 10-yr commercial	7-yr residential 3-yr commercial

Division 10
Specialties

Division 11
Equipment

CSI #: 11 31 00

24" Recessed Handle Dishwasher

Benchmark™ Series – Stainless Steel SHE8PT55UC

BOSCH
Invented for life

SHE8PT55UC
Stainless Steel

Expandable wings on our flexible 3rd rack provide extra height to fit ramekins, measuring cups and extra-large utensils.

Features & Benefits
40 dBA: Quietest dishwasher brand.
A flexible 3rd rack with folding tines adds 30% more loading capacity.
The full-color TFT display is easy to read and easy to navigate.
A clean white light illuminates the interior when the door is open.
Water softener ensures optimally spot-free and shiny dishes.

General Properties	
Number of wash cycles	6
Number of options	5
dBA	40
Third rack	Flexible
Rack adjustability	RackMatic®
Tub material	Stainless steel
Control type	SteelTouch™ Control
Concealed heating element	Yes
Leak protection system	24/7 AquaStop®
Water softener	Yes
Five-level wash	Yes
ChildLock	No
Special features	TFT Display, Interior Light, Duo-Flex Silverware Basket, SpeedPerfect™

Efficiency	
Water usage per cycle	2.9
Energy efficiency class	Tier 1
ENERGY STAR® qualified	Yes
Total annual energy consumption (kWh)	259
Total annual water consumption (g)	624

Capacity	
Number of place settings	16

ENERGY STAR

Technical Details	
Watts (W)	1300 W
Current (A)	12 Amps
Volts (V)	120 V
Frequency (Hz)	60 Hz
Power cord length	56 5/16"
Minimum water pressure (lb/sin)	14
Length inlet hose (in)	60"
Length outlet hose (in)	79"

Dimensions & Weight	
Overall appliance dimensions (HxWxD) (in)	33 7/8" x 23 9/16" x 23 7/8"
Required cutout size (HxWxD) (in)	33 7/8" x 23 5/8" x 24"
Adjustable feet	Yes
Net weight (lbs)	109 lbs

Accessories–Optional	
Dishwasher Softener Salt (4.4 lbs)	SGZ9091UC
Dishwasher Supply and Drainage Hose Extension 76 3/4"	SGZ1010UC
Dishwasher 3-Prong Power Cord 66 7/8"	SMZPC002UC
Dishwasher Accessory Kit	SMZ5000

For help and assistance with Bosch accessories please visit: www.bosch-eshop.com/eshop/bosch/us or call 1-800-944-2904 Mon-Fri 5am to 6pm PST Sat 6am to 3pm PST

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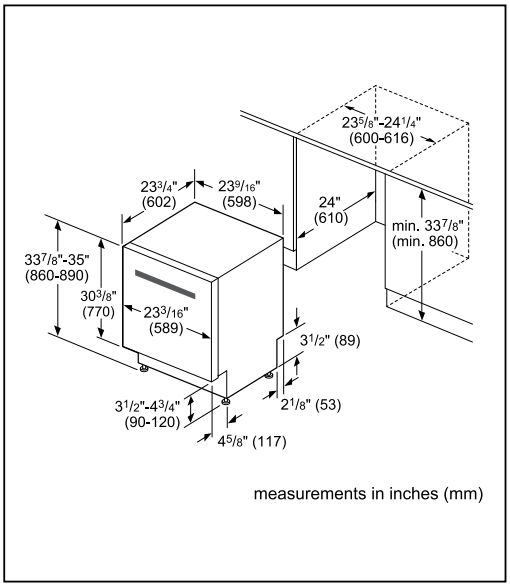
CSI #: 11 31 00

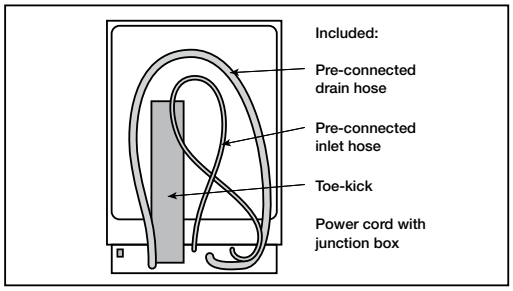
24" Recessed Handle Dishwasher

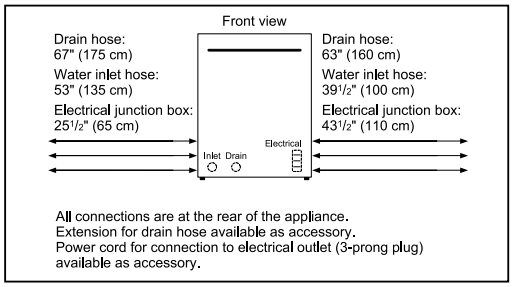
Benchmark™ Series – Stainless Steel SHE8PT55UC

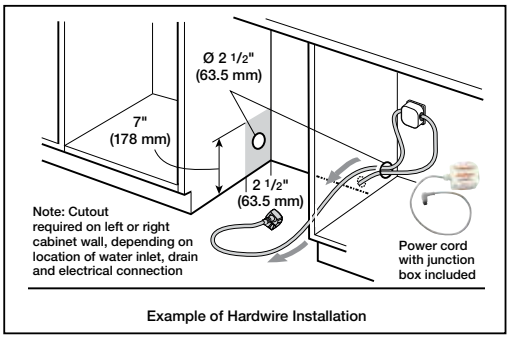
BOSCH
Invented for life

Installation Details

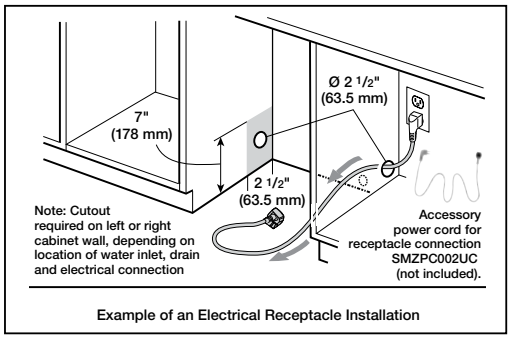








Example of Hardwire Installation



Example of an Electrical Receptacle Installation

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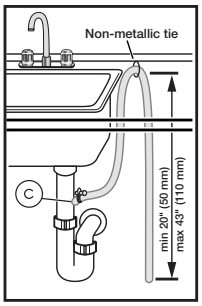

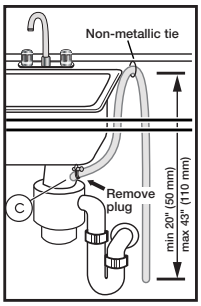

Note: Plumbing installations will vary - refer to local codes. Drain hose included is 79 (201 cm) and can be extended to a maximum of 155 3/4" (396 cm).

Always use the approved drain hose extension kit (SGZ1010UC).

Ensure a portion of the drain hose is raised between min. 20" (50 cm) and max. 43" (110 cm) above the cabinet floor.

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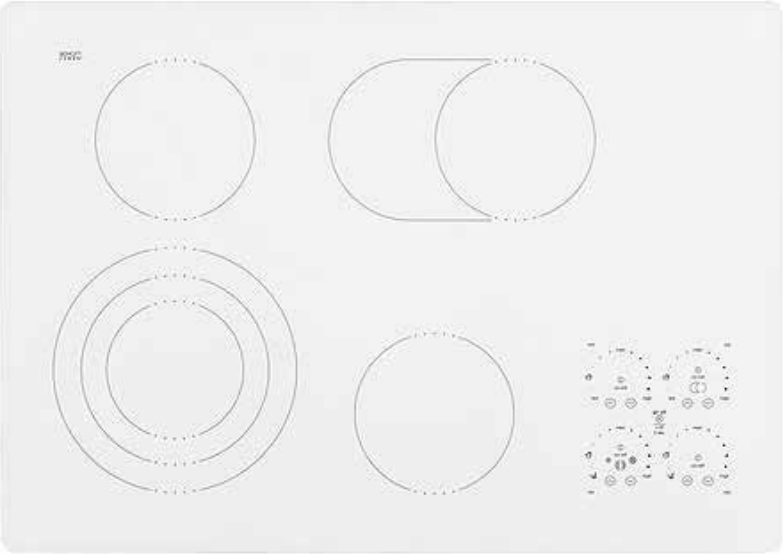


NUTID
Glass ceramic cooktop, white

Product dimensions
Depth: 21 1/4 “
Height: 3 “
Width: 30 3/8 “

Depth: 54.1 cm
Height: 7.6 cm
Width: 77.0 cm

Key features
- 5-year Limited Warranty. Read about the terms in the Limited Warranty brochure.
- Cooktop with cooking zones that heat evenly.
- Touch-control panel is easy to access and use, since it is placed in the front.
- A heat indicator shows when the cooking zone has cooled so that you are not in danger of burning yourself.
- Cooktop with 2 variable cooking zones that provide even and effective heating adapted to the shape and size of your cookware.

Designer:
IKEA of Sweden
Package measurements and weight
Packages: 1
Article Number: 701.826.19
Width: 24 1/4”
Height: 7 5/8”
Length: 35 3/4”
Weight: 37lb
Quantity: 1

CSI #: 11 31 00

DATID
Self-cleaning oven, Stainless steel

Product dimensions
Depth: 25 1/8 “
Height: 29 “
Width: 29 3/4 “

Depth: 63.8 cm
Height: 73.6 cm
Width: 75.5 cm

Key features
- 5-year Limited Warranty. Read about the terms in the Limited Warranty brochure.
- Fan-forced air convection oven function that combines top and bottom heating with the fan for even heating; ideal for baking cookies, tarts and other pastry.
- The self-cleaning function burns grease and food residue to ashes that you can easily brush off.
- 3 functions, i.e. all basic functions you will need for daily cooking.
- Oven with timer; can be preset to switch on and off at the time desired.
- The automatic lock prevents the door from being opened during self-cleaning at a high temperature.
- The oven emits a signal when it reaches the correct temperature and when the cooking time you have set has expired.

Designer:
IKEA of Sweden
Package measurements and weight
Packages: 1
Article Number: 501.822.05
Width: 31 1/2”
Height: 29 3/4”
Length: 35 1/2”
Weight: 146lb
Quantity: 1

Article Number: 501.822.05
Width: 80 cm
Height: 76 cm
Length: 90 cm
Weight: 66.2 kg
Quantity: 1

CSI #: 11 31 00

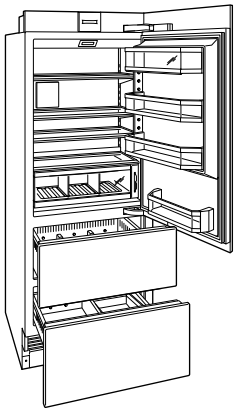
30" Integrated Combination—Tall

SUB-ZERO

subzero.com

FEATURES

- Upper cabinet refrigerator and two freezer storage drawers.
- Custom front panels and hardware allow for infinite design options.
- Integrated design allows for dual installation and point-of-use refrigeration.
- Dual refrigeration system ensures the freshest food and energy efficiency.
- Interactive smart-touch control panel.
- Internal dispenser provides ice and chilled water inside refrigerator (IT-30CIID).
- Air purification system reduces odors, bacteria, viruses and ethylene gas.
- Advanced water filtration system.
- LED lit interior.
- Adjustable nano-coated spill-proof glass shelves, door shelves and dairy compartment.
- High-humidity crisper drawer with adjustable dividers.
- Smooth-glide, full-extension freezer drawers with adjustable dividers.
- Door/drawer alarm and smart home features.
- Informational freshness cards.
- Automatic ice maker with max ice feature temporarily increases production.



Model IT-30CI

MODEL OPTIONS	
Combination	IT-30CI
Internal Dispenser	IT-30CIID

Specify RH or LH door.

INTERIOR FEATURES
REFRIGERATOR
3 Adjustable glass shelves
1 Stationary shelf
Crisper drawer with 2 adjustable dividers
Adjustable dairy compartment
2 Adjustable door shelves
1 Stationary door shelf
FREEZER
3 Adjustable drawer dividers
Removable ice container
Automatic ice maker

ACCESSORIES

- Stainless steel front panels with tubular or pro handles.
- Stainless steel tubular and pro handles.
- Dual installation kit for installation with column, tall or drawer model.
- Stainless steel kickplate.
- Dozen egg container.
- Replacement air purification cartridge and water filter.

Accessories available through an authorized Sub-Zero dealer. For local dealer information, visit the find a showroom section of our website, subzero.com.

CSI #: 11 31 00

30" Integrated Combination—Tall

SUB-ZERO

subzero.com

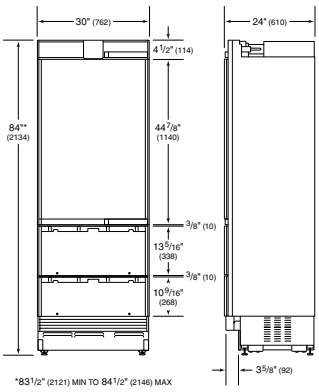
SPECIFICATIONS	
PRODUCT	
Dimensions	30"W x 84"H x 24"D
Door Clearance	28 1/2"
Weight	400 lb
CAPACITY	
Refrigerator	10.6 cu ft
Freezer	5.0 cu ft
ELECTRICAL	
Supply	115 VAC, 60 Hz
Service	15 amp circuit
PLUMBING	
Supply	1/4" OD copper, braided stainless steel or PEX tubing
Pressure	35–120 psi

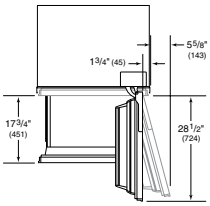
Product dimensions do not include panels or handles and will vary with panel thickness. Allow for panel thickness when planning the finished opening depth.

Specifications are subject to change without notice. Visit subzero.com/specs for the most up-to-date information.

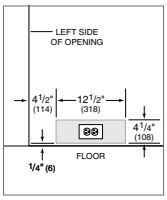
Dimensions may vary ±1/8" (3). Dimensions in parentheses are millimeters unless otherwise specified.

DIMENSIONS

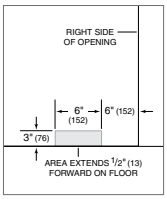




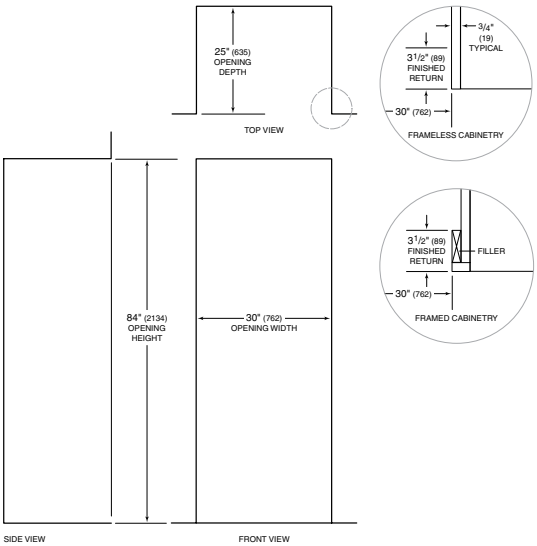
ELECTRICAL



PLUMBING



INSTALLATION



NOTE: 3 1/2" (89) finished returns will be visible and should be finished to match cabinetry.

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6/2014

CSI #: 11 31 00

24" Compact Washer

Axxis® Plus - White WAP24202UC

BOSCH
Invented for life

WAP24202UC
White

Bosch compact washers offer one of the fastest washing cycles on the market. Wash 5 men's dress shirts in just 15 minutes.

Features & Benefits
Aqua Stop® leak protection works 24/7 to prevent water damage.
Wash 5 men's dress shirts in just 15 minutes.
The droplet-shaped drum delivers a powerful yet gentle wash.
ActiveWater adjusts to your specific load for an efficient wash cycle.
Rigid AntiVibration side walls reduce noise by up to 30%.

General Properties	
Tub material	Stainless Steel
Maximum spin speed (rpm)	1,200
Leak protection systems	AquaStop™ Hose & Sensor
Internal water heater	Yes
Stackable	Yes
Silence level - washing (dBA)	59
Silence level - spinning (dBA)	73
Special cycles	Super quick 15 min., Mixed
Energy consumption (kWh/yr)	135
Water consumption (gal/y)	3,640
ENERGY STAR® qualified	Yes
CEE	Tier 2
Capacity	
Capacity (cu. ft.)	2.2 cu. ft.
Relative load	18 bath towels
Design Elements	
Door ring	Chrome
Control buttons	Chrome
Dial	Chrome

Technical Details	
Watts (W)	2,300 W
Circuit breaker (A)	20
Volts (V)	208/220-240
Frequency (Hz)	60
Plug type	240V; NEMA 6-15 (3 prong)
Power cord included	Yes
Power cord length (in)	61 (Full Length)
Drain hose length (in)	57 (Full Length)
Inlet hose length (in)	59 (Full Length)
Door hinge	Left Side (Not Reversible)
Dimensions & Weight	
Overall appliance dimensions (HxWxD) (in)	33 1/4" x 23 1/2" x 25"
Net weight (lbs)	170 lbs
Minimum stack height (in)	67 3/4"
ADA compliant	Yes, When installed on a Bosch pedestal.
Accessories–Optional	
Pedestal	WMZ20490
Short Stainless Steel Hose (If needed for plumbing box clearance with AQS hose)	P/N 645787

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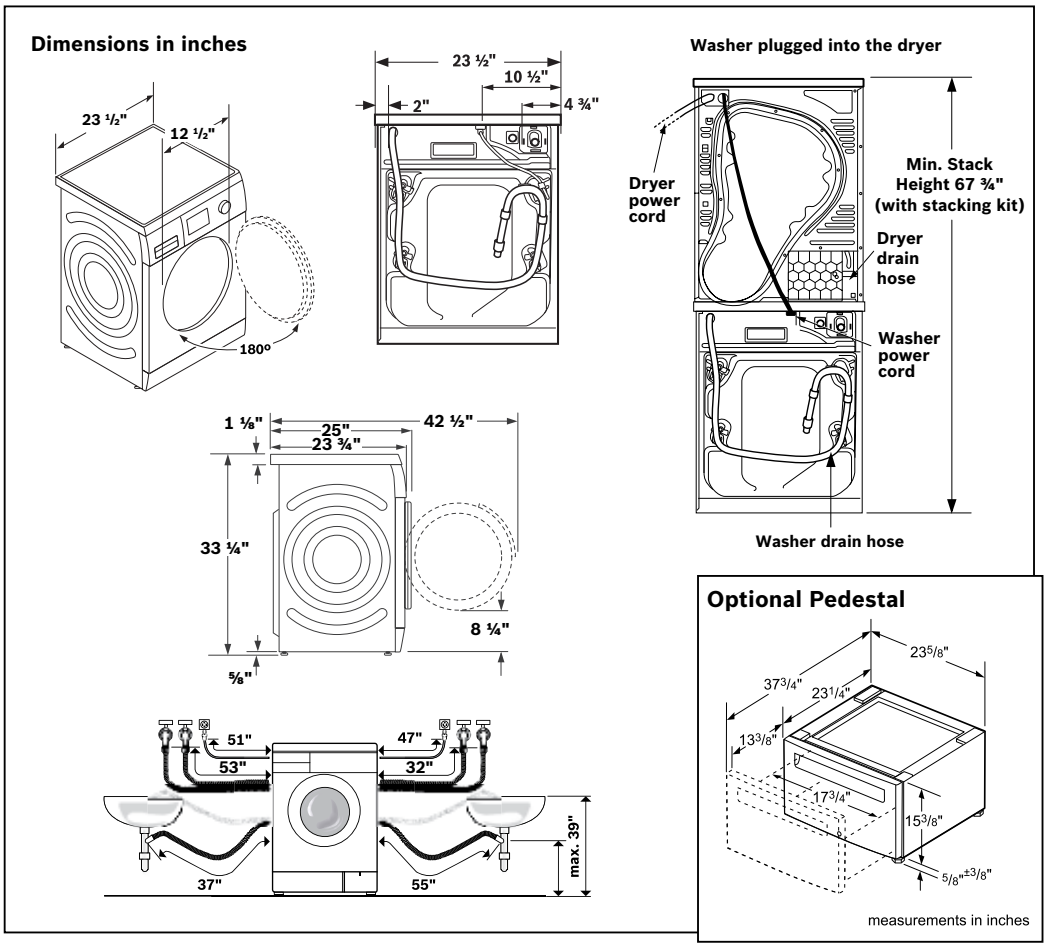
CSI #: 11 31 00

24" Compact Washer

Axxis® Plus - White WAP24202UC

BOSCH
Invented for life

Installation Details



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CSI #: 11 31 00

24" Compact Washer

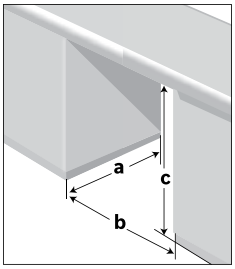
Axxis® Plus - White WAP24202UC

BOSCH
Invented for life

Installation Details

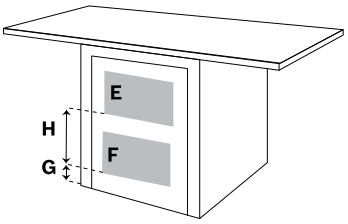
Enclosure Dimensions

Under Counter: (Preferred)



Front of the appliance fully open. No doors or coverings.

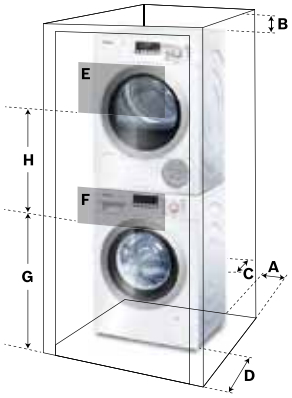
Under Counter: (Less Preferred)



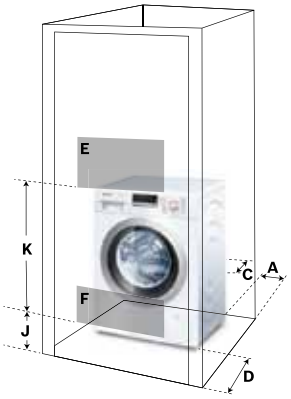
If front of the appliance is covered, ventilation openings must be installed.

Minimum opening dimensions	
a	23 7/8 in.
b	23 7/8 in.
c	33 1/2 in.
E & F are minimum area sizes	
E	63 sq. in.
F	63 sq. in.
G & H actual spacing dimensions for min. open area sizes	
G	3 in.
H	14 in.

Closet: Stacked



Closet: Stand Alone (shown) or Side by Side



Clearance requirements (Minimum)	
A Both Sides	5/8 in.
B Top	6 1/4 in.
C Rear	3 1/4 in.
D Front	3 1/2 in.
Ventilation Area (Minimum)	
E Top	63 sq. in
F Bottom	63 sq. in.
Vent Spacing	
G	37 in.
H	26 in.
J	3 in.
K	29 in.

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CSI #: 11 31 00

Design

Design options

The Bosch compact laundry pairs feature matching washer and dryer designs across the different series. The series specific design accents include white, silver or chrome control knobs, buttons and door ring.

Axxis+ Washer
WAP24202UC

Axxis+ Dryer
WTB86202UC

LED Control Panel

The sleek design is apparent in the larger LED control panel which is easier to read and operate.

Bosch Magneto

The compact laundry units feature the iconic Bosch Magneto*.

*On Axxis and Axxis+ models only.

Design step up features

Ascenta Washer
WAP24200UC

Ascenta Dryer
WTB86200UC

Axxis® Washer
WAP24201UC

Axxis® Dryer
WTB86201UC

Axxis+ Washer
WAP24202UC

Axxis+ Dryer
WTB86202UC

Ascenta Series	Axxis	Axxis+
White design accents	+ Silver design accents	+ Chrome design accents
Stainless steel structured drum for washer	+ Stainless steel structured drum for washer and dryer	+ Interior light for dryer
Large LED display	+ Bosch Magneto on the door	
	+ Reversible dryer door	

2 |

CSI #: 11 31 00

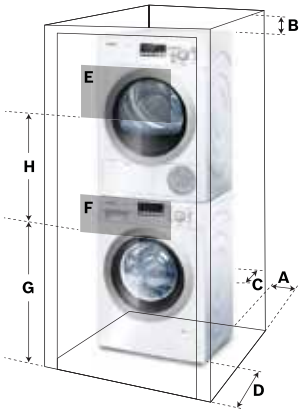
Compact Dryer Technical Details

Series	Ascenta Condensation Dryer	Axxis® Condensation Dryer	Axxis® Plus Condensation Dryer
Color			
White	WTB86200UC	WTB86201UC	WTB86202UC
Core Features			
Capacity (cu ft)	4.0 cu ft	4.0 cu ft	4.0 cu ft
Drying Capability	16 towels	18 towels	18 towels
Silence Rating	65 dBA	65 dBA	65 dBA
Number of Drying Programs	15	15	15
Number of Drying Options	6	6	6
Design Elements			
Display	Large LED Display	Large LED Display	Large LED Display
Cabinet	White	White	White
Dial and Buttons	White	Silver	Chrome
Door	White	Silver	Chrome
Bosch Magneto		■	■
See-thru Door	■	■	■
Drum	Galvalume Drum	One Piece Stainless Steel, Structured Drum	One Piece Stainless Steel, Structured Drum
Programs	15	15	15
Cotton Extra Dry	■	■	■
Cotton Dry (Regular)	■	■	■
Cotton Damp	■		
Permanent Press Extra Dry	■	■	■
Permanent Press Dry	■	■	■
Permanent Press Damp	■		
Sanitary	■		
Jeans	■	■	■
Quick Dry	■	■	■
Air Fluff/No Heat	■	■	■
Time Dry	■	■	■
Time Program 40 Hot	■	■	■
Delicates	■	■	■
Heavy Duty	■		
Super Quick 15 min			■
Active Wear		■	■
Anti-shrink		■	
Woolens	■	■	■
Towels		■	
Iron Dry		■	■
Mixed			■
Options	6	6	6
Time Dry	■	■	■
Dry Level	■	■	■
Finished in	■	■	■
Low Heat	■	■	■
WrinkleBlock®	■	■	■
Signal	■	■	■
Advanced Features			
Control Types	Electronic	Electronic	Electronic
Unique Structured Drum	■	■	■
WrinkleBlock®	Up to 60 min	Up to 60 min	Up to 60 min
Fully Electronic Moisture Sensor	■	■	■
Reversible Door		■	■
Interior Light			■
Lint Filter Indicator	■	■	■
Dimensions			
Product HxWxD	33 ¼"x 23 ½"x 25"	33 ¼"x 23 ½"x 25"	33 ¼"x 23 ½"x 25"
Packaging HxWxD	34 ¼"x 25 ¼"x 26 ¾"	34 ¼"x 25 ¼"x 26 ¾"	34 ¼"x 25 ¼"x 26 ¾"
Minimum Staking Height	67 ¾"	67 ¾"	67 ¾"
Leveling Legs/Height Adjustment Range	Yes, ⅝"	Yes, ⅝"	Yes, ⅝"
Weight	99 lb	99 lb	99 lb
Shipping Weight	101 lb	101 lb	101 lb
Door Opening (Angle)	180°	180°	180°
Technical Information			
Supply Voltage	208/220-240 V	208-240 V	208-240 V
Frequency	60 Hz	60 Hz	60 Hz
Connected Load	2,800 W	2,800 W	2,800 W
Amperage	13 A	13 A	13 A
Required Circuit Amperage	30 A	30 A	30 A
Air-Flow–Intake	118 CFM (200 m³/h)	118 CFM (200 m³/h)	118 CFM (200 m³/h)
Plug Included	NEMA 14-30 (4-prong)	NEMA 14-30 (4-prong)	NEMA 14-30 (4-prong)
Type	Electric	Electric	Electric
Drain Pump and Hose	Yes, Dryer and Washer Drain Hoses Routed Together	Yes, Dryer and Washer Drain Hoses Routed Together	Yes, Dryer and Washer Drain Hoses Routed Together

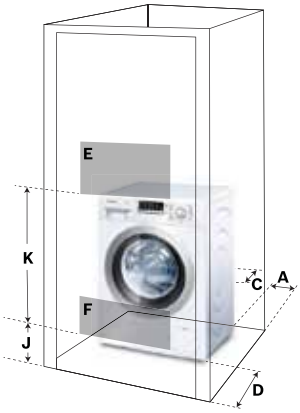
CSI #: 11 31 00

Dimensions and Installation

Closet: Stacked

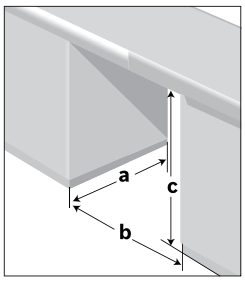


Closet: Stand Alone (shown) or Side by Side



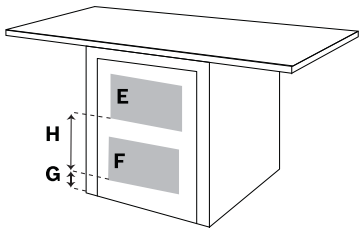
Clearance requirements (Minimum)	
A Both Sides	5/8 in.
B Top	6 1/4 in.
C Rear	3 1/4 in.
D Front	3 1/2 in.
Ventilation Area (Minimum)	
E Top	63 sq. in
F Bottom	63 sq. in.
Vent Spacing	
G	37 in.
H	26 in.
J	3 in.
K	29 in.

Under Counter: (Preferred)



Front of the appliance fully open. No doors or coverings.

Under Counter: (Less Preferred)



If front of the appliance is covered, ventilation openings must be installed.

Minimum opening dimensions	
a	23 7/8 in.
b	23 7/8 in.
c	33 1/2 in.
E & F are minimum area sizes	
E	63 sq. in.
F	63 sq. in.
G & H actual spacing dimensions for min. open area sizes	
G	3 in.
H	14 in.

ADA Compliant

Bosch washer and dryers are ADA compliant and offer easy to access doors when they are installed on pedestals.

13 |

Division 12
Furnishings

Division 13

Special Construction

CSI #: 13 48 53

Central Piers Inc.
PO Box 11333
Fresno CA 93772
800-653-0387
centralpiers.com

CP-Seismic Pier™

The Patented CP-Seismic Pier™ with its versatility, strength, and ease of installation makes it a popular choice with contractors and homeowners. Our CP-Seismic Pier™ is designed for Foundation, Tiedown and E.R.B.S. Systems, designed for ease of installation thus saving valuable labor costs. We offer the CP-Seismic Pier™ with either a Reinforced Concrete Pad, Pressure Treated 3/4" Plywood Pad or Anchor Bolts or for wet or dry concrete installations. Frame attachments available for I-beam, C-Channel, J-Channel and Box Frame installation.

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Central Piers Inc.
PO Box 11333
Fresno CA 93772
800-653-0387
centralpiers.com

Complete CP Seismic Pier™ with all Components

CP-Seismic Pier
On **Concrete** Pad
112 - 7" Pier
89 - 11"Pier
96 - 18" Pier
104 - 19" Pier

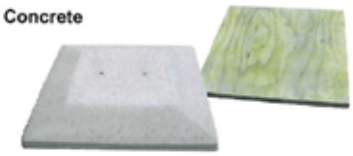
CP-Seismic Pier
On **Plywood** Pad
113- 7" Pier
91- 11"Pier
98 - 18" Pier
105 - 19" Pier

CP-Seismic **Perimeter** Pier
On **Concrete** Pad
1981- 7" Pier
90- 11"Pier
97 - 18" Pier
109 - 19" Pier

CP-Seismic **Perimeter** Pier
On **Plywood** Pad
116- 7" Pier
94- 11"Pier
101 - 18" Pier
106 - 19" Pier

Each Complete CP-Seismic Pier™ comes with:

Predrilled Pressure Treated Plywood Pad or Pre-cast Concrete



CP-Seismic Pier™ Base and Pipe

3 X 3 Plates

Hard Ware Kit

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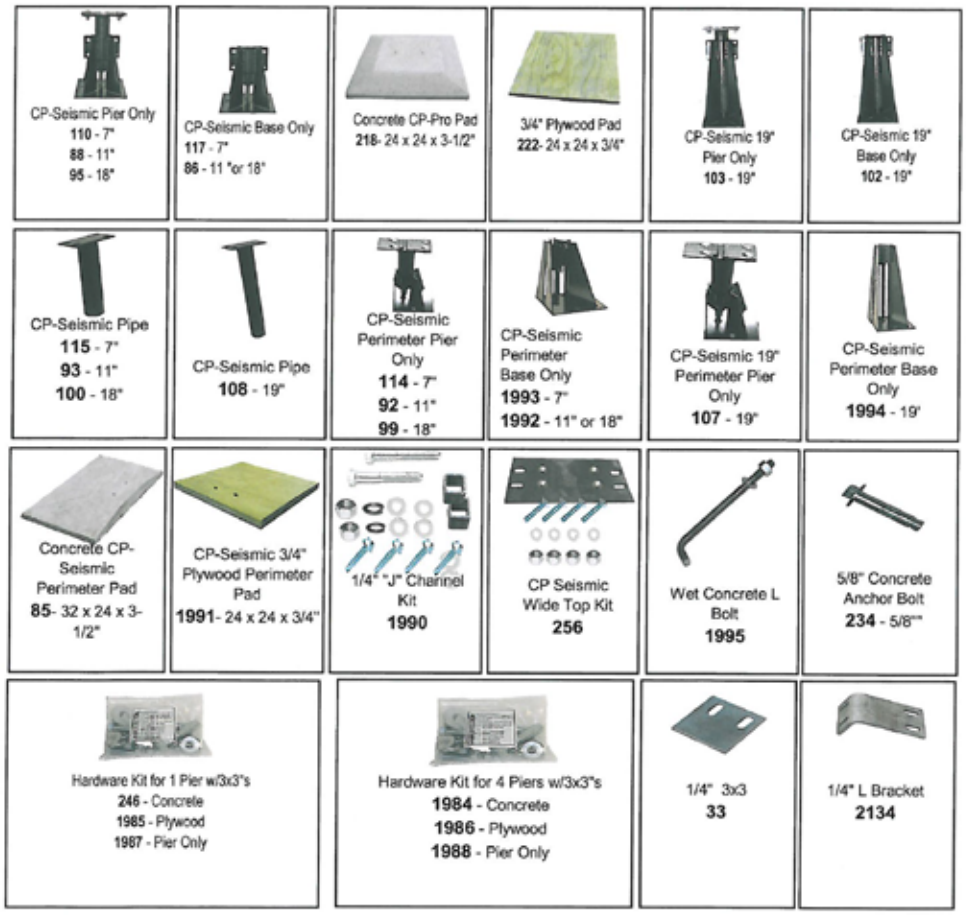
Individual Components



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Height Adjustment Charts

Concrete Pad *(Beam to Ground)*

7" Pier Adjusts	10 1/2"	to	13 1/2"
11" Pier Adjusts	14 1/2"	to	21 1/2"
18" Pier Adjusts	19 1/2"	to	26 1/2"
19" Pier Adjusts	22 1/2"	to	36"(max height)

Plywood Pad *(Beam to Ground)*

7" Pier Adjusts	7 3/4"	to	10 3/4"
11" Pier Adjusts	11 3/4"	to	18 3/4"
18" Pier Adjusts	16 3/4"	to	23 3/4"
19" Pier Adjusts	19 3/4"	to	33 3/4"

In-Ground System *(Beam to Ground)*

7" Pier Adjusts	7"	to	10"
11" Pier Adjusts	11"	to	18"
18" Pier Adjusts	16"	to	23"
19" Pier Adjusts	19"	to	33"

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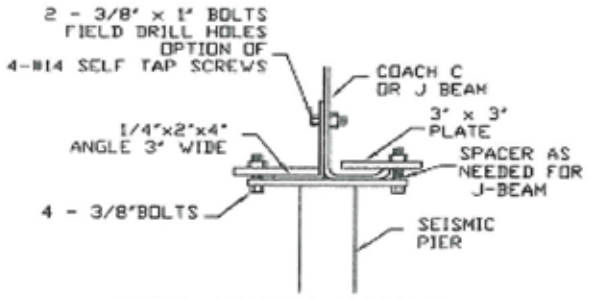
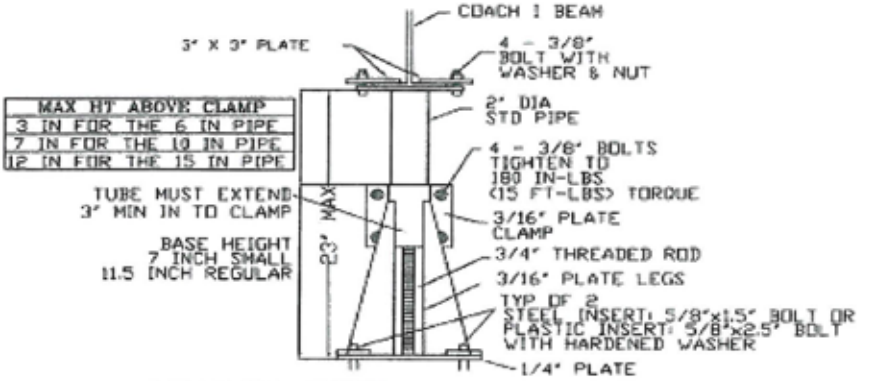
Technical Drawing



TYP BEAM CONNECTION

Not to Scale



MAX HT ABOVE CLAMP
3 IN FOR THE 6 IN PIPE
7 IN FOR THE 10 IN PIPE
12 IN FOR THE 15 IN PIPE

SEISMIC PIER Not to Scale

C.P. SEISMIC PIER#1-PATENT #5595366
LISTING #C03-044-60F BY BSK

CSI #: 13 48 53

Central Piers Inc.
PO Box 11333
Fresno CA 93772
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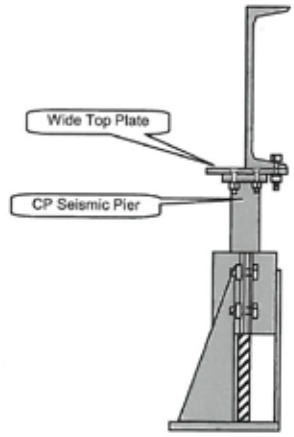
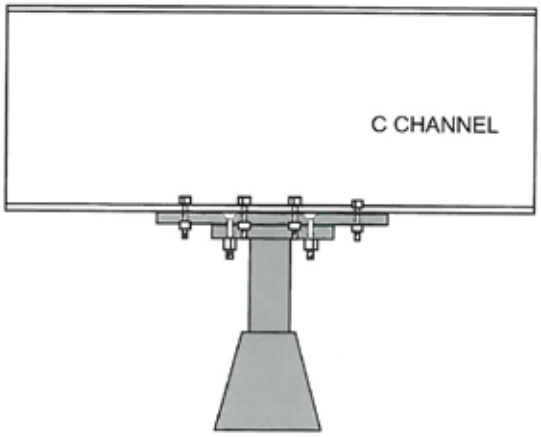
We can accommodate all types of beam connections and alternative frame attachments.



Sample Illustrations.



Division 14

Conveying Equipment

Division 21

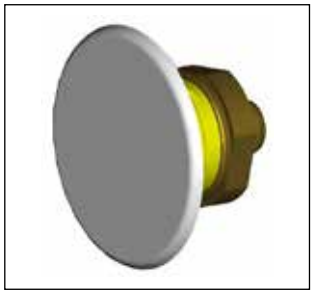
Fire Supression

CSI #: 21 13 13

VIKING	TECHNICAL DATA	FREEDOM® RESIDENTIAL CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK480

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION



Viking Freedom® Residential Concealed Horizontal Sidewall Sprinkler VK480 is a small high-sensitivity solder link and lever residential sprinkler designed for installation on concealed pipe systems, where the appearance of a smooth wall is desired. The sprinkler orifice design, with a K-Factor of 4.0 (57.7 metric*), allows the sprinkler's efficient use of available water supplies for the hydraulically designed fire-protection system. The operating element and special deflector characteristics meet the challenges of residential sprinkler standards.

The sprinkler is hidden from view by a low profile, small diameter cover plate installed flush to the wall. The cover plate is available in several decorative finishes to meet design requirements. The two-piece design allows installation and testing of the sprinkler prior to installation of the cover plate. After the system has been tested and wall finish has been applied, the push-on design of the cover plate assembly allows easy installation of the cover plate with up to 1/4" (6.4 mm) adjustment. Sprinkler VK480 is provided with a pipe guide to properly locate the sprinkler and allow the 1/4" adjustment of the cover plate.

2. LISTINGS AND APPROVALS

cULus Listed: Category VKKW (VK480)

Refer to the Approval Chart and Design Criteria on page 153c for cULus Listing requirements that must be followed.

3. TECHNICAL DATA

Specifications:
Available since 2010.
Minimum Operating Pressure: Refer to the Approval Chart.
Maximum Working Pressure: 175 psi (12 bar). Factory tested hydrostatically to 500 psi (34.5 bar).
Thread size: 1/2" (15 mm) NPT
Nominal K-Factor: 4.0 U.S. (57.7 metric*)

* Metric K-factor measurement shown is in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.

Available Cover Plate Horizontal Adjustment: 1/4" (6.4 mm)
Overall Length (Sprinkler Body): 2" (50 mm)
Patents Pending

Material Standards:
Sprinkler Body: QM Brass and Brass UNS-C84400
Belleville Spring Sealing Assembly: Nickel Alloy, coated on both sides with Teflon Tape
Seat: Brass UNS-C31400
Deflector Ring: Brass UNS-C23000
Deflector Pins: Stainless Steel UNS-S30200
Halo: Brass UNS-C31400 or Phosphor Bronze UNS-C51000
Flow Shaper: Phosphor Bronze UNS-C51000
Lever Bar Ring: Brass UNS-C31400 or Brass UNS-C84400
Compression Screw: 18-8 Stainless Steel
Fusible Link Assembly: Nickel Alloy and Eutectic Solder
Fusible Link Levers: Stainless Steel UNS-S31600
Guide Pin: Stainless Steel UNS-S43000
Shipping Cap: Polyethylene

Viking Technical Data may be found on The Viking Corporation's Web site at http://www.vikinggroupinc.com. The Web site may include a more recent edition of this Technical Data Page.

Cover Assembly Materials:
Cover Plate Assembly: Copper UNS-C11000 and Brass UNS-C26800
Spring: Beryllium Nickel
Solder: Eutectic

Ordering Information: (Also refer to the current Viking price list.)
Viking Freedom® Residential Concealed HSW Sprinkler VK480 and Cover Plate Assembly must be ordered separately:
Sprinkler: Part No. 16116AC (includes a 165 °F (74 °C) rated sprinkler with a protective plastic cap covering the unit).

Form No. F_121609

Replaces page 153a-f, dated August 4, 2011. (Revised sprinkler materials and added reference to TIA 1028R.)

CSI #: 21 13 13

VIKING	TECHNICAL DATA	FREEDOM® RESIDENTIAL CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK480

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Cover Plate Assembly: Base Part No. 16207 (3-5/16" diameter)
Specify finish and temperature rating of the cover plate assembly by adding the appropriate suffixes for the finish and the cover temperature rating to the base part number:
Finish Suffix: Painted White = M-/W
Temperature Suffix: 135 °F (57 °C) = A
For example, cover 16207 with a White Painted finish and a 135 °F (57 °C) temperature rating = 16207MA/W.
Available Finishes And Temperature Ratings: Refer to Table 1.
Accessories: (Also refer to the "Sprinkler Accessories" section of the Viking data book.)
Sprinkler Wrenches:**
A. Heavy Duty Wrench Part No. 16208W/R** (available since 2010)
B. Head Cabinet Wrench Part Number 16267*** (available since 2010)
C. Optional Large Concealed Cover Plate Installer Tool Part No. 14867 (available since 2007)
**Requires a ½" ratchet (not available from Viking).
***Ideal for sprinkler cabinets.
Sprinkler Cabinet: Part No. 01731A (available since 1971)

4. INSTALLATION
Refer to appropriate NFPA Installation Standards. For NFPA 13D horizontal ceiling criteria and slopes, refer to TIA 1028R for slope ceiling criteria exceptions.

5. OPERATION
During fire conditions, when the temperature around the sprinkler approaches its operating temperature, the cover plate detaches. Continued heating of the exposed sprinkler causes the fusible element to disengage, releasing the sealing assembly. Water flowing through the sprinkler orifice strikes the flow shaper, forming a uniform spray pattern over a specific area of coverage determined by the water supply pressure at the sprinkler to extinguish or control the fire.

6. INSPECTIONS, TESTS AND MAINTENANCE
Refer to NFPA 25 for Inspection, Testing and Maintenance requirements.

7. AVAILABILITY
Viking Freedom® Residential Concealed Horizontal Sidewall Sprinkler VK480 is available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

Identification of Custom Paint Color:
All custom color painted cover plates will have an identifying label affixed to the inside of the cover that indicates custom color and will have a representative sample (a paint dot) of the paint on the label.

Figure 1: Identification of Custom Paint Color for Concealed Covers

8. GUARANTEE
For details of warranty, refer to Viking's current list price schedule or contact Viking directly.

TABLE 1: AVAILABLE SPRINKLER TEMPERATURE RATINGS AND FINISHES

Sprinkler Temperature Classification	Sprinkler Nominal Temperature Rating[1]	Maximum Ambient Ceiling Temperature[2]	Temperature Rating of the Cover Assembly (Required)	Cover Plate Base Part Number[3]
Ordinary	165 °F (74 °C)	100 °F (38 °C)	135 °F (57 °C)	16207
Cover Plate Finish: Painted White				

Footnotes
[1] The sprinkler temperature rating is stamped on the inlet.
[2] Based on NFPA-13, NFPA 13R, and NFPA 13D. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.
[3] Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.

CSI #: 21 13 13

VIKING	TECHNICAL DATA	FREEDOM® RESIDENTIAL CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK480

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Approval Chart

Residential Concealed Horizontal Sidewall Sprinkler VK480
For systems designed to NFPA 13D[7] or NFPA 13R.
For systems designed to NFPA 13, refer to the design criteria below.

Sprinkler Temperature Rating
Cover Plate Temperature Rating
AW1 Cover Plate Finish KEY

Sprinkler Part Number[1]	SIN	NPT Thread Size		Nominal K-Factor		Maximum Water Working Pressure
		Inches	mm	U.S.	metric[2]	
16116AC	VK480	1/2	15	4.0	57.7	175 psi (12 bar)

Maximum Areas of Coverage[6] Width x Length	Minimum Water Supply Requirements[6]	Listings and Approvals[3] (Refer also to Design Criteria below.)		
		cULus[4]	NYC	NSF
Installed below smooth, flat, horizontal ceilings, includes ceilings with slopes up to and including 2/12 (9.5°). With the centerline of the sprinkler located between 4-3/8" and 6-3/8" (112 mm and 162 mm) below the ceiling.				
12 ft. x 12 ft. (3.7 m x 3.7 m)	11 gpm @ 7.6 psi (41.7 L/min @ 0.52 bar)	AX1	See Footnote 5.	--
14 ft. x 14 ft. (4.3 m x 4.3 m)	13 gpm @ 10.6 psi (49.3 L/min @ 0.73 bar)	AX1	See Footnote 5.	--
16 ft. x 16 ft. (4.9 m x 4.9 m)	16 gpm @ 16 psi (60.6 L/min @ 1.1 bar)	AX1	See Footnote 5.	--
16 ft. x 18 ft. (4.9 m x 5.5 m)	17 gpm @ 18.1 psi (64.4 L/min @ 1.25 bar)	AX1	See Footnote 5.	--
Installed below smooth, flat, horizontal ceilings, includes ceilings with slopes up to and including 2/12 (9.5°). With the centerline of the sprinkler located between 6-3/8" and 12-3/8" (162 mm and 314 mm) below the ceiling.				
12 ft. x 12 ft. (3.7 m x 3.7 m)	12 gpm @ 9 psi (45.5 L/min @ 0.62 bar)	AX1	See Footnote 5.	--
14 ft. x 14 ft. (4.3 m x 4.3 m)	14 gpm @ 12.3 psi (53 L/min @ 0.84 bar)	AX1	See Footnote 5.	--
16 ft. x 16 ft. (4.9 m x 4.9 m)	16 gpm @ 16 psi (60.6 L/min @ 1.1 bar)	AX1	See Footnote 5.	--
16 ft. x 18 ft. (4.9 m x 5.5 m)	18 gpm @ 20.3 psi (68.1 L/min @ 1.4 bar)	AX1	See Footnote 5.	--

Sprinkler Temperature Rating	Cover Temperature Rating	Cover Plate Finish
A - 165 °F (74 °C)	X - 135 °F (57 °C) Cover Part No. 16207[1]	1 - Painted White[8]

Footnotes

[1] For complete part number, also refer to current Viking price list schedule.
[2] Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.
[3] This chart shows the listings and approvals available at the time of printing. Other approvals may be in process. Check with the manufacturer for any additional approvals.
[4] Sprinkler VK480 is Listed by Underwriter's Laboratories for use in the U.S. and Canada.
[5] Meets New York City requirements, effective July 1, 2008.
[6] For areas of coverage smaller than shown, use the "Minimum Water Supply Requirement" for the next larger area listed. Flows and pressures listed are per sprinkler. The distance from sprinklers to walls shall not exceed one-half the sprinkler spacing indicated for the "Minimum Water Supply Requirement" used.
[7] Refer to TIA 1028R slope ceiling criteria exceptions.
[8] Other paint colors are available on request with the same listings as the standard finish colors. Listings and approvals apply for any paint manufacturer. Contact Viking for additional information. Custom colors are indicated on a label inside the cover assembly. Refer to Figure 1.

DESIGN CRITERIA

(Also refer to the Approval Chart above.)

cULus Listing Requirements:

When using Viking Residential Concealed Horizontal Sidewall Sprinkler VK480 for systems designed to NFPA 13D or NFPA 13R, apply the listed areas of coverage and minimum water supply requirements shown in the Approval Chart above.

For systems designed to NFPA 13: The number of design sprinklers is to be the four contiguous most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in the Approval Chart above for NFPA 13D and NFPA 13R applications for each listed area of coverage, **or**
- Calculated based on a minimum discharge of 0.1 gpm/sq. ft. over the "design area" in accordance with sections 8.5.2.1 or 8.6.2.1.2 of NFPA 13.
- **THE TOP OF THE SPRINKLER BODY AND THE TOP OF THE INSTALLATION WRENCH ARE MARKED "TOP".** Orient the top of the sprinkler element parallel with the ceiling as shown in Figure 3.
- Minimum distance between residential sprinklers: 8 ft. (2.4 m).

NOTE: Concealed sprinklers must be installed in neutral or negative pressure plenums only.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to pages RES1-17 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA and any other similar Authorities Having Jurisdiction, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable. Final approval and acceptance of all residential sprinkler installations must be obtained from the Authorities Having Jurisdiction.

CSI #: 21 13 13

VIKING	TECHNICAL DATA	FREEDOM® RESIDENTIAL CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK480

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Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

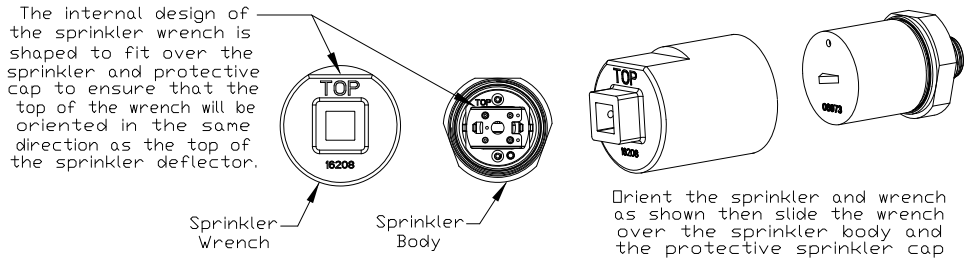


Figure 2: Sprinkler VK480 Installation and Correct Use of Wrench

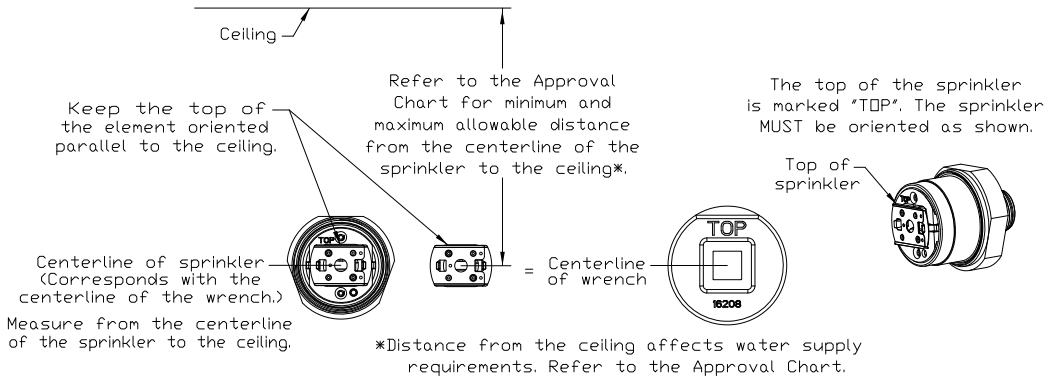


Figure 3: Sprinkler VK480 Correct Deflector Orientation

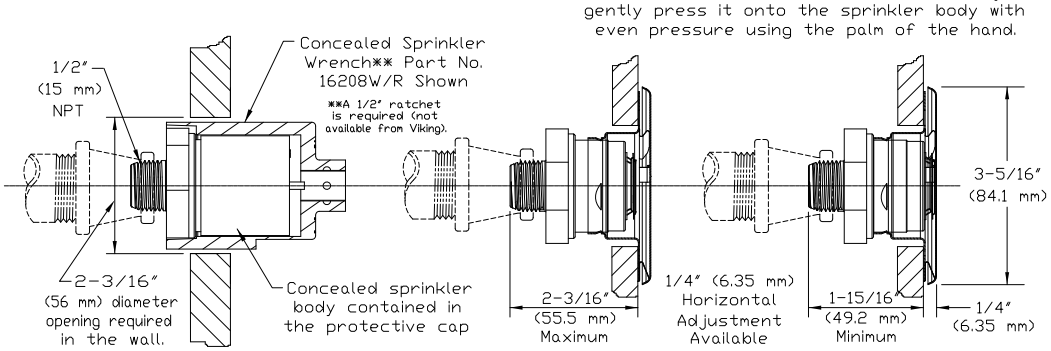
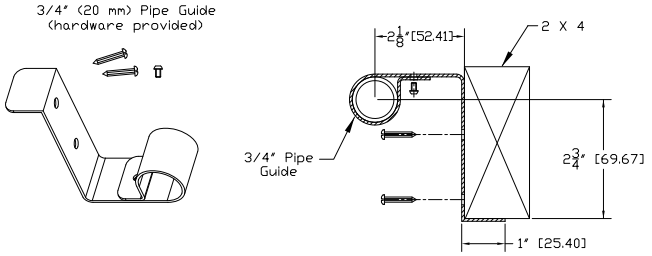


Figure 4: Sprinkler VK480 Dimensions and Cover Installation

CSI #: 21 13 13

VIKING	TECHNICAL DATA	FREEDOM® RESIDENTIAL CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK480

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com



NOTE: To ensure that the sprinkler is located the correct distance from the face of the finished wall, use the pipe guide (included with Sprinkler VK480) and attach it to the 3/4" CPVC pipe and the 2 x 4 inside the wall as shown.

All piping, hangers/bracing must be installed in accordance with NFPA 13.

Figure 5: Sprinkler VK480 Pipe Guide

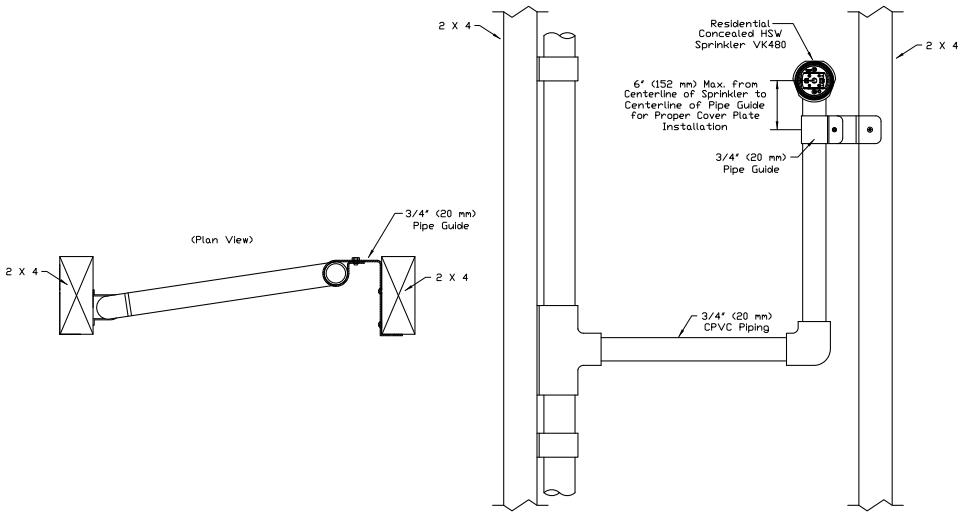


Figure 6: Sprinkler VK480 Pipe Guide Installation Instructions

CSI #: 21 13 13

VIKING®	TECHNICAL DATA	QUICK RESPONSE CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK481

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION

Viking Quick Response Concealed Horizontal Sidewall Sprinkler VK481 is a small solder link and lever spray sprinkler designed for installation on concealed pipe systems. The sprinkler is hidden from view by a low profile, small diameter cover plate installed flush with the wall.

The two-piece design allows installation and testing of the sprinkler prior to installation of the cover plate. The "push-on", "pull-off" design of the concealed cover plate assembly allows easy installation of the cover plate after the system has been tested and finish has been applied to the wall, while also permitting up to ¼" (6.4 mm) of horizontal adjustment. The cover assembly can be removed and reinstalled, allowing access behind the wall without taking the sprinkler system out of service and removing the sprinkler.

SPECIAL FEATURES:

- **Designed for Light Hazard and Ordinary Hazard Occupancies**

2. LISTINGS AND APPROVALS

cULus Listed: Category VNIV
Refer to the Approval Chart on page 63j and Design Criteria on page 63k for cULus Listing requirements that must be followed.

3. TECHNICAL DATA

Specifications:
Available since 2012.
Minimum Operating Pressure: 7 psi (0.5 bar)
Rated to 175 psi (1 207 kPa) water working pressure.
Thread size: 1/2" (15 mm) NPT
Nominal K-Factor: 5.6 U.S. (80.6 metric†)
† Metric K-factor measurement is shown in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.
Available Cover Plate Horizontal Adjustment: 1/4" (6.4 mm)
Overall Length (Sprinkler Body): 2" (50 mm)
Patents Pending

Material Standards:
Sprinkler Body: QM Brass and Brass UNS-C84400
Belleville Spring Sealing Assembly: Nickel Alloy, coated on both sides with Teflon Tape
Seat: Brass UNS-C31400
Deflector Ring: Brass UNS-C23000
Deflector Pins: Stainless Steel UNS-S30200
Halo: Brass UNS-C31400 or UNS-C31600 or Phosphor Bronze UNS-C51000
Flow Shaper: Phosphor Bronze UNS-C51000
Lever Bar Ring: Brass UNS-C31400 or Brass UNS-C84400
Compression Screw: 18-8 Stainless Steel
Fusible Link Assembly: Nickel Alloy and Eutectic Solder
Fusible Link Levers: Stainless Steel UNS-S31600
Guide Pin: Stainless Steel UNS-S43000
Shipping Cap: Polyethylene

Cover Assembly Materials:
Cover Plate Assembly: Brass UNS-C26000 or UNS-C26800
Spring: Nickel Alloy
Solder: Eutectic

Viking Technical Data may be found on The Viking Corporation's Web site at http://www.vikinggroupinc.com. The Web site may include a more recent edition of this Technical Data Page.

Ordering Information: (Also refer to the current Viking price list.)
Viking Quick Response Concealed Horizontal Sidewall Sprinklers and Cover Plate Assemblies must be ordered separately:
Sprinkler: Base Part No. 17555A (includes sprinkler with a protective plastic cap covering the unit).
Specify sprinkler temperature rating by adding the appropriate suffix for the temperature rating to the base part number:
Temperature Suffix: 165 °F (74 °C) = C, 220 °F (104 °C) = F
For example, sprinkler VK481 with a 165 °F (74 °C) temperature rating = 17555AC.

CSI #: 21 13 13

VIKING®	TECHNICAL DATA	QUICK RESPONSE CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK481

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Cover Plate Assembly: Base Part No. 16207
Specify finish and temperature rating of the cover plate assembly by adding the appropriate suffixes for the finish and the cover temperature rating to the base part number:
Finish Suffix: Polished Chrome = F, Brushed Chrome = F-/B, Bright Brass = B, Antique Brass = B-/A, Brushed Brass = B-/B, Brushed Copper = E-/B, Painted White = M-/W, Painted Ivory = M-/I, Painted Black = M-/B
Temperature Suffix: 135 °F (57 °C) = A , 165 °F (74 °C) = C
For example, cover 16207 with a Polished Chrome finish and a 165 °F (74 °C) temperature rating = 16207FC.
Available Finishes And Temperature Ratings: Refer to Table 1.
Accessories: (Also refer to the "Sprinkler Accessories" section of the Viking data book.)
Sprinkler Wrenches*:
A. Heavy Duty Wrench Part No. 16208W/R* (available since 2010)
B. Head Cabinet Wrench Part Number 16267** (available since 2010)
C. Optional Large Concealed Cover Plate Installer Tool Part No. 14867 (available since 2007)
*Requires a ½" ratchet (not available from Viking).
**Ideal for sprinkler cabinets.
Sprinkler Cabinet: Part No. 01731A (available since 1971)

4. INSTALLATION
Refer to appropriate NFPA Installation Standards.

5. OPERATION
During fire conditions, when the temperature around the sprinkler approaches its operating temperature, the cover plate detaches. Continued heating of the exposed sprinkler causes the fusible element to disengage, releasing the sealing assembly. Water flowing through the sprinkler orifice strikes the flow shaper, forming a uniform spray pattern to extinguish or control the fire.

6. INSPECTIONS, TESTS AND MAINTENANCE
Refer to NFPA 25 for Inspection, Testing and Maintenance requirements.

7. AVAILABILITY
Viking concealed sprinklers are available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

8. GUARANTEE
For details of warranty, refer to Viking's current list price schedule or contact Viking directly.

TABLE 1: AVAILABLE SPRINKLER TEMPERATURE RATINGS AND FINISHES

Sprinkler Temperature Classification	Sprinkler Nominal Temperature Rating[1]	Maximum Ambient Ceiling Temperature[2]	Temperature Rating of Cover Assembly (Required)		Cover Plate Base Part Number[3]
Ordinary	165 °F (74 C)	100 °F (38 °C)	135 °F (57 °C)	165 °F (74 °C)	16207
Intermediate	220 °F (104 C)	150 °F (65 °C)	135 °F (57 °C)	165 °F (74 °C)	16207

Cover Plate Finishes: Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, and Painted Black.

Footnotes

[1] The sprinkler temperature rating is stamped on the sprinkler body.
[2] Based on NFPA-13. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.
[3] Base part number is shown. For complete part number, refer to Viking's current price list schedule.

CSI #: 21 13 13

VIKING®	TECHNICAL DATA	QUICK RESPONSE CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK481

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Approval Chart

Quick Response Concealed Horizontal Sidewall Sprinkler VK481

Sprinkler Temperature Rating
Cover Plate Temperature Rating
AW1 ← Cover Plate Finish KEY

Position with the centerline of the sprinkler located between 4-3/8" and 12-3/8" (112 mm and 314 mm) below the ceiling.

Sprinkler Base Part Number[1]	SIN	NPT Thread Size		Nominal K-Factor		Maximum Water Working Pressure	Overall Length (Sprinkler Body)		Listings and Approvals[3,4] (Refer also to Design Criteria on page 63k.)			
		Inch	mm	U.S.	metric[2]		Inches	mm	cULus[5]	NYC	LPCB	CE
17555	VK481	1/2"	15	5.6	80.6	175 psi (12 bar)	2"	50	AX1, BX1	See Footnote 6.	--	--

Sprinkler Temperature Ratings	Cover Plate Assembly Temp. Ratings[7]	Finishes of the Cover Plate Assembly[8]
A - 165 °F (74 °C) B - 220 °F (104 °C)	X - 135 °F (57 °C) or 165 °F (74 °C) Cover Part No. 16207[1]	1 - Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, or Painted Black

Footnotes

[1] Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.

[2] Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.

[3] This chart shows the listings and approvals available at the time of printing. Other approvals may be in process. Check with the manufacturer for any additional approvals.

[4] Listed for use in Light or Ordinary Hazard Occupancies for use below smooth, flat, horizontal ceilings only.

[5] Listed by Underwriter's Laboratories for use in the U.S. and Canada.

[6] Meets New York City requirements, effective July 1, 2008.

[7] The 135 °F (57 °C) cover has an orange label. The 165 °F (74 °C) cover has a white label.

[8] Painted finish consists of Polyester Baked Enamel. Other paint colors are available on request with the same listings as the standard paint colors. Listings and approvals apply for any paint manufacturer. Contact Viking for additional information.

NOTE: Custom colors are indicated on a label inside the cover assembly. Refer to Figure 3.

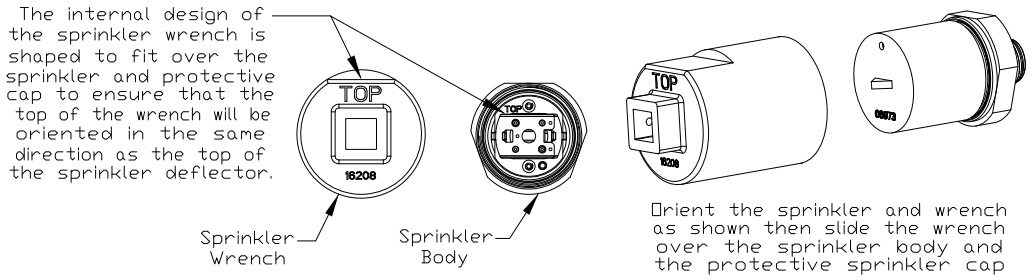


Figure 1: Sprinkler VK481 Installation and Correct Use of Wrench

CSI #: 21 13 13

VIKING®	TECHNICAL DATA	QUICK RESPONSE CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK481

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Approval Chart

Quick Response Concealed Horizontal Sidewall Sprinkler VK481

Sprinkler Temperature Rating
Cover Plate Temperature Rating
AW1 Cover Plate Finish KEY

Position with the centerline of the sprinkler located between 4-3/8" and 12-3/8" (112 mm and 314 mm) below the ceiling.

Sprinkler Base Part Number[1]	SIN	NPT Thread Size		Nominal K-Factor		Maximum Water Working Pressure	Overall Length (Sprinkler Body)		Listings and Approvals[3,4] (Refer also to Design Criteria on page 63k.)			
		Inch	mm	U.S.	metric[2]		Inches	mm	cULus[5]	NYC	LPCB	CE
17555	VK481	1/2"	15	5.6	80.6	175 psi (12 bar)	2"	50	AX1, BX1	See Footnote 6.	--	--

Sprinkler Temperature Ratings	Cover Plate Assembly Temp. Ratings[7]	Finishes of the Cover Plate Assembly[8]
A - 165 °F (74 °C) B - 220 °F (104 °C)	X - 135 °F (57 °C) or 165 °F (74 °C) Cover Part No. 16207[1]	1 - Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, or Painted Black

Footnotes

[1] Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.
[2] Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.
[3] This chart shows the listings and approvals available at the time of printing. Other approvals may be in process. Check with the manufacturer for any additional approvals.
[4] Listed for use in Light or Ordinary Hazard Occupancies for use below smooth, flat, horizontal ceilings only.
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[6] Meets New York City requirements, effective July 1, 2008.
[7] The 135 °F (57 °C) cover has an orange label. The 165 °F (74 °C) cover has a white label.
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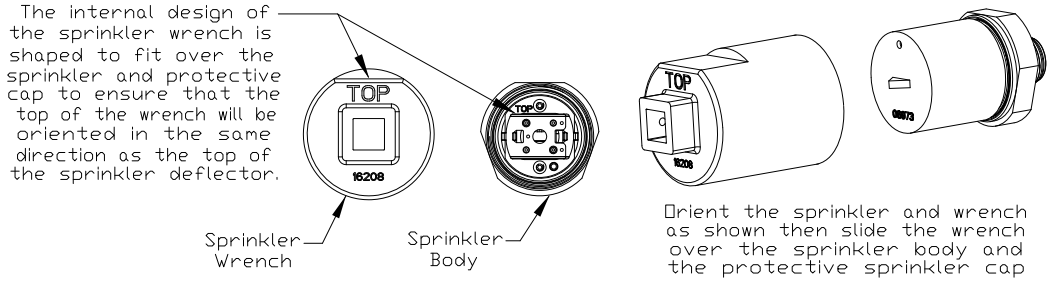


Figure 1: Sprinkler VK481 Installation and Correct Use of Wrench

CSI #: 21 13 13

VIKING®	TECHNICAL DATA	QUICK RESPONSE CONCEALED HORIZONTAL SIDEWALL SPRINKLER VK481

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

DESIGN CRITERIA

(Also refer to the Approval Chart on page 63j.)

cULus Listing Requirements:

Quick Response Concealed Horizontal Sidewall Sprinkler VK481 is cULus Listed for installation in accordance with the latest edition of NFPA 13 for standard coverage sidewall spray sprinklers as indicated below:

- Designed for use in Light or Ordinary Hazard Occupancies for use below smooth, flat, horizontal ceilings only.
- **Position with the centerline of the sprinkler located between 4-3/8" and 12-3/8" (112 mm and 314 mm) below the ceiling. THE TOP OF THE SPRINKLER BODY AND THE TOP OF THE INSTALLATION WRENCH ARE MARKED "TOP".** Orient the top of the sprinkler element parallel with the ceiling as shown in Figure 3.
- This sprinkler must be installed flush with the wall.
- Protection areas and maximum spacing shall be in accordance with the tables provided in NFPA 13 for standard sidewall sprinklers. Minimum spacing allowed is 7 ft. (2.1 m).
- Maximum distance from end walls shall be no more than one-half of the allowable distance between sprinklers. The distance shall be measured perpendicular to the wall. Minimum distance from end walls is 4 in. (102 mm).
- The sprinkler installation and obstruction rules contained in NFPA 13 for standard coverage sidewall spray sprinklers must be followed.

NOTE: Concealed sprinklers must be installed in neutral or negative pressure plenums only.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to page QR1-3 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, FM Global, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

Identification of Custom Paint Color:
All custom color painted cover plates will have an identifying label affixed to the inside of the cover that indicates custom color and will have a representative sample (a paint dot) of the paint on the label.

Figure 2: Identification of Custom Paint Color for Concealed Covers

CSI #: 21 13 13

Kidde

Silhouette120V AC/DC Wire-in Low Profile Smoke Alarm

Part Number 21007288 **Model KN-SMFM-i**

- Innovative low profile alarm design
- Ionization Sensing Technology
- One button design (operates Smart Hush™ and test)
  Test verifies alarm operation
  Hush silences nuisance alarms
- Sealed rechargeable battery backup (included) will last the life of the alarm
- LED indicates alarm condition
- Alarm memory
- Pre-stripped wiring harness with tinned strands

Description

The Kidde Silhouette is a low profile AC/DC powered, ionization smoke alarm that operates on a 120V power source with a sealed rechargeable battery backup.

This alarm uses ionization sensing technology. Ionization sensing alarms may detect invisible fire particles (associated with flaming fires) sooner than photoelectric alarms. Photoelectric sensing alarms may detect visible particles (associated with smoldering fires) sooner than ionization alarms.

Kidde strongly recommends that both ionization and photoelectric smoke alarms be installed to help insure maximum detection of the various types of fire that can occur within the home.

This smoke alarm is available in a 4-piece cut case with tray for easy display. This unit is a UL Listed product with a 10-year limited warranty.

10 YEAR LIMITED WARRANTY

SIGNALING UL LISTED

Install Confidence

Easy Installation

- Innovative low profile alarm fits in most common electrical 2-gang and plastic, round boxes with 3 1/2" hole spacing.
- Pre-stripped wiring harness with easy off cap does not require stripper tool. Tinned strands increase conductivity and wire nut grip.

Fewer Callbacks

- One button design for easy operation and less confusion. Operates Smart Hush™ and alarm test.
- Sealed rechargeable battery does not need to be replaced for the life of the alarm.

User-Friendly Features

- Battery backup provides protection in case of power failure.
- Unit can be interconnected with up to 24 total devices (12 smoke alarms and 6 heat alarms, CO alarms or similar devices). See user's guide for complete instructions.

silhouette

CSI #: 21 13 13

120V AC/DC Wire-in Low Profile Smoke Alarm
Sealed Rechargeable Battery Backup

Part Number 21007288
Model KN-SMFM-i

Architectural and Engineering Specifications

The smoke alarm shall be Kidde model KN-SMFM-i or approved equal. It shall be powered by a 120VAC, 60Hz source along with a rechargeable battery backup. The unit shall incorporate an ionization sensor with nominal sensitivity of .50 to .98%ft. The temperature operation range shall be between 40˚F and 100˚F (4.4˚C and 37.8˚C) and the humidity operating range shall be up to 85% relative humidity.

The smoke alarm can be installed in standard junction boxes listed below. The electrical connection (to the alarm) shall be made with a plug-in connector. A maximum of 24 Kidde devices can be interconnected in a multiple station arrangement. The interconnect system must not exceed the NFPA (National Fire Protection Association) limit of 18 initiation devices, of which 12 can be smoke alarms. With 18 initiating devices (smoke, heat, CO, etc.), interconnected, it is still possible to interconnect 6 strobe lights and or relay modules.

The alarm shall include a test button that will electronically simulate the presence of smoke and cause the unit to go into alarm. This sequence tests the unit's electronics, battery and horn to ensure proper operation.

The unit shall include a piezoelectric horn that is rated at 85 decibels at 10 feet. Single button operates both Smart Hush™ and alarm test for easy operation and less confusion. The unit shall also include a low battery warning utilizing a brief alarm chirp every 60 seconds for a minimum of seven (7) days.

The unit shall incorporate red and green LED indicators. The green LED indicates the status of the alarm. The red LED is a visual indicator of alarm and warning chirps.

Standby Condition: The green LED will be lit if on AC power or blink once every 30 seconds if on battery backup. ***Alarm Condition:*** When the alarm senses products of combustion and enters alarm the red LED will blink in unison with the sounder and the green LED will flash once every 2 seconds. The flashing LEDs and pulsating alarm will continue until the air is cleared. When the units are interconnected, only the green LED of the alarm(s) sensing smoke or is being tested (the originating unit) will flash. All other units in the interconneced system will sound an alarm and flash the red LED but the green LED will remain at is standby state. ***Alarm Memory:*** This smoke alarm is equipped with an alarm memory, which provides a visual indication when an alarm has been activated. The green LED will flash every 16 seconds to indicate the memory condition. ***Smart Hush™ Mode:*** The green LED will flash every 3 seconds but the alarm will not make any sound, indicating the smoke alarm is in the Smart Hush™ Mode.

The unit shall at a minimum meet the requirements of UL217, NFPA72, (chapter 11), The State of California Fire Marshall, NFPA 101 (One and two family dwellings) Federal Housing Authority (FHA), Housing and Urban Development (HUD). It shall also include a 10-year manufacture's limited warranty.

Install Options

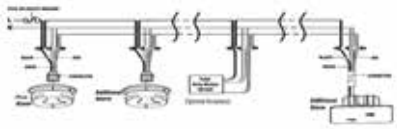
Square Box **Octagon Box** **Round Box** **2 Gang Box**

Width of screw posts must not exceed .45"

Innovative low profile alarm fits in most common electrical 2-gang and plastic, round boxes with 3 1/2" hole spacing. Depth of box must exceed 2 1/8". Unit will displace 7.5 cubic inches.

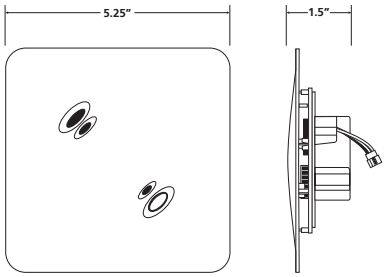
Installation of Smoke Alarm

The smoke alarm must be installed to comply with all local codes having jurisdiction in your area. All wiring shall be in accordance with articles 210 and 300.3(B) of the US National Electrical Code, ANSI / NFPA 70 and NFPA 72. The multiple station interconnect wiring must be in the same raceway as the AC power wiring. In addition the resistance if the interconnect wiring shall be a maximum of 10 ohms. Make certain all alarms are wired to a single, continuous (non-switched) power line, which is not protected by a ground fault interrupter. A maximum of 1000 ft. of wire can be used in the interconnect system. Use standard UL listed household wire as required by code.



Technical Specifications

Model:	KN-SMFM-i
UPC:	0-47871-07288-0
Power Source:	120VAC (80mA) with Rechargeable Battery Back Up
Sensor:	Ionization
Audio Alarm:	85dB at 10ft
Temperature Range:	40˚F (4.4˚C) to 100˚F (37.8˚C)
Humidity Range:	up to 85% relative humidity (RH)
Size:	5.25" width x 1.5" depth x (.5"installed)
Weight:	.5lb
Interconnects:	Up to 24 Kidde devices/18 initiating
Wiring:	Quick-connect plug with 6" pigtails
LED:	Red, visual alarm indicator Green, current state indicator
Warranty:	10 year limited



Ordering Information

Ordering Number	UPC	I2F5	Pack Quantity	Dimensions (w x d x h inches)	Weight	Case/ Skid	Layers/ Skid	Skid Weight
21007288	0-47871-07288-0	100-47871-07288-7	Cut Case (4 units)	6.5 x 13.25 x 6	3 lbs	75	4	230 lbs

**Not for sale by individual unit*

Kidde

1016 Corporate Park Drive, Mebane NC 27302
1-800-880-6788 • www.kidde.com

Distributed by:

P/N: KL-SIL-SM sheet *rev. 01-2009*

Division 22
Plumbing

CSI #: 22 14 29

GRUNDFOS

Series KP Stainless Steel Submersible Sump & Utility Pump

KP 150, 250, 350

Submittal Data

JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO:	DATE:
SPECIFICATION REF:	

QTY.	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS
					115	1	
					115	1	

Repair Kit P/N:

Technical Data

PERFORMANCE RANGE:
- Flow: .5 - 62 U.S. GPM
- Head: 0 - 31 feet of water
- Horsepower: 1/4, 1/3, 1/2 HP

SOLIDS HANDLING:
- 3/8 Inch Spherical

PUMPING LEVEL:
- **Manual Operation**
  - Minimum 1 3/16" or 1/2" with suction strainer removed.
- **Automatic Operation**
  - Minimum 4" for KP 150 & KP 250
  - Minimum 4 3/8" for KP 350

MOTOR TYPE:
- AC Induction
- Non-toxic motor liquid
- Class F insulation
- Manufactured by Grundfos

THERMAL PROTECTION:
- Automatic reset

FLUID TEMPERATURE RANGE:
- 32° - 122°F Continuous Operation
- 123° - 158°F Intermittent Operation

Intermittent run time, 2 minutes every 30 minutes totally submerged

DISCHARGE SIZE:
- 1 1/4" NPT

APPROVALS:

Applications

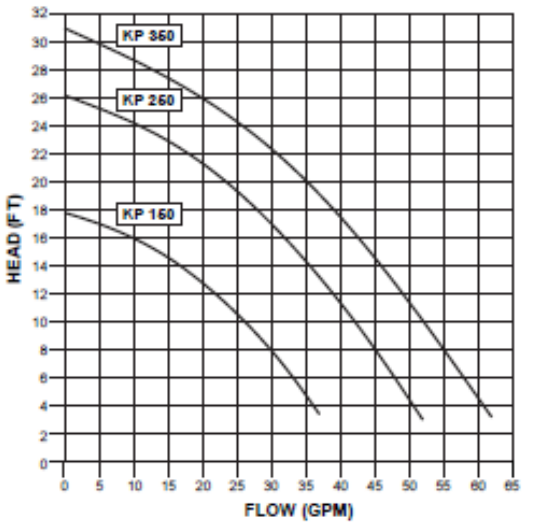
Use for:
Effluent
Clear or dirty sump water
Grey water
Draining ponds, pits and tanks
De-Watering, Draining and filling tanks, Draining pools & spas
Light Chemical Mixing*
Fountains

Do not use for:
Raw sewage
Flammables
Highly corrosive liquids

* Flush after use

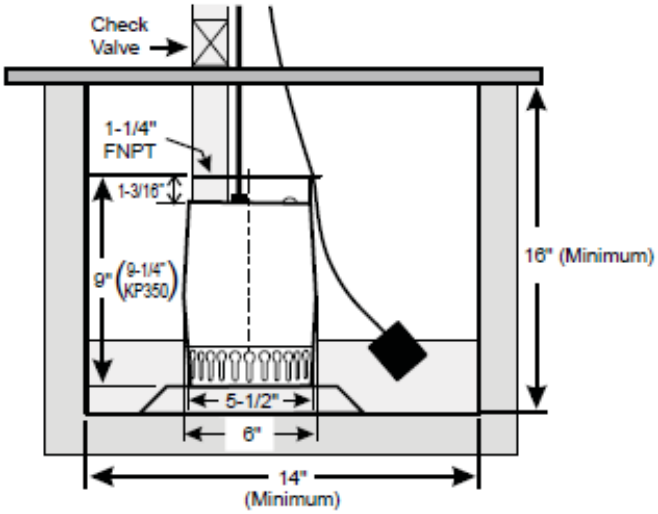
Performance Curve

3350 RPM 60 Hertz



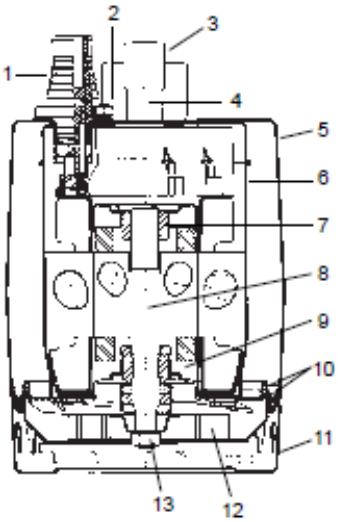
CSI #: 22 14 29

Dimensions/Installation



Power cord length: 10 ft. and 25 ft. standard, float switch length: 10 ft. and 25 ft. available.

Sectional Drawing

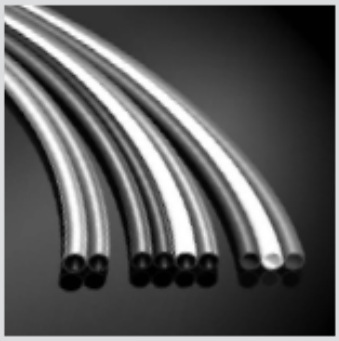


Materials of Construction

Position	Description	Material	ASTM
1	Power cord	Neoprene	
2	Fasteners (nut and washer)	Stainless steel	304
3	Handle cover / Cord position lock	Luranyl	
4	Handle structure	Stainless steel	304
5	Pump housing	Stainless steel	304
6	Stator housing	Stainless steel	304
7	Bearings	Carbon	
8	Shaft with rotor	Stainless steel / Silumin	304
9	Motor liquid	SML2	
10	O'ring / Seal ring	NBR	
11	Strainer	Stainless steel	304
12	Impeller	Stainless steel	304
13	Nut	Stainless steel	304

GRUNDFOS
Grundfos Pumps Corporation • 17100 W. 118th Terrace • Olathe, KS 66061

CSI #: 22 14 29



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MANABLOC is a registered trademark of Viega LLC
ViegaPEX is a trademark of Viega LLC
FostaPEX is a registered trademark of Viega GmbH & Co. KG
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Working with Viega is the perfect solution.

Viega researches, develops and produces complete system solutions for contractors. The components are produced at our plants or are supplied exclusively by the finest quality manufacturers. Each of our systems is developed in-house and tested under stringent quality control conditions to guarantee safety and efficient operation.

An international company with a national commitment.

Viega PureFlow plumbing combines technology from both sides of the Atlantic into the very best PEX plumbing systems for our customers.

Viega's reach extends throughout North America with distribution across the U.S., Canada and Mexico.

Our network of sales experts and wholesale distributors can meet your needs whether you are in Boston or Berkeley. The products we deliver are the finest quality offered at a highly competitive price. Our goal is to remain on the forefront of the plumbing industry well into the new century, and with our advanced products and a determination to remain the quality leader, we are convinced this accomplishment is well within our reach.

Call 800-976-9819 for your local representative and wholesale location.

Why you can depend on Viega PureFlow.

- A safe system
- Competitively priced
- Leakproof fitting connection
- Highly flexible and kink resistant
- Lightweight and easy to handle
- Fast and solder-free installation
- No open flame during installation
- Reduced number of fittings used in wall
- Long life expectancy
- Non-corroding
- Reduced flow noises
- In coils or straight lengths
- FostaPEX form stable tubing ideal for exposed runs
- Listed by NSF to meet the requirements of ANSI 14 and 61 and NSF Protocol P171 (CL-R/CL-TD)
- Listed to ASTM F876/F2023 and F877

IMPORTANT NOTICE

This installation guide is intended for traditional (branch and main) plumbing systems and hybrid plumbing systems using termination manifolds, MANABLOC® and MINIBLOC parallel / manifold plumbing system.

NOTE: References to ViegaPEX™ tubing made throughout this publication include the entire line of Viega cross-linked polyethylene products.

IN THE EVENT OF CONFLICT OR INCONSISTENCY BETWEEN THESE INSTALLATION GUIDELINES AND LOCAL BUILDING OR PLUMBING CODES, LOCAL CODES SHOULD TAKE PRECEDENCE.

NOTE: Failure to follow the installation instructions will void the Viega Plumbing Warranty. Nothing in this publication is intended to create any warranty beyond Viega's applicable warranty. For additional information, contact Viega at 800-976-9819.

CSI #: 22 41 39

Kitchen
32800680+27714970 Two-hole mixer with individual flanges and handspray set
Article number: 32800680+27714970

Product specifications

- **9 1/4" projection**
- Swivel spout 360°
- Total height 13 5/8"
- Hand spray hole diameter 1 1/4"
- Height to aerator/spout outlet 12 1/2"
- Single-lever-mixer hole diameter 1 3/4"
- Spout hole diameter 1 3/8"
- M 24 x 1 aerator – male thread
- Ceramic disc cartridge
- M 10 x 1/2 flex line
- Automatic diverter
- 2x M 10 x 1 x 16 1/2" high pressure hose
- Connection pipe with nipple 7 1/4"
- Individual flanges 2 1/8" x 2 1/8"
- 68 7/8" metal shower hose for handspray
- Hand spray with descaling system
- Water flow rate limited to max. 1.5 gpm
- low lead compliant
- Hand spray flow rate max. 1.5 gpm

[ADA]
Internal backflow preventer.
36 Psi minimum recommended water pressure
Flexible positioning of components

Surfaces

- chrome 32800680+27714970-00
- matt platinum 32800680+27714970-06

DORNBRACHT AMERICAS INC. 1700 EXECUTIVE DRIVE SOUTH SUITE 600 DULUTH, GA 30096
TEL. +1 (800) 774-1181(770)564-3599 FAX +1 (800) 899-8527 E-MAIL: DORNBRACHTAM@DORNBRACHTGROUP.COM

CSI #: 22 41 39

DORN BRACHT

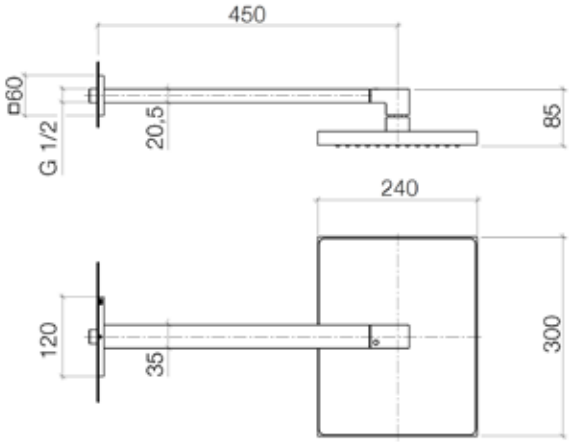
28745979 Wall mounted rain shower, 11 3/4” 9 1/2”
Article number: 28745979
Product specifications

- 17 3/4" projection
- Rain showerhead 300 x 9 1/2" with descaling system
- 1/2" connection
- 1/2" wall elbow with back flow preventer
- 2 3/8" x 4 3/4" flange
- Flow rate limited to max. 2.0 gpm in combination with eSET shower 35 026 970 90

For more stability order 35 085 970 90
Can be used in combination with eSET shower 35 026 970 90
Surfaces

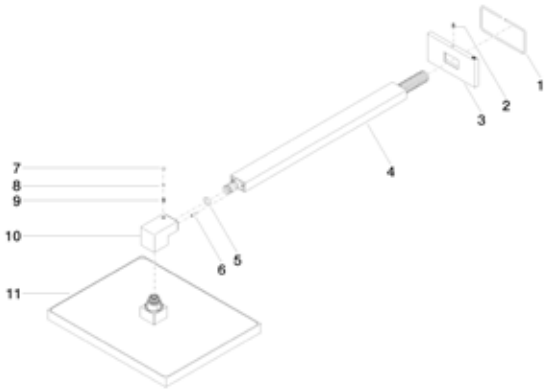
- chrome 28745979-000010
- matt platinum 28745979-060010

Accessories required



Order quantity

No.	Article number	Name	Installation quantity
1	09140312790	seal	1
2	09311113490	pin	1
3	092779008ff	plate	1
4	04282224701ff	pipe	1
5	09141001190	seal	1
6	09311104090	pin	1
7	093120087ff	plug	1
8	09141013390	seal	1
9	09311103690	pin	1
10	091701180ff	connection	1
11	04120505010ff	shower	1



CSI #: 22 40 00

ODENSVIK
Sink, 1 bowl

Product dimensions
sink cabinet width: 39 3/8 “
Depth: 19 1/4 “
Thickness: 2 3/8 “
Width: 40 1/2 “

sink cabinet width: 100 cm
Depth: 49 cm
Thickness: 6 cm
Width: 103 cm

Key features
- 10-year Limited Warranty. Read about the terms in the Limited Warranty brochure.
- The included water trap is easy to connect to the drain, washing machine and dryer because it is flexible.
- Unique water trap design gives room for a full sized drawer.
Designer:
Magnus Elebäck
Package meas

CSI #: 22 41 16

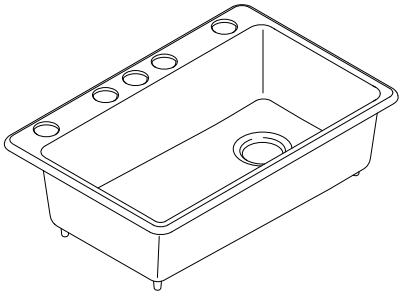
KOHLER®

RIVERBY™

UNDER-MOUNT KITCHEN SINK
K-5871

Features
- *KOHLER cast iron*
- *Acid-resistant enamel finish*
- *Under-mount installation available with five holes*
- *Single bowl*
- *Under-mount sink kit 23″ (584 mm) included*
- *Includes left bottom bowl rack, colander with integral cutting board, and utility rack with soaking cup*
- *33″ (838 mm) x 22″ (559 mm) x 9-5/8″ (244 mm)*

Codes/Standards Applicable
Specified model meets or exceeds the following:
- *ASME A112.19.1/CSA B45.2*



Colors/Finishes
- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories
- 0: White
- CP: Polished Chrome
- ST: Stainless Steel
- NA: None applicable
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-5871-5UA3	Under-mount kitchen sink	❑ 0	❑ Other_____
Included Accessories			
K-6237	Bottom bowl rack, left side		❑ ST
K-6239	Colander with integral cutting board	❑ 0	
K-6194	Utility rack with soaking cup		❑ ST
Recommended Accessories			
K-9000	P-Trap		❑ CP

Product Specification
The kitchen sink shall be made of cast iron with acid-resistant enamel finish. Sink shall be 33″ (838 mm) in length, 22″ (559 mm) in width, and 9-5/8″ (244 mm) in depth. Sink shall be for under-mount installation available with five holes. Sink shall be single bowl. Sink shall include left bottom bowl rack, colander with integral cutting board, utility rack with soaking cup, and 23″ (584 mm) under-mount sink kit. Sink shall be Kohler Model K-5871-5UA3-_____.

Page 1 of 2
1173298-4-**C**

USA/Canada: 1-800-4KOHLER
(1-800-456-4537)
www.kohler.com

CSI #: 22 41 16

RIVERBY™

Optional Accessories					
K-5807	Under-mount sink kit 36″ (914 mm)			❑ NA	
K-6246	Wood cutting board			❑ NA	
K-6255	Bottom bowl rack, right side		❑ ST		
K-8801	Duostrainer® sink strainer	❑ CP			❑ Other_____

Technical Information

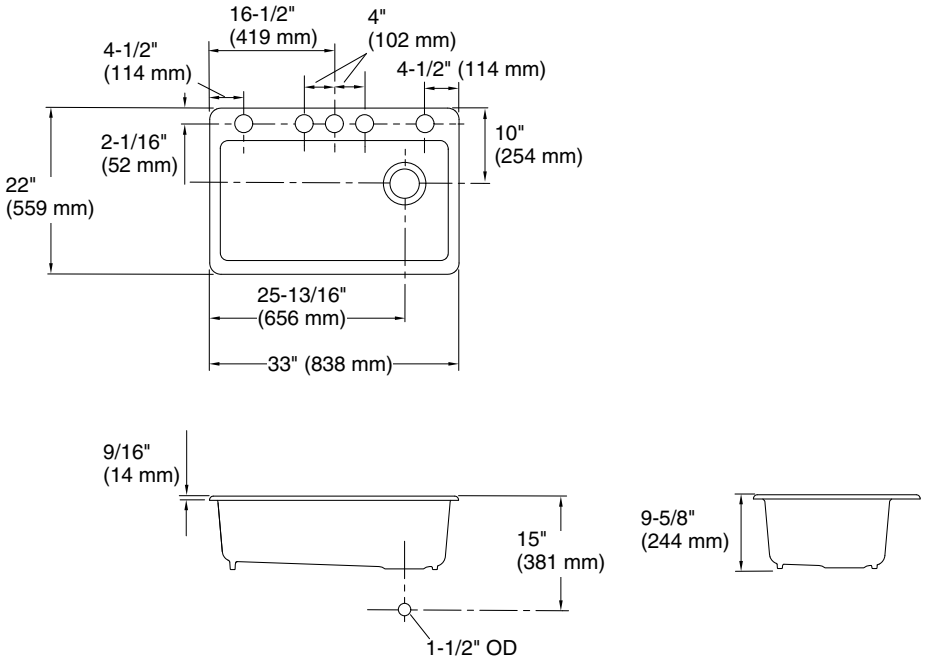
Fixture*:	
Bowl area	30-1/4″ (768 mm) x 17-1/4″ (438 mm)
Water depth	9″ (229 mm)
Drain hole	Ø 3-7/8″ (98 mm)
Faucet holes	Ø 2-3/8″ (60 mm)
* Approximate measurements for comparison only.	

Included components:	
Cut-out template	1166727-7
Under-mount sink kit 23″ (584 mm)	1054375

Installation Notes

Install this product according to the installation guide.

NOTICE: Countertop manufacturer or cutter **must** use the cut-out template provided with the product, or a current one provided by Kohler Co. (call 1-800-4-KOHLER). Kohler Co. is not responsible for cutout errors when the incorrect cut-out template is used.



Product Diagram

RIVERBY™ UNDER-MOUNT KITCHEN SINK
Page 2 of 2
1173298-4-**C**

THE BOLD LOOK OF KOHLER®

CSI #: 22 40 00

TOTO®

CST474CEF(G)

Vespin® II Close Coupled High-Efficiency Toilet, 1.28GPF

FEATURES

- Double Cyclone® flushing system, low consumption (1.28GPF/4.8LPF)
- Skirted design
- SanaGloss® ceramic glaze - prevents debris and mold from sticking to ceramic surfaces, leading to fewer chemicals and less water in cleaning (not avail on Ebony #51)
- Universal Height
- Decorative two-piece design with high-profile tank
- Elongated front bowl and tank set, less seat
- Chrome trip lever
- 12" Uni-Fit® Rough-in (included), less supply

MODELS

- CST474CEFG
  With SanaGloss ceramic glaze

- CST474CEF
  Less SanaGloss ceramic glaze (#51 only)

COMPONENTS

- CT474CEFG Elongated bowl with SanaGloss
- CT474CEF Elongated bowl, less SanaGloss
- ST454E Tank and cover only
- ST454ER Tank and cover only - right-hand trip lever

- SS224 SoftClose® seat (sold separately)
- SS214 SoftClose® seat (sold separately)
- SS204 SoftClose® seat (sold separately)
- SS114 SoftClose® seat (sold separately)
- SS154 SoftClose® seat (sold separately)
- TSU01W.10 10" rough-in (sold separately)
- TSU01W.14 14" rough-in (sold separately)

COLORS/FINISHES

- #01 Cotton
  #03 Bone
  #11 Colonial White
  #12 Sedona Beige
  #51 Ebony (not available in SanaGloss)

PRODUCT SPECIFICATION

The Two-piece high-efficiency Double Cyclone flushing system toilet shall be 1.28GPF/4.8LPF. Toilet shall have optional SanaGloss ceramic glaze and be at Universal Height. Toilet shall have high-profile tank, elongated front bowl and Chrome trip lever. Toilet shall be TOTO Model CST474CEF____.

SanaGloss
CYCLONE®
FLUSHING SYSTEM BY TOTO®

CODES/STANDARDS

- Meets or exceeds ASME A112.19.2/CSA B45.1
- Certifications: IAPMO(cUPC), EPA Watersense, State of Massachusetts , City of Los Angeles, and others
- Code compliance: UPC, IPC, NSPC, NPC Canada, and others
- Legislative Compliance: California AB715, California Green Building Code, City of Los Angeles Water Efficiency Ordinance
- ADA compliant (when installed with trip lever located on the approach side)

CSI #: 22 41 13

CST474CEF(G)

Vespin® II Close Coupled High-Efficiency Toilet, 1.28GPF

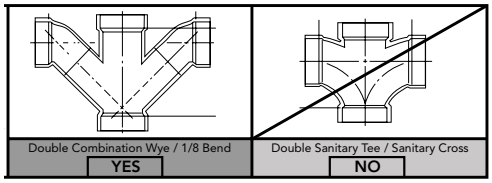
SPECIFICATIONS

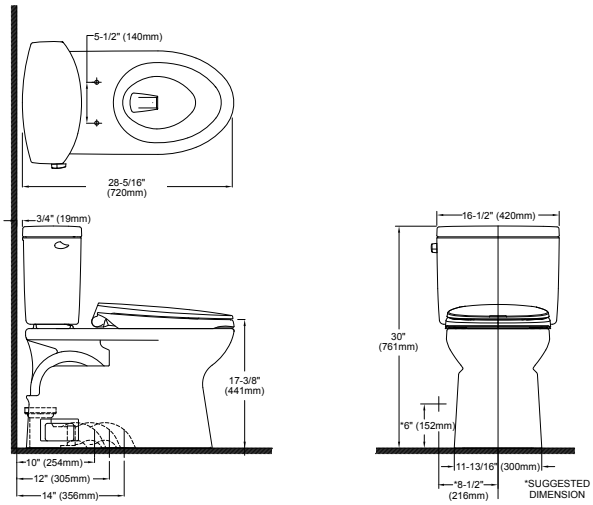
- Water Use — 1.28 GPF/4.8LPF
- Flush System — Double Cyclone
- Min. Water Pressure — 8 psi (flowing)
- Water Surface — 6-7/8" x 9-3/4"
- Trap Diameter — 2-1/8"
- Rough-in — 12" (10" or 14" optional)
- Trap Seal — 2-1/8"
- Warranty — One Year Limited Warranty
- Material — Vitreous china
- Shipping Weight — CT474CEF(G) 75lbs.
  ST454E(R) 31.5lbs.
- Shipping Dimensions — CT474CEF(G)
  30-1/8"L x 16-3/4"W x 22"H

  ST454E(R)
  18" L X 9" W X 16" H

INSTALLATION NOTES

Back-to-Back Toilet Installations:
TOTO recommends the use of a nationally listed, double sanitary tee-wye only, in vertical waste stacks, in accordance with the stipulations noted in the majority of nationally recognized plumbing codes.





TOTO®

These dimensions and specifications are subject to change without notice

Ph: (888) 295-8134 | Fax: (800) 699-4889 | www.totousa.com

#SS-00461 v.06

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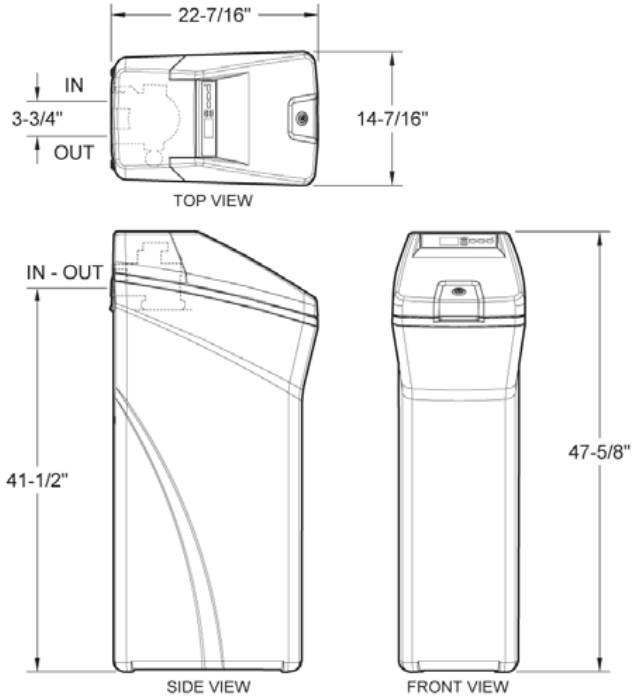
CSI #: 22 31 00

GE Appliances

GXSH40V – GE SmartWater™ Water Softener



Above Illustration intended for dimensional reference only. Refer to photograph for actual product appearance.

Specification Created 12/11
380232

Salt Capacity – 230 lbs.

Important: All units must be installed according to local codes.

Note: Before installing, consult installation instructions packed with product for current dimensional data.

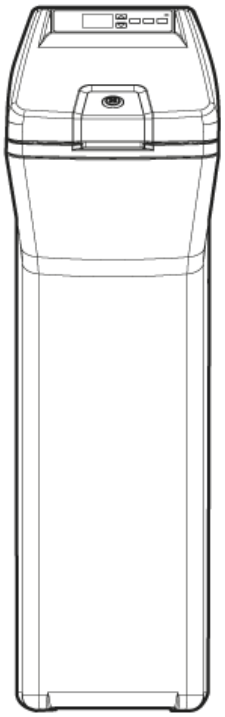
NSF GXSH40V conforms to ANSI/NSF 44 for specifically claimed performance.

For answers to your Monogram,® GE Profile™ or GE appliance questions, visit our website at GEAppliances.com or call GE Answer Center® service, 800.626.2000.

CSI #: 22 31 00

GE Appliances

GXSH40V – GE SmartWater™ Water Softener



Specification Created 12/11
380232

Features and Benefits

- Easy to use up-front electronic controls with status light indicator
- 40,200 Grain Capacity
- Efficiency (5100 gpg)
- Maximum Hardness Removal (125 gpg) / Maximum Iron Removal (10 ppm)
- Salt Capacity (230 lbs)
- GE Exclusive Custom Select™ blending valve allows you to select how soft you want your water.
- GE Exclusive Salt Saver™ helps reduce salt consumption and uses up to 34% less salt*
- GE Exclusive SmartSoft™ Technology ensures there is always plenty of softened water available by "learning" a family's water-use patterns
- GE Exclusive Days to Empty makes sure you never have to guess when to refill the salt tank
- Uses up to 35% less water*
- Self-cleaning sediment filter protects your home's plumbing
- Plumbing connection up to 1.25"

*Based on internal analysis. Verses GE water softeners manufactured prior to 2009

- Model GXSH40V

CSI #: 22 33 00

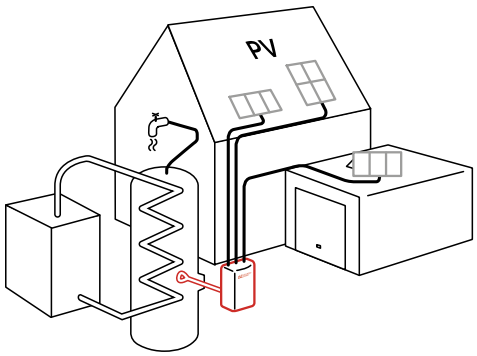
ADVANCED ENERGY®

AE PV Heater

Hot water from photovoltaics

- Cost-efficient
- Flexible
- Simple

The PV Heater uses the direct current produced by PV modules in a private home to heat the domestic hot water in heating systems. It boasts an efficiency grade of 99 % and saves hard cash. With the PV Heater a kilowatt hour of heat costs between 8 and 10 euro cents – which makes heat from the PV system cheaper than from an oil heating system. In addition, the heating system's CO_2 emissions are also lower, it does not use fossil fuels, and it is not tied to the price of oil. Six to twelve PV modules are sufficient for operating the PV Heater. The modules can even be aligned east to west or installed on facades. Extensive connection work is not required. No inverters, tubing, or similar is required. The only thing to do is to lay the cables. As the direct current voltage generated is only 50 V, you can even perform the connection yourself. There is no need to get to grips with bureaucracy, as the PV Heater is operated in your own home, completely independently of the grid. Energy efficiency was never so simple!



CSI #: 22 33 00

TECHNICAL DATA	AE PV Heater
Art. no.	401R1K5
ELECTRICAL DATA	
Recommended PV power, kWp	1.5 ... 2.7
Heating capacity, W	1,500
MPPT range, V	16 ... 40
DC start voltage, V	18
Max. voltage DC, V	50
Max. current DC, A	3 x 20 (over-configuration up to 30 A permitted)
Recommended module type	60, 66, or 72 cells, mono or poly
MPP trackers	3
Number of DC inputs	3 x spring terminals 2.5 ... 6 m^2
Max. efficiency, %	> 99
European efficiency, %	> 99
Production starting at, W	2
Self consumption in night operation, W	0
AMBIENT CONDITIONS	
Cooling	Natural convection
Ambient temperature, °C	-25 ... +50, derating 4 %/K up to 70 °C
Site altitude, m above sea level	4,000
Noise, dBA	< 35
STANDARDS AND APPROVALS	
Product standard	EN 60730-1:2011, EN 60730-2-11:2008
EMC	EN 61000-6-3, EN 61000-6-2
Internal overvoltage protection (EN 61643-11)	Type 3
Protection class	III (as per IEC 62103-1), protective extra-low voltage / PELV
Overvoltage category	DC: II (as per IEC 60664-1)
Certification, EC conformity	Can be found on our website
MANAGEMENT, COMMUNICATION	
Interfaces	6 status LEDs, Ethernet, 1 x inverter contact, (5 A, 30 VDC), digital input, 2 external PT1000 sensors
Monitoring	Integrated data logger, energy meter, AE SiteLink
Max. heating temperature (configurable), °C	Up to 80
Safety limit, °C	85
MECHANICAL DATA OF HOUSING	
Type of protection	IP21 as per EN 60529
Dimensions W x H x D, mm	210 x 235 x 90
Weight, kg	1.7
MECHANICAL DATA OF HEATING ELEMENT	
Material of heating element	High-quality nickel iron chrome alloy
Maximum operating pressure, bar	10
Unheated area, mm	100
Dimensions L x Ø, mm	400 x 40
Connection thread	1 1/2"
Fitting length, mm	14
Use	Drinking water, hot water
Weight, kg	1.0

Subject to modification. Technical specifications are subject to change without notice.

REFUsol GmbH | Uracher Straße 91 | 72555 Metzingen | Germany | Tel. +49 7123 969-0 | Fax +49 7123 969-165 | info@refusol.com

AE_PV-Heater_Datasheet_EN-V03-20140630

CSI #: 22 33 00

LUMOS

LSX200 Series

A true systems approach to photovoltaic module and racking integration

Features	Benefits
Frameless Module	No aluminum = lower embodied energy Lower profile
No Module Grounding	No ground lugs No continuous module equipment ground
Constrained Module Positioning	Perfect alignment Speeds installation time
Integrated Wireway	UV and rodent protection Speeds installation time
Tamper Resistant Stainless Fasteners	Keeps your investment working for you
Available with black, clear or white back sheet	Aesthetic options for different applications

CSI #: 22 33 00

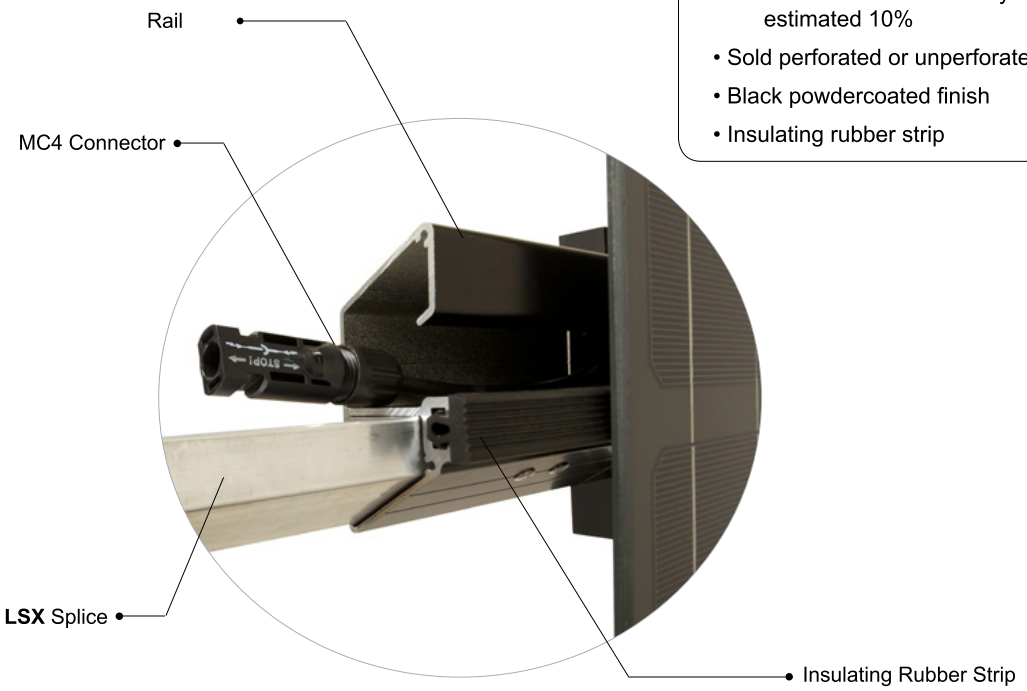
LSX Racking System

Our **LSX** Rail is the proprietary racking solution for the **LSX Module System**.

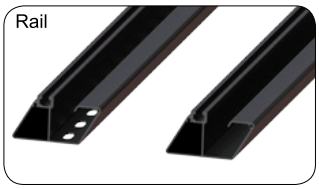
LSX Rail is sold with the insulating rubber strip and pre-installed, pre-positioned fasteners.

Features:

- Integrated wireway provides rodent and UV protection
- Shortens installation time by an estimated 10%
- Sold perforated or unperforated
- Black powdercoated finish
- Insulating rubber strip

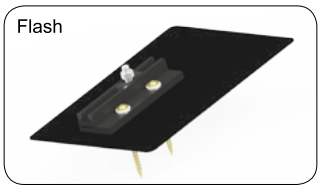


Rail



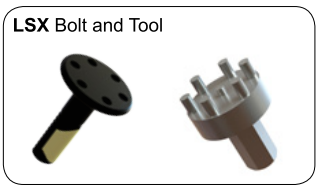
- Perforated or Unperforated
- Integrated Wireway
- Black Powdercoated Finish

Flash



- Compatible with all racking systems
- Low profile and easily adjustable
- IRC and IBC Code Compliant

LSX Bolt and Tool



- Tamper Resistant Stainless Steel Bolt
- Custom Installation Tool

3550 Frontier Ave Ste C-2
Boulder, Colorado 80301
877-301-3582
www.lumossolar.com

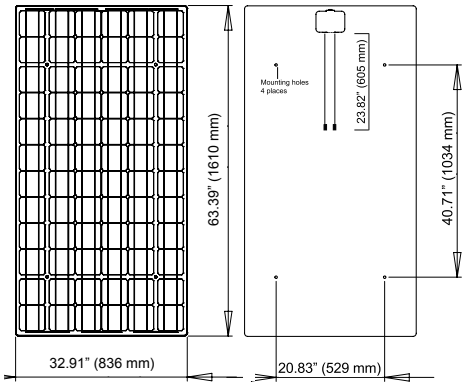
LUMOS

CSI #: 22 33 00

LSX200 Series

Mechanical Specifications

Solar Cell	Monocrystalline 5" x 5" (125 mm x 125 mm)
Number of Cells	72 (6 x 12)
Internal Bypass Diodes	3
Module Dimensions	63.39" x 32.91" x 1.38" (1610 mm x 836 mm x 35 mm)
Module Area	14.49 ft^2 (1.35 m^2)
Module Weight	49.8 lbs (22.4 kg)
Front Glass	.24" (6 mm) Tempered Glass
Backsheet	Black, White, and Clear
LSX Rail Assembly Options	1-7 Portrait Module Lengths (Black Powdercoated Finish) 1-3 Landscape Module Lengths (Black Powdercoated Finish)
Output Cables	12 Awg. 21.65" (550 mm) PV Wire with MC4 Connectors
Static Load	50 PSF (2400 Pa) Portrait/113 PSF (5400 Pa) Landscape
Hail	Maximum Diameter 1" (25 mm) at 52 mph (23 m/s)
Warranty	12 years at 90% of the rated power output 25 years at 80% of the rated power output
Certifications	ETL per UL-1703 & CEC listed



Packaging Configuration

Quantity/Pallet, Quantity/40' Container	36 pcs/pallet -792 pcs/40' HQ

Nominal Operating Cell Temperature (NOCT)	46± 2 °C
Power Temperature Coefficient	-0.47 % / °C
Voltage Temperature Coefficient (Voc)	-0.35 % / °C
Current Temperature Coefficient (Isc)	+0.05 % / °C

Electrical Specifications

Model	LSX 180-72M-B/W/C*	LSX 185-72M-B/W/C*	LSX 190-72M-B/W/C*	LSX 195-72M-B/W/C*	LSX 200-72M-B/W/C*
Rated Power @ STC	180 W	185 W	190 W	195 W	200 W
Black/Clear PTC	160.9 W	165.5 W	170.1 W	174.7 W	179.3 W
White PTC	161.3 W	165.9 W	170.5 W	175.1 W	179.7 W
Nominal Voltage	24 V	24 V	24 V	24 V	24 V
Peak Power Voltage (Vmp)	35.3 V	35.4 V	35.8 V	36.2 V	36.5 V
Maximum Power Current (Imp)	4.96 A	5.09 A	5.17 A	5.25 A	5.34 A
Open Circuit Voltage (Voc)	44.5 V	44.6 V	44.8 V	45.0 V	45.1 V
Short Circuit Current (Isc)	5.34 A	5.40 A	5.48 A	5.50 A	5.53 A
Operating Temperature	-40 °C to 85 °C	-40 °C to 85 °C	-40 °C to 85 °C	-40 °C to 85 °C	-40 °C to 85 °C
Max System Voltage (UL / IEC)	600 V / 1000 V	600 V / 1000 V	600 V / 1000 V	600 V / 1000 V	600 V / 1000 V
Max Series Fuse Rating	15 A	15 A	15 A	15 A	15 A
Power Tolerance	±3%	±3%	±3%	±3%	±3%
Module Efficiency	13.4%	13.7%	14.1%	14.5%	14.9%

*B-Black Backsheet
*W-White Backsheet
*C-Clear Backsheet

PATENTS PENDING

Specifications are subject to change without notice. Lumos reserves the right of final interpretation and revision of this datasheet.

Version 201401-LSX72M-1.0

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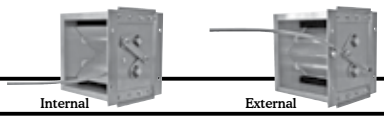
LUMOS

Division 23

Heating,Ventilating, and Air-Conditioning

CSI #: 23 33 13

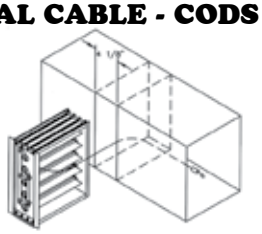
DuroZone®



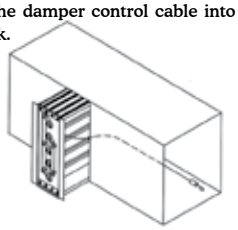
INSTALLATION INSTRUCTIONS

Rectangular Opposed Blade Cable Operated Damper

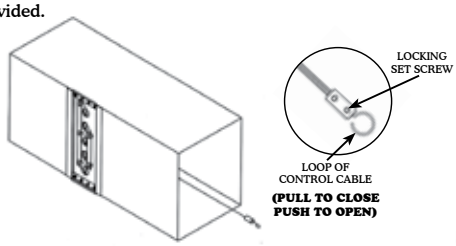
INTERNAL CABLE - CODS Series



Step 1: Cut 4-1/8" wide slot into the side of the sheet metal duct.
Step 2: If desired, install gasket around the damper frame per the enclosed instructions.
Step 3: Insert the damper control cable into the slot cut into the ductwork.



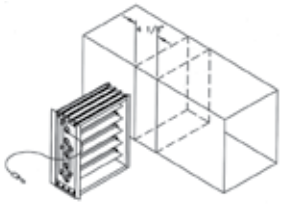
Step 4: Slide the damper into the duct work.
Step 5: Secure the damper to the ductwork with the screws provided.



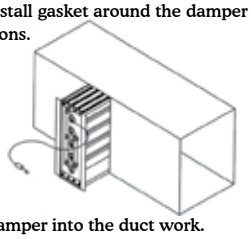
Step 6: Adjust the damper blade position for proper air flow by pushing or pulling the looped wire end of the control cable.
Step 7: Tighten the set screw nearest to the looped wire end of the cable to lock the damper blade in the desired position.
Step 8: Store the control cable appropriately.

For adjustments: To re-adjust the damper blade position, loosen the locking set screw closest to the looped wire end of the control cable. Push or pull the looped wire until the desired air flow is achieved. Then tighten the locking set screw closest to the looped wire end of the control cable.

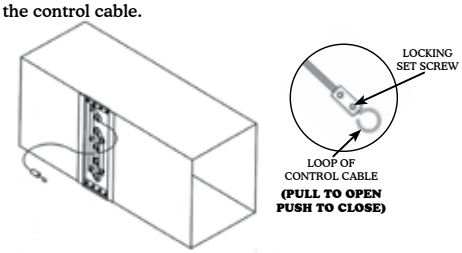
EXTERNAL CABLE - XCODS Series



Step 1: Cut 4-1/8" wide slot into the side of the sheet metal duct.
Step 2: If desired, install gasket around the damper frame per enclosed instructions.



Step 3: Slide the damper into the duct work.
Step 4: Secure the damper to the ductwork with the screws provided.
Step 5: Route the damper control cable to the remote adjustment point, being sure to avoid severe bending or kinking of the control cable.



Step 6: Adjust the damper blade position for proper air flow by pushing or pulling the looped wire end of the control cable.
Step 7: Tighten the set screws nearest to the looped wire end of the cable to lock the damper blade in the desired position.
Step 8: Store the control cable appropriately.

For adjustments: To re-adjust the damper blade position, loosen the locking set screw closest to the looped wire end of the control cable. Push or pull the looped wire until the desired air flow is achieved. Then tighten the locking set screw closest to the looped wire end of the control cable.

Install all devices in accordance with applicable electrical and mechanical codes.

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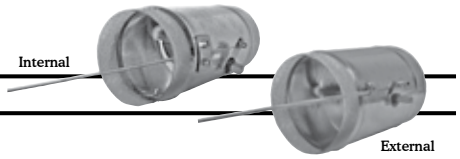
ALL DUROZONE DAMPERS FEATURE:
• 5 year limited warranty • Controlled bypass • Maintenance free operation • Quick install mounting clips (except Round Dampers) • 100% factory testing • Custom dampers and special controls are available on request.

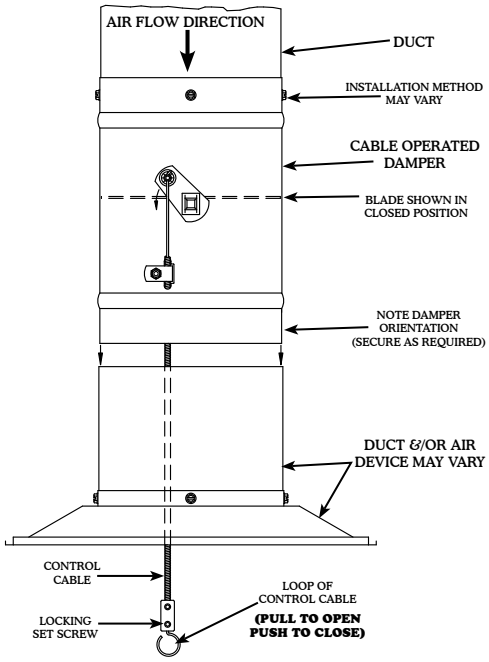
CSI #: 23 33 13

DuroZone®



INSTALLATION INSTRUCTIONS
Round Cable Operated Damper

INTERNAL CABLE - CODR Series



Step 1: Install the damper in the duct as required.

Step 2: Pass the damper control cable through the duct to the air device or the remote adjustment point.

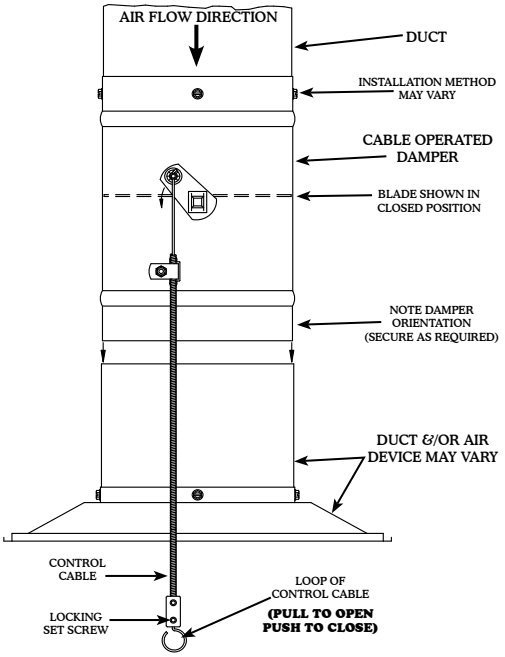
Step 3: Adjust the damper blade position for proper air flow by pushing or pulling the looped wire end of the control cable.

Step 4: Tighten the set screw nearest to the looped wire end of the cable to lock the damper blade in the desired position.

Step 5: Store the control cable appropriately.

For adjustments: To re-adjust the damper blade position, loosen the locking set screw closest to the looped wire end of the control cable. Push or pull the looped wire until the desired air flow is achieved. Then tighten the locking set screw closest to the looped wire end of the control cable.

EXTERNAL CABLE - XCODR Series



Step 1: Install the damper in the duct as required.

Step 2: Route the damper control cable to the remote adjustment point, being sure to avoid severe bending or kinking of the control cable.

Step 3: Adjust the damper blade position for proper air flow by pushing or pulling the looped wire end of the control cable.

Step 4: Tighten the set screw nearest to the looped wire end of the cable to lock the damper blade in the desired position.

Step 5: Store the control cable appropriately.

For adjustments: To re-adjust the damper blade position, loosen the locking set screw closest to the looped wire end of the control cable. Push or pull the looped wire until the desired air flow is achieved. Then tighten the locking set screw closest to the looped wire end of the control cable.

Install all devices in accordance with applicable electrical and mechanical codes.

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ALL DUROZONE DAMPERS FEATURE:
• 5 year limited warranty • Controlled bypass • Maintenance free operation • Quick install mounting clips (except Round Dampers) • 100% factory testing • Custom dampers and special controls are available on request.

CSI #: 23 37 13

Engineering Data

Engineering Data

Hart&Cooley
install confidence

301 Curved-Blade Register (Page 11)

Face Velocity		300	400	500	600	700	800	900	1000
6 x 6 Ak .09	CFM	30	40	45	55	65	75	85	95
	Ps	.007	.013	.020	.029	.040	.052	.066	.081
	Throw	6.0	8.0	10.0	11.0	13.0	15.0	17.0	19.0
8 x 4 Ak .11	CFM	30	45	55	65	75	85	95	105
	Ps	.007	.013	.021	.030	.041	.053	.067	.083
	Throw	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
8 x 6 Ak .12	CFM	35	50	60	75	85	100	110	125
	Ps	.007	.013	.021	.030	.040	.053	.067	.082
	Throw	7.0	9.0	11.0	13.0	15.0	17.0	19.0	22.0
8 x 8 Ak .16	CFM	50	65	80	95	110	130	145	160
	Ps	.008	.014	.022	.031	.042	.055	.070	.086
	Throw	8.0	10.0	12.0	15.0	17.0	20.0	22.0	25.0
10 x 4 Ak .12	CFM	35	50	60	70	85	95	110	120
	Ps	.008	.013	.021	.030	.041	.054	.068	.084
	Throw	6.0	9.0	11.0	13.0	15.0	17.0	19.0	21.0
10 x 6 Ak .14	CFM	40	55	70	80	95	110	120	135
	Ps	.008	.014	.021	.031	.042	.054	.069	.085
	Throw	7.0	9.0	11.0	14.0	16.0	18.0	20.0	23.0
10 x 8 Ak .19	CFM	55	75	95	115	130	150	170	190
	Ps	.008	.014	.022	.031	.043	.056	.071	.087
	Throw	8.0	11.0	13.0	16.0	19.0	21.0	24.0	27.0
10 x 10 Ak .24	CFM	70	95	120	145	170	190	215	240
	Ps	.008	.014	.021	.030	.042	.054	.069	.085
	Throw	8.0	11.0	14.0	16.0	19.0	22.0	24.0	27.0
12 x 4 Ak .13	CFM	40	55	65	80	95	105	120	135
	Ps	.008	.014	.021	.031	.042	.054	.069	.085
	Throw	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
12 x 6 Ak .18	CFM	55	75	95	110	130	150	165	185
	Ps	.008	.015	.023	.033	.045	.059	.074	.091
	Throw	7.0	9.0	11.0	13.0	16.0	18.0	20.0	22.0
12 x 8 Ak .22	CFM	65	85	110	130	150	170	195	215
	Ps	.008	.014	.022	.032	.043	.056	.071	.088
	Throw	8.0	11.0	13.0	16.0	19.0	21.0	24.0	26.0
12 x 12 Ak .30	CFM	90	120	150	180	210	235	265	295
	Ps	.008	.014	.022	.032	.044	.057	.073	.090
	Throw	10.0	13.0	16.0	19.0	22.0	25.0	28.0	31.0
14 x 4 Ak .15	CFM	45	60	75	90	105	120	130	145
	Ps	.008	.140	.021	.031	.042	.055	.069	.086
	Throw	10.0	14.0	17.0	20.0	24.0	27.0	30.0	34.0
14 x 6 Ak .22	CFM	65	85	110	130	150	175	195	215
	Ps	.008	.014	.022	.031	.042	.055	.070	.087
	Throw	7.0	9.0	12.0	14.0	16.0	19.0	21.0	23.0
14 x 8 Ak .24	CFM	75	95	120	145	170	195	220	240
	Ps	.008	.014	.022	.032	.043	.057	.072	.089
	Throw	9.0	12.0	14.0	17.0	20.0	23.0	26.0	29.0

Terminal Velocity of 75 FPM

302 Curved-Blade Register (Page 12)

Face Velocity		300	400	500	600	700	800	900	1000
8 x 4 Ak .11	CFM	30	40	50	65	75	85	95	105
	Ps	.012	.021	.033	.047	.064	.083	.106	.013
	Throw	3.0	4.0	6.0	7.0	8.0	9.0	10.0	11.0
8 x 6 Ak .13	CFM	40	50	65	75	90	100	115	125
	Ps	.012	.020	.032	.046	.063	.082	.104	.128
	Throw	4.0	5.0	6.0	7.0	8.0	9.0	11.0	12.0
8 x 8 Ak .19	CFM	55	75	90	110	130	150	165	185
	Ps	.011	.020	.031	.045	.061	.080	.101	.125
	Throw	5.0	6.0	7.0	9.0	10.0	11.0	13.0	14.0
10 x 6 Ak .17	CFM	50	65	85	100	115	130	150	165
	Ps	.011	.020	.031	.045	.062	.080	.102	.126
	Throw	4.0	6.0	7.0	8.0	9.0	11.0	12.0	13.0
10 x 8 Ak .23	CFM	65	90	110	135	155	180	200	225
	Ps	.011	.020	.031	.044	.061	.079	.100	.124
	Throw	5.0	7.0	8.0	10.0	11.0	13.0	14.0	15.0
12 x 6 Ak .21	CFM	60	80	100	125	145	165	15	205
	Ps	.011	.020	.031	.045	.061	.079	.101	.124
	Throw	5.0	6.0	8.0	9.0	10.0	12.0	13.0	15.0
12 x 8 Ak .27	CFM	80	105	130	160	185	210	240	265
	Ps	.011	.020	.031	.044	.060	.079	.099	.123
	Throw	5.0	7.0	9.0	10.0	12.0	14.0	15.0	17.0
14 x 6 Ak .24	CFM	70	95	115	140	165	190	210	235
	Ps	.011	.020	.031	.044	.060	.079	.100	.123
	Throw	5.0	7.0	8.0	10.0	11.0	13.0	14.0	16.0
14 x 8 Ak .31	CFM	90	120	150	185	215	245	275	305
	Ps	.011	.020	.031	.044	.060	.078	.099	.122
	Throw	6.0	8.0	9.0	11.0	13.0	14.0	16.0	18.0

Terminal Velocity of 75 FPM

303 Curved-Blade Register (Page 12)

Face Velocity		300	400	500	600	700	800	900	1000
6 x 6 Ak .12	CFM	35	50	60	75	85	100	110	125
	Ps	.014	.025	.039	.056	.077	.100	.126	.156
L	Throw	5.0	7.0	9.0	10.0	12.0	14.0	15.0	17.0
S	Throw	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
8 x 4 Ak .10	CFM	30	40	50	65	75	85	95	105
	Ps	.015	.027	.041	.060	.081	.106	.134	.166
L	Throw	5.0	6.0	8.0	9.0	11.0	12.0	14.0	15.0
S	Throw	3.0	4.0	5.0	6.0	7.0	8.0	8.0	9.0
8 x 6 Ak .14	CFM	40	55	70	85	100	115	125	140
	Ps	.015	.026	.041	.059	.080	.104	.132	.163
L	Throw	6.0	7.0	9.0	11.0	13.0	15.0	16.0	18.0
S	Throw	3.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
8 x 8 Ak .18	CFM	55	75	90	110	130	145	165	185
	Ps	.013	.022	.035	.050	.069	.090	.114	.140
L	Throw	6.0	8.0	11.0	13.0	15.0	17.0	19.0	21.0
S	Throw	4.0	5.0	6.0	8.0	9.0	10.0	11.0	12.0
10 x 4 Ak .12	CFM	35	50	60	75	85	100	110	125
	Ps	.014	.025	.039	.056	.076	.100	.126	.156
L	Throw	5.0	7.0	9.0	10.0	12.0	14.0	15.0	17.0
S	Throw	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
10 x 6 Ak .17	CFM	50	70	85	105	120	140	155	175
	Ps	.015	.027	.043	.062	.084	.110	.139	.171
L	Throw	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
S	Throw	4.0	5.0	6.0	7.0	9.0	10.0	11.0	12.0
10 x 8 Ak .22	CFM	65	90	110	135	155	180	200	225
	Ps	.012	.022	.034	.049	.066	.086	.109	.135
L	Throw	7.0	9.0	12.0	14.0	16.0	18.0	21.0	23.0
S	Throw	4.0	6.0	7.0	8.0	10.0	11.0	12.0	14.0
10 x 10 Ak .31	CFM	95	125	155	185	220	250	280	310
	Ps	.015	.027	.043	.062	.084	.110	.139	.172
L	Throw	8.0	11.0	14.0	16.0	19.0	22.0	24.0	27.0
S	Throw	5.0	7.0	8.0	10.0	11.0	13.0	14.0	16.0
12 x 6 Ak .21	CFM	60	85	105	125	145	165	185	205
	Ps	.012	.022	.034	.049	.066	.086	.109	.135
L	Throw	7.0	9.0	11.0	13.0	15.0	18.0	20.0	22.0
S	Throw	4.0	6.0	7.0	8.0	9.0	11.0	12.0	13.0
12 x 8 Ak. 26	CFM	80	105	130	160	185	210	240	265
	Ps	.008	.014	.022	.032	.044	.057	.072	.089
L	Throw	8.0	10.0	13.0	15.0	17.0	20.0	22.0	25.0
S	Throw	5.0	6.0	8.0	9.0	11.0	12.0	13.0	15.0
12 x 12 Ak .38	CFM	115	155	190	230	270	305	345	385
	Ps	.008	.014	.023	.033	.044	.058	.073	.090
L	Throw	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
S	Throw	6.0	7.0	9.0	11.0	13.0	14.0	16.0	18.0
14 x 4 Ak .16	CFM	50	65	80	100	115	130	150	165
	Ps	.008	.014	.022	.031	.042	.055	.070	.086
L	Throw	6.0	8.0	10.0	12.0	14.0	16.0	17.0	19.0
S	Throw	4.0	5.0	6.0	7.0	9.0	10.0	11.0	12.0
14 x 6 Ak .20	CFM	60	80	100	120	145	165	185	205
	Ps	.009	.017	.026	.037	.051	.066	.084	.104
L	Throw	7.0	9.0	11.0	13.0	15.0	17.0	20.0	22.0
S	Throw	4.0	6.0	7.0	8.0	9.0	11.0	12.0	13.0
14 x 8 Ak .30	CFM	90	120	150	185	215	245	275	305
	Ps	.008	.014	.022	.032	.044	.057	.073	.090
L	Throw	8.0	11.0	13.0	16.0	19.0	21.0	24.0	27.0
S	Throw	5.0	7.0	8.0	10.0	11.0	13.0	14.0	16.0
16 x 6 Ak .26	CFM	80	105	130	160	185	210	240	265
	Ps	.008	.014	.022	.032	.044	.057	.072	.089
L	Throw	8.0	10.0	12.0	15.0	17.0	20.0	22.0	25.0
S	Throw	5.0	6.0	8.0	9.0	11.0	12.0	14.0	15.0

Terminal Velocity of 75 FPM

304 Curved-Blade Register (Page 13)

Face Velocity		300	400	500	600	700	800	900	1000
6 x 6 Ak .16	CFM	50	65	80	95	110	125	145	160
	Ps	.040	.072	.112	.161	.219	.287	.363	.448
L	Throw	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
S	Throw	4.0	5.0	6.0	7.0	8.0	9.0	11.0	12.0
8 x 8 Ak .22	CFM	65	85	110	130	155	175	195	220
	Ps	.024	.043	.067	.096	.130	.170	.216	.266
L	Throw	4.0	5.0	6.0	7.0	8.0	10.0	11.0	12.0
S	Throw	4.0	6.0	7.0	8.0	10.0	11.0	12.0	14.0
10 x 10 Ak .28	CFM	85	115	140	170	200	225	255	285
	Ps	.016	.029	.045	.064	.087	.114	.144	.178
L	Throw	4.0	6.0	7.0	8.0	10.0	11.0	12.0	14.0
S	Throw	5.0	6.0	8.0	10.0	11.0	13.0	14.0	16.0
12 x 12 Ak .40	CFM	120	160	200	235	275	315	355	395
	Ps	.012	.022	.032	.047	.064	.084	.107	.133
L	Throw	5.0	7.0	8.0	10.0	11.0	13.0	14.0	16.0
S	Throw	6.0	8.0	9.0	11.0	13.0	15.0	17.0	18.0
14 x 14 Ak .48	CFM	145	190	240	285	335	380	430	475
	Ps	.009	.016	.025	.037	.049	.065	.081	.102
L	Throw	6.0	7.0	9.0	11.0	12.0	14.0	16.0	18.0
S	Throw	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0

Terminal Velocity of 75 FPM

Recommended Noise Criteria and Face Velocity Ranges are on page 37

CSI #: 23 37 13

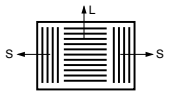
Engineering Data

Hart&Cooley
install confidence

631 Register (Page 17)

Face Velocity		300	400	500	600	700	800	900	1000
Pressure Loss		.006	.010	.016	.022	.031	.040	.050	.062
10 x 6	CFM	85	110	140	170	195	225	250	280
Ak .18	Throw L/S	4.0/8.0	5.5/10.0	7.0/13.0	8.5/16.0	9.5/19.0	11.0/21.0	13.0/24.0	15.0/26.0
12 x 6	CFM	100	135	170	205	240	275	305	340
Ak .34	Throw L/S	4.0/8.0	5.0/10.0	6.0/13.0	7.5/16.0	9.0/20.0	10.0/22.0	11.5/24.0	13.0/28.0
10 x 8	CFM	115	150	190	230	265	305	340	380
Ak .38	Throw L/S	3.5/9.5	5.0/13.0	6.0/16.0	7.0/18.0	8.0/21.0	9.0/24.0	10.5/29.0	11.5/32.0
14 x 6	CFM	120	160	200	240	280	320	360	400
Ak .40	Throw L/S	4.0/10.0	5.0/12.0	6.5/16.0	8.0/19.0	9.0/22.0	10.0/24.0	11.0/27.0	12.5/30.0
12 x 8	CFM	140	190	235	280	330	375	425	470
Ak .47	Throw L/S	4.5/10.0	6.0/13.0	7.5/15.0	9.0/18.0	10.0/21.0	11.5/25.0	13.0/28.0	14.5/31.0
14 x 8	CFM	165	220	275	330	385	440	495	550
Ak .55	Throw L/S	4.0/10.0	5.5/13.5	7.5/18.0	8.5/22.0	10.0/25.0	11.5/29.0	13.0/33.0	15.0/36.0

Terminal Velocity of 75 FPM



650 & A650 Return Air Grille (Page 17, 18)
659 Return Air Filter Grille (Page 18)

Face Velocity*		300	400	500	600
6 x 4	CFM	33	44	55	66
Ak .111	Ps	.010	.018	.029	.041
6 x 6	CFM	50	67	83	100
Ak .167	Ps	.010	.018	.029	.041
8 x 4	CFM	44	59	74	89
Ak .148	Ps	.010	.018	.029	.041
8 x 6	CFM	67	89	112	134
Ak .223	Ps	.010	.018	.029	.041
8 x 8	CFM	90	120	150	179
Ak .299	Ps	.010	.018	.029	.041
10 x 4	CFM	56	74	93	111
Ak .186	Ps	.010	.018	.029	.041
10 x 6	CFM	84	112	140	168
Ak .280	Ps	.010	.018	.029	.041
10 x 8	CFM	112	150	187	225
Ak .375	Ps	.010	.018	.029	.041
10 x 10	CFM	141	188	235	282
Ak .470	Ps	.010	.018	.029	.041
12 x 6	CFM	101	135	168	202
Ak .337	Ps	.010	.018	.029	.041
12 x 8	CFM	135	180	226	271
Ak .451	Ps	.010	.018	.029	.041
12 x 10	CFM	170	226	283	339
Ak .566	Ps	.010	.018	.029	.041
12 x 12	CFM	204	272	340	408
Ak .681	Ps	.010	.018	.029	.041
12 x 18	CFM	308	411	513	616
Ak 1.027	Ps	.010	.018	.029	.041
14 x 6	CFM	118	158	197	236
Ak .394	Ps	.010	.018	.029	.041
14 x 8	CFM	158	211	264	316
Ak .527	Ps	.010	.018	.029	.041
14 x 10	CFM	198	265	331	397
Ak .661	Ps	.010	.018	.029	.041
14 x 12	CFM	239	318	398	477
Ak .796	Ps	.010	.018	.029	.041
14 x 14	CFM	279	372	465	558
Ak .930	Ps	.010	.018	.029	.041
14 x 18	CFM	360	480	600	720
Ak 1.200	Ps	.010	.018	.029	.041

Face Velocity*		300	400	500	600
16 x 6	CFM	135	180	226	271
Ak .451	Ps	.010	.018	.029	.041
16 x 8	CFM	181	242	302	362
Ak .604	Ps	.010	.018	.029	.041
16 x 10	CFM	227	303	379	454
Ak .757	Ps	.010	.018	.029	.041
16 x 12	CFM	273	364	455	547
Ak .911	Ps	.010	.018	.029	.041
16 x 14	CFM	320	426	533	639
Ak 1.065	Ps	.010	.018	.029	.041
16 x 16	CFM	366	488	610	732
Ak 1.219	Ps	.010	.018	.029	.041
16 x 24	CFM	552	736	920	1104
Ak 1.840	Ps	.010	.018	.029	.041
18 x 6	CFM	153	203	254	305
Ak .508	Ps	.010	.018	.029	.041
18 x 18	CFM	465	619	774	929
Ak 1.548	Ps	.010	.018	.029	.041
20 x 6	CFM	170	226	283	339
Ak .566	Ps	.010	.018	.029	.041
20 x 10	CFM	285	380	475	570
Ak .949	Ps	.010	.018	.029	.041
20 x 12	CFM	343	457	571	685
Ak 1.142	Ps	.010	.018	.029	.041
20 x 14	CFM	401	534	668	801
Ak 1.335	Ps	.010	.018	.029	.041
20 x 20	CFM	575	767	959	1150
Ak 1.917	Ps	.010	.018	.029	.041
20 x 24	CFM	692	923	1153	1384
Ak 2.307	Ps	.010	.019	.029	.042
20 x 25	CFM	721	962	1202	1442
Ak 2.404	Ps	.010	.019	.029	.042

For sizes not listed and sizing tips see page 37

Face Velocity*		300	400	500	600
24 x 4	CFM	135	180	226	271
Ak .451	Ps	.010	.018	.029	.041
24 x 6	CFM	204	272	340	408
Ak .681	Ps	.010	.018	.029	.041
24 x 8	CFM	273	364	455	547
Ak .911	Ps	.010	.018	.029	.041
24 x 10	CFM	343	457	571	685
Ak 1.142	Ps	.010	.018	.029	.041
24 x 12	CFM	412	550	687	825
Ak 1.374	Ps	.010	.018	.029	.041
24 x 14	CFM	482	643	803	964
Ak 1.607	Ps	.010	.018	.029	.041
24 x 24	CFM	832	1110	1387	1665
Ak 2.775	Ps	.010	.019	.029	.042
30 x 4	CFM	170	226	283	339
Ak .566	Ps	.010	.018	.029	.041
30 x 6	CFM	256	341	427	512
Ak .853	Ps	.010	.018	.029	.041
30 x 8	CFM	343	457	571	685
Ak 1.142	Ps	.010	.018	.029	.041
30 x 10	CFM	430	573	716	859
Ak 1.432	Ps	.010	.018	.029	.041
30 x 12	CFM	517	689	862	1034
Ak 1.723	Ps	.010	.018	.029	.041
30 x 14	CFM	604	806	1007	1209
Ak 2.015	Ps	.010	.018	.029	.042
30 x 18	CFM	780	1040	1300	1560
Ak 2.599	Ps	.010	.019	.029	.042
30 x 20	CFM	868	1157	1446	1735
Ak 2.892	Ps	.010	.019	.029	.042
30 x 24	CFM	1044	1392	1740	2088
Ak 3.479	Ps	.010	.019	.029	.042
30 x 30	CFM	1309	1745	2181	2618
Ak 4.363	Ps	.010	.019	.029	.042
36 x 6	CFM	308	411	513	616
Ak 1.027	Ps	.010	.018	.029	.041
36 x 8	CFM	412	550	687	825
Ak 1.374	Ps	.010	.018	.029	.041

*Filter grilles: Tested without filters. Typical capacity is 2 CFM per square inch of nominal filter area. Recommended face velocity is 300-450 FPM. Velocities higher will decrease filter performance, increase flow resistance, and possibly be of noise concern. Velocity measured 1" from face.

651 Baseboard Register (Page 18)

Face Velocity		300	400	500	600	700	800	900	1000
Pressure Loss		.006	.010	.016	.022	.031	.040	.050	.062
8 x 4	CFM	33	44	55	66	77	88	100	110
Ak .110	Throw	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
10 x 4	CFM	40	54	67	80	95	110	120	135
Ak .135	Throw	6.5	8.5	10.5	12.5	15.0	17.5	19.0	21.0
12 x 4 and 8 x 6	CFM	55	72	90	108	125	145	162	180
Ak .180	Throw	7.5	10.0	12.5	15.0	17.5	20.5	23.0	25.0
10 x 6	CFM	70	92	115	140	160	185	205	230
Ak .230	Throw	9.0	11.5	14.5	17.5	20.0	23.0	25.5	29.0
12 x 6	CFM	85	115	145	175	205	230	260	290
Ak .290	Throw	10.0	13.0	17.0	20.0	23.5	26.5	30.0	33.0
14 x 6	CFM	102	135	170	205	240	270	305	340
Ak .340	Throw	11.0	14.5	18.0	22.0	25.5	29.0	32.5	36.0

Terminal Velocity of 75 FPM

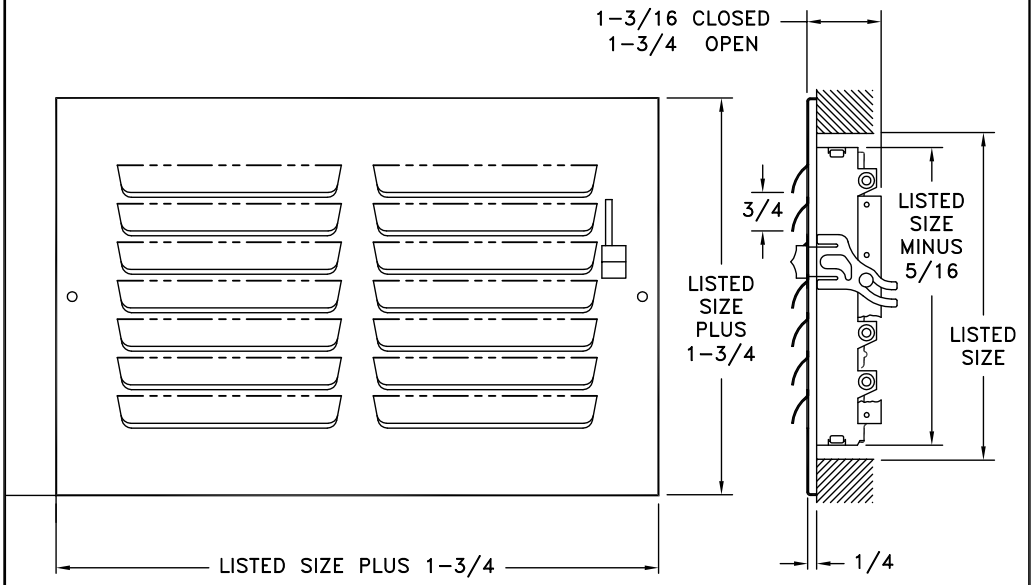
Recommended Noise Criteria and Face Velocity Ranges are on page 37

CSI #: 23 33 13

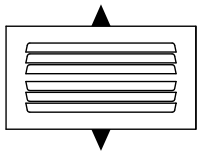
HART COOLEY

SUBMITTAL DRAWING

FACE MATERIAL: .032 ALUMINUM
- INTEGRAL STEEL MULTI-SHUTTER DAMPER
- SIZES VARY BY FACE STYLE
- TWO DAMPERS ON HEIGHTS GREATER THAN 8 INCHES
- FINISH: WHITE (W) ENAMEL



A301



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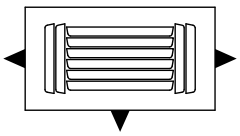
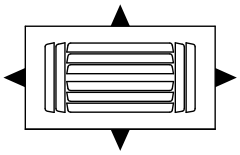


A303



A304

DAMPER AND DIMENSIONS ARE TYPICAL FOR ALL DEFLECTIONS

JOB NAME:	SUBMITTED BY:	DATE: 03/27/2013 SD-2500
LOCATION:		**A300** Stamped Aluminum Curved Blade Register
ARCHITECT:		
ENGINEER:		
CONTRACTOR:		

Hart & Cooley, Inc., Grand Rapids, MI 49512 Telephone 800-433-6341 Fax: 800-223-8461 © Hart & Cooley, Inc 2002

CSI #: 23 33 13

Engineering Data

Engineering Data

Hart&Cooley
install confidence

A500 Series (Page 29, 30)

A501MS/A501OB
One-Way Diffuser

Face Velocity		400	500	600	700	900	1100	1500
Pressure Loss		.010	.016	.022	.031	.050	.075	.140
6 x 6	CFM	55	65	75	90	120	140	195
Ak .13	Throw	5.0	6.0	7.0	8.0	10.0	12.0	15.0
8 x 8	CFM	75	90	105	120	150	180	240
Ak .20	Throw	6.0	7.0	8.0	10.0	12.0	15.0	18.0
10 x 10	CFM	115	135	155	175	235	290	395
Ak .29	Throw	7.0	8.0	10.0	12.0	15.0	19.0	24.0
12 x 12	CFM	170	210	255	300	380	470	610
Ak .42	Throw	8.0	10.0	12.0	15.0	19.0	24.0	29.0
14 x 14	CFM	250	305	360	410	505	610	800
Ak .59	Throw	11.0	13.0	15.0	18.0	24.0	30.0	35.0

A504MS/A504OB
Four-Way Diffuser

Face Velocity		400	500	600	700	900	1100	1500
Pressure Loss		.010	.016	.022	.031	.050	.075	.140
6 x 6	CFM	55	65	75	90	120	140	195
Ak .13	Throw	2.0	3.0	4.0	5.0	6.0	7.0	9.0
8 x 8	CFM	75	90	105	120	150	180	240
Ak .20	Throw	3.0	4.0	5.0	6.0	8.0	10.0	13.0
10 x 10	CFM	115	135	155	175	235	290	395
Ak .29	Throw	4.0	5.0	6.0	7.0	9.0	12.0	14.0
12 x 12	CFM	170	210	255	300	380	470	610
Ak .42	Throw	5.0	6.0	7.0	8.0	10.0	12.0	15.0
14 x 14	CFM	250	305	360	410	505	610	800
Ak .59	Throw	6.0	7.0	8.0	9.0	11.0	14.0	18.0

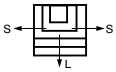
A502MS/A502OB
Two-Way Diffuser

Face Velocity		400	500	600	700	900	1100	1500
Pressure Loss		.010	.016	.022	.031	.050	.075	.140
6 x 6	CFM	55	65	75	90	120	140	195
Ak .13	Throw	3.0	4.0	5.0	6.0	7.0	9.0	12.0
8 x 8	CFM	75	90	105	120	150	180	240
Ak .20	Throw	4.0	5.0	6.0	7.0	9.0	12.0	16.0
10 x 10	CFM	115	135	155	175	235	290	395
Ak .29	Throw	5.0	6.0	7.0	8.0	10.0	14.0	20.0
12 x 12	CFM	170	210	255	300	380	470	610
Ak .42	Throw	6.0	7.0	8.0	10.0	13.0	17.0	23.0
14 x 14	CFM	250	305	360	410	505	610	800
Ak .59	Throw	7.0	9.0	11.0	13.0	16.0	19.0	27.0

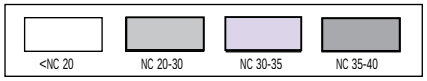
A505MS/A505OB
Two-Way Corner Diffuser

Face Velocity		400	500	600	700	900	1100	1500
Pressure Loss		.010	.016	.022	.031	.050	.075	.140
6 x 6	CFM	55	65	75	90	120	140	195
Ak .13	Throw	3.0	4.0	5.0	6.0	7.0	9.0	12.0
8 x 8	CFM	75	90	105	120	150	180	240
Ak .20	Throw	4.0	5.0	6.0	7.0	9.0	12.0	16.0
10 x 10	CFM	115	135	155	175	235	290	395
Ak .29	Throw	5.0	6.0	7.0	8.0	10.0	14.0	20.0
12 x 12	CFM	170	210	255	300	380	470	610
Ak .42	Throw	6.0	7.0	8.0	10.0	13.0	17.0	23.0
14 x 14	CFM	250	305	360	410	505	610	800
Ak .59	Throw	7.0	9.0	11.0	13.0	16.0	19.0	27.0

A503MS/A503OB
Three-Way Diffuser



Face Velocity		400	500	600	700	900	1100	1500
Pressure Loss		.010	.016	.022	.031	.050	.075	.140
6 x 6	CFM	55	65	75	90	120	140	195
Ak .13	Throw L/S	3.5/2.5	4.0/3.0	5.0/3.5	5.5/4.0	7.0/5.0	9.0/6.0	12.0/9.0
8 x 8	CFM	75	90	105	120	150	180	240
Ak .20	Throw L/S	4.0/2.0	5.0/2.5	6.0/3.5	7.0/4.0	8.0/4.5	10.0/5.5	12.0/7.0
10 x 10	CFM	115	135	155	175	235	290	395
Ak .29	Throw L/S	5.0/3.0	7.0/4.0	8.0/4.5	10.0/5.5	12.0/7.0	14.0/8.5	18.0/10.5
12 x 12	CFM	170	210	255	300	380	470	610
Ak .42	Throw L/S	7.0/4.0	8.5/4.5	10.0/5.5	12.0/6.5	15.0/8.5	18.0/10.0	23.0/14.0
14 x 14	CFM	250	305	360	410	505	610	800
Ak .59	Throw L/S	8.0/5.5	10.0/6.0	11.5/7.0	13.0/7.5	15.5/9.0	20.0/11.0	27.0/16.0



Terminal velocity of FPM
NC Noise criteria rating. NC is based on 10db room absorption (ref. 10^{-12} watts).
Tested in accordance with ASHRAE 36-72, ADC 1062: GRD84 and ISO 3741.

Recommended Noise Criteria and Face Velocity Ranges are on page 37

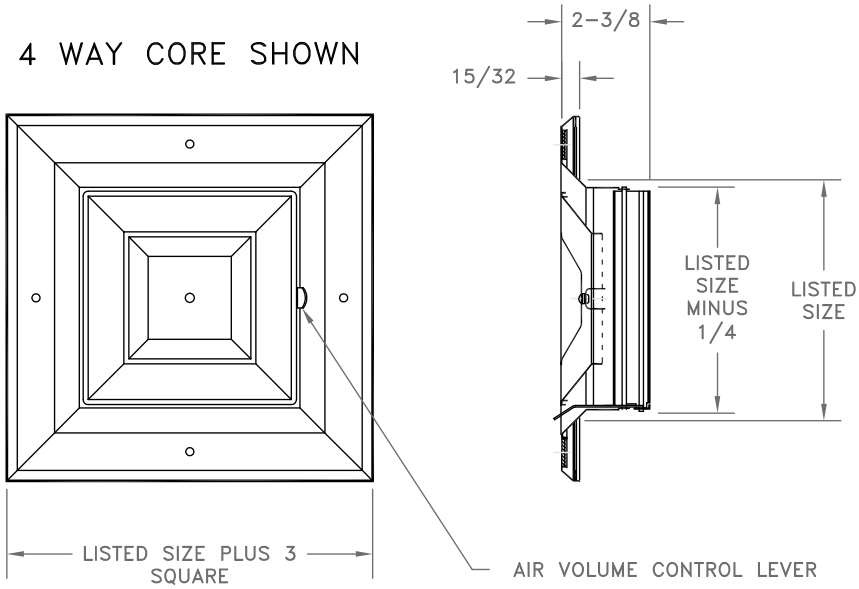
CSI #: 23 34 23

HART COOLEY

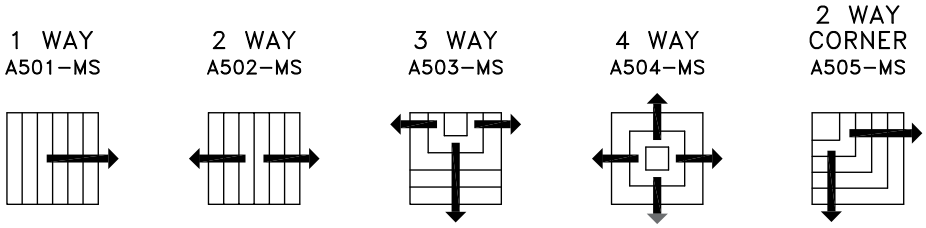
SUBMITTAL DRAWING

- INTEGRAL MULTI–SHUTTER DAMPER
- AVAILABLE IN SIZES 6 X 6 THROUGH 14 X 14 IN 2 INCH INCREMENTS
- A STEEL PANEL FOR ALL SIZES AND PATTERNS FITS 24 X 24 INCH T–BAR CEILINGS SEE SD–2302
- FINISH: WHITE (W) ENAMEL

4 WAY CORE SHOWN



FLOW PATTERNS



JOB NAME:	SUBMITTED BY:	DATE: 08/26/2013 SD–2300
LOCATION:		**A500MS** Aluminum Square Diffuser With Multi–Shutter Damper
ARCHITECT:		
ENGINEER:		
CONTRACTOR:		

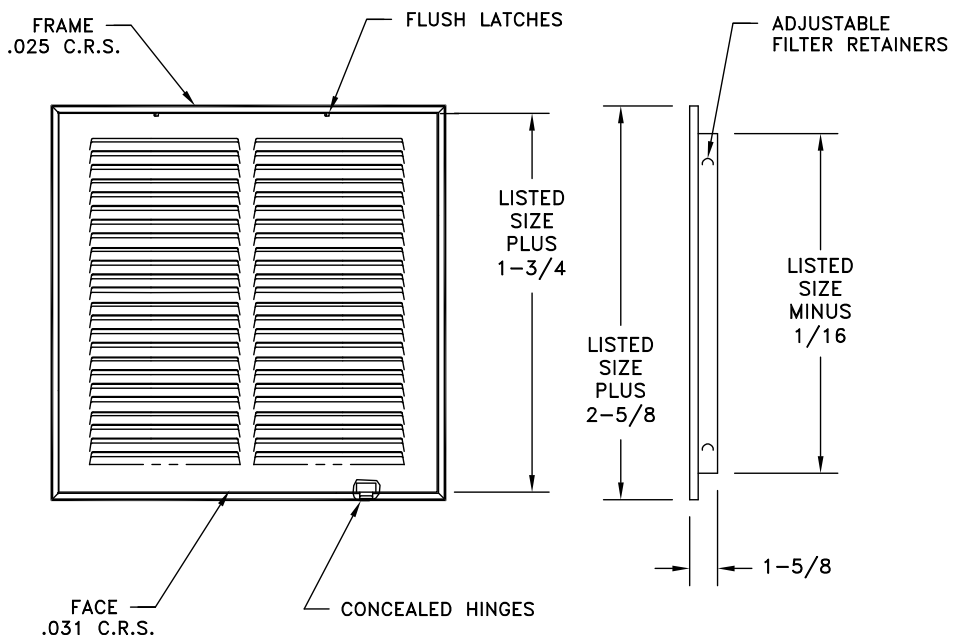
Hart & Cooley, Inc., 5030 Corporate Exchange Blvd, SE Grand Rapids, MI 49512 Telephone 1–800–433–6341 Fax: 1–800–223–8461 © Hart & Cooley, Inc 2002

CSI #: 23 33 00

HART COOLEY

SUBMITTAL DRAWING

- FLUSH, REMOVABLE FACE WITH CONCEALED LATCHES AND HINGES, CAN BE INSTALLED TWO WAYS
- 1/3 INCH SPACED FINS SET AT 20 DEGREES
- EQUIPPED WITH FILTER RETAINERS
- USES NOMINAL 1 INCH DISPOSABLE FILTERS
- MINIMUM SIZE = 10 X 10
- MAXIMUM SIZE = 36 X 24, 30 X 30, 24 X 36
- FINISH: WHITE (W) ENAMEL



JOB NAME:	SUBMITTED BY:	DATE: 08/23/2013 SD-2421
LOCATION:		**659** Steel Lanced Face Filter Grille
ARCHITECT:		
ENGINEER:		
CONTRACTOR:		

Hart & Cooley, Inc., 5030 Corporate Exchange Blvd, SE. Grand Rapids, MI 49512 Telephone 1-800-433-6341 Fax: 1-800-223-8461 © Hart & Cooley, Inc 2005

CSI #: 23 33 00

Engineering Data

Engineering Data

Hart&Cooley
install confidence

SD & SDD Ceiling Diffuser (Page 31)

Face Velocity		400	500	600	700	800	900	1000
Pressure Loss		**.010**	**.016**	**.022**	**.031**	**.040**	**.050**	**.062**
6 x 6	CFM	60	80	95	110	125	140	155
Ak .155	Throw	2.5	3.5	4.0	4.5	5.5	6.0	6.5
8 x 8	CFM	110	135	160	190	215	245	270
Ak .270	Throw	3.5	4.0	5.0	6.0	6.5	7.5	8.5
10 x 10	CFM	170	215	255	300	340	385	425
Ak .425	Throw	4.0	5.5	6.0	7.5	8.5	9.5	10.0
12 x 12	CFM	240	300	360	420	480	540	600
Ak .600	Throw	5.0	6.0	7.5	8.5	9.5	11.0	12.0
14 x 14	CFM	320	400	480	560	640	720	800
Ak .625	Throw	5.5	7.0	8.0	9.5	11.0	12.0	14.0
16 x 16	CFM	425	530	635	740	850	955	1060
Ak 1.060	Throw	6.5	8.0	9.5	11.0	13.0	14.0	16.0
18 x 18	CFM	545	680	815	950	1090	1225	1360
Ak 1.360	Throw	7.0	9.0	11.0	13.0	14.0	16.0	18.0
20 x 20	CFM	660	825	990	1155	1320	1485	1650
Ak 1.650	Throw	8.0	10.0	12.0	14.0	16.0	18.0	20.0

Terminal Velocity of 50 FPM

ECFM Aluminum Diffuser (Page 31)

Face Velocity		400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
14 x 14	CFM	368	460	552	644	736	828	920	1104	1288	1472	1656	1840
Ak .920	Pt	.013	.020	.028	.038	.050	.063	.078	.112	.152	.199	.251	.310
16 x 16	CFM	484	605	726	847	968	1089	1210	1452	1694	1936	2178	2420
Ak 1.210	Pt	.013	.020	.028	.038	.050	.063	.078	.112	.153	.199	.252	.311
18 x 18	CFM	564	705	846	987	1128	1269	1410	1692	1974	2256	2538	2820
Ak 1.410	Pt	.012	.019	.027	.036	.047	.060	.074	.106	.144	.188	.235	.294
20 x 20	CFM	756	945	1134	1323	1512	1701	1890	2268	2646	3024	3402	3780
Ak 1.890	Pt	.013	.020	.028	.038	.050	.063	.078	.113	.153	.200	.252	.311

Notes:
1. ECFM diffusers tested with damper fully open.
2. Pt = Total Pressure is the sum of the static pressure and velocity pressure.
3. Ak is the effective area of the diffuser face.

ECBX Steel Box Diffuser (Page 32)

Face Velocity		400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
14 x 14	CFM	383	479	574	670	766	861	957	1148	1340	1531	1723	1914
Ak .960	Pt	.043	.064	.090	.119	.152	.188	.228	.318	.421	.536	.665	.806
18 x 18	CFM	464	580	696	812	928	1044	1160	1392	1624	1856	2088	2320
Ak 1.160	Pt	.028	.042	.056	.075	.094	.115	.138	.190	.248	.313	.383	.460
20 x 20	CFM	537	670	804	938	1072	1206	1340	1608	1876	2144	2412	2680
Ak 1.340	Pt	.028	.042	.059	.077	.098	.121	.146	.203	.267	.339	.419	.505
22 x 22	CFM	668	836	1003	1170	1337	1504	1671	2005	2339	2674	3008	3342
Ak 1.670	Pt	.017	.027	.040	.056	.075	.097	.121	.179	.250	.333	.428	.537
24 x 24	CFM	730	912	1094	1277	1459	1642	1824	2189	2554	2918	3283	3648
Ak 1.820	Pt	.032	.048	.066	.086	.109	.134	.161	.222	.291	.367	.452	.544
30 x 30	CFM	1118	1398	1678	1957	2237	2516	2796	3355	3914	4474	5033	5592
Ak 2.790	Pt	.026	.040	.057	.076	.098	.122	.149	.211	.283	.365	.457	.558
36 x 36	CFM	1404	1756	2107	2458	2809	3160	3511	4213	5915	5618	6320	7022
Ak 3.510	Pt	.030	.043	.060	.078	.098	.120	.144	.197	.257	.324	.397	.477

Notes:
1. ECBX diffusers tested with damper fully open.
2. Pt = Total Pressure is the sum of the static pressure and velocity pressure.
3. Ak is the effective area of the diffuser face.
4. Tests conducted in accordance with ASHRAE 70-1991.

ECSD & ECSDD Step-Down Evaporative Cooler Diffuser (Page 32)

Face Velocity		400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
14 x 14	CFM	255	320	385	450	510	575	640	770	895	1025	1150	1280
Ak .740	Pt	.012	.018	.023	.035	.044	.051	.067	.094	.130	.171	.210	.250
16 x 16	CFM	370	465	560	650	745	835	930	1115	1300	1490	1675	1860
Ak .930	Pt	.016	.020	.031	.041	.055	.069	.084	.120	.160	.198	.240	.265
18 x 18	CFM	480	600	700	840	960	1080	1200	1440	1680	1920	2160	2400
Ak 1.200	Pt	.015	.022	.031	.044	.057	.072	.088	.122	.164	.205	.250	.290
20 x 20	CFM	600	750	900	1050	1200	1350	1500	1800	2100	2400	2700	3000
Ak 1.500	Pt	.017	.024	.035	.051	.058	.075	.091	.125	.170	.218	.260	.300

Notes:
1. ECSD diffusers tested with damper fully open.
2. Pt = Total Pressure is the sum of the static pressure and velocity pressure.
3. Ak is the effective area of the diffuser face.

Face Velocity		400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
14 x 14	CFM	303	379	454	530	606	681	757	908	1060	1211	1363	1514
Ak .760	Ps	.015	.023	.034	.046	.061	.077	.096	.139	.191	.250	.318	.394
16 x 16	CFM	384	480	576	672	768	864	960	1152	1344	1536	1728	1920
Ak .960	Ps	.019	.029	.041	.055	.071	.089	.109	.156	.210	.271	.341	.418
18 x 18	CFM	495	619	743	867	990	1114	1238	1486	1733	1981	2228	2476
Ak 1.240	Ps	.018	.027	.039	.053	.068	.086	.105	.150	.202	.261	.329	.403
20 x 20	CFM	642	803	963	1124	1284	1445	1605	1926	2247	2568	2889	3210
Ak 1.600	Ps	.015	.025	.036	.050	.066	.084	.105	.154	.213	.282	.361	.450

Notes:
1. ECSDD diffusers tested with damper fully open.
2. Pt = Total Pressure is the sum of the static pressure and velocity pressure.
3. Ak is the effective area of the diffuser face.
4. Tests conducted in accordance with ASHRAE 70-1991.

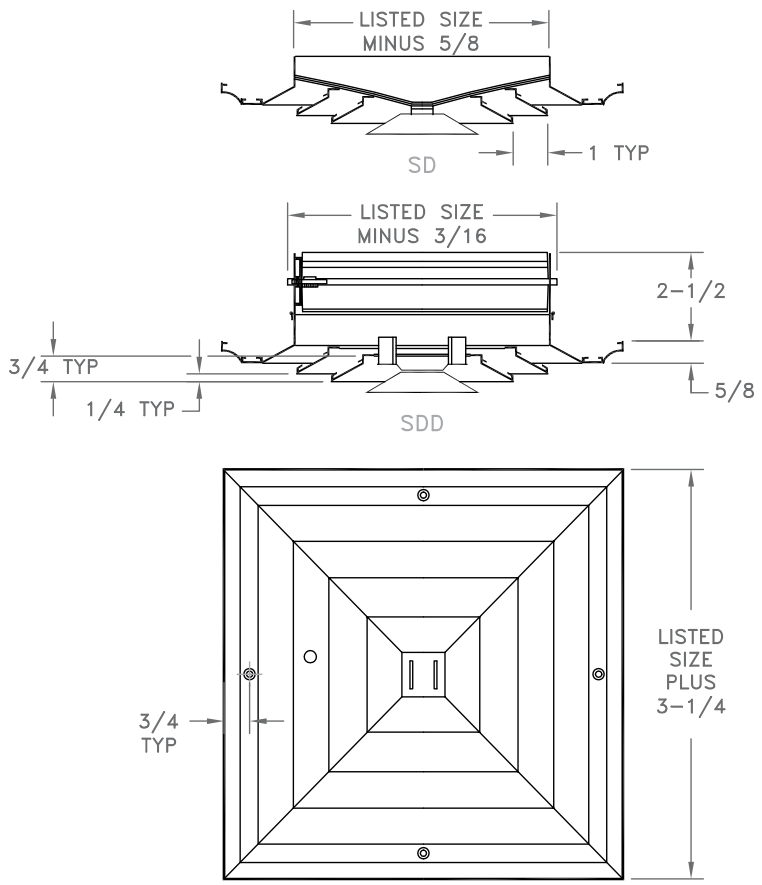
Recommended Noise Criteria and Face Velocity Ranges are on page 37

CSI #: 23 33 13

HART COOLEY

SUBMITTAL DRAWING

- ALL EXTRUDED ALUMINUM CONSTRUCTION
- SD MODEL IS DIFFUSER ONLY
- SDD MODEL IS DIFFUSER WITH OPPOSED BLADE DAMPER
- MOUNTING SCREWS FURNISHED
- AVAILABLE IN SIZES 6 X 6 THROUGH 20 X 20 IN 2 INCH INCREMENTS
- 20 X 20 IS FURNISHED WITH TWO DAMPERS
- FINISH: WHITE (W) ENAMEL OR SATIN ANODIZED (SA)



JOB NAME:	SUBMITTED BY:	DATE: 08/26/2013 SD-2305
LOCATION:		**SD, SDD** Extruded Aluminum Step Down Face Diffuser
ARCHITECT:		
ENGINEER:		
CONTRACTOR:		

Hart & Cooley, Inc., 5030 Corporate Exchange Blvd, SE Grand Rapids, MI 49512 Telephone 1-800-433-6341 Fax: 1-800-223-8461 © Hart & Cooley, Inc 2002

CSI #: 23 09 13

Rectangular Opposed Blade Cable Operated Damper

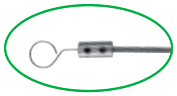
Internal Mounted Cable

DuroZone® A Division Of DURO DYNE®

Cable operated dampers are the most convenient and economical way to balance air flow through the face of a diffuser. The damper is inserted into a slot in the side of the duct upstream of the diffuser. The air flow is adjusted by simply pushing or pulling on the core wire which changes the damper blade position. Once the adjustment has been made, it is locked by tightening the set screw nearest to the looped end.

Features

- Available with cable lengths of up to 15'
- Opposed blade action
- Rigid extruded aluminum frame



Looped end of adjustment cable with two set screws

Ordering Information - INTERNAL Cable

Description	3 foot Cable*		5 foot Cable*		8 foot Cable*		10 foot Cable*		15 foot Cable*	
	Item #	Code	Item #	Code	Item #	Code	Item #	Code	Item #	Code
6x6 Rectangular Cab Op Damper	54001	CODS060603	54002	CODS060605	54003	CODS060608	54004	CODS060610	54005	CODS060615
8x6 Rectangular Cab Op Damper	54006	CODS080603	54007	CODS080605	54008	CODS080608	54009	CODS080610	54010	CODS080615
10x6 Rectangular Cab Op Damper	54011	CODS100603	54012	CODS100605	54013	CODS100608	54014	CODS100610	54015	CODS100615
12x6 Rectangular Cab Op Damper	54016	CODS120603	54017	CODS120605	54018	CODS120608	54019	CODS120610	54020	CODS120615
14x6 Rectangular Cab Op Damper	54021	CODS140603	54022	CODS140605	54023	CODS140608	54024	CODS140610	54025	CODS140615
16x6 Rectangular Cab Op Damper	54026	CODS160603	54027	CODS160605	54028	CODS160608	54029	CODS160610	54030	CODS160615
18x6 Rectangular Cab Op Damper	54031	CODS180603	54032	CODS180605	54033	CODS180608	54034	CODS180610	54035	CODS180615
20x6 Rectangular Cab Op Damper	54036	CODS200603	54037	CODS200605	54038	CODS200608	54039	CODS200610	54040	CODS200615
22x6 Rectangular Cab Op Damper	54041	CODS220603	54042	CODS220605	54043	CODS220608	54044	CODS220610	54045	CODS220615
24x6 Rectangular Cab Op Damper	54046	CODS240603	54047	CODS240605	54048	CODS240608	54049	CODS240610	54050	CODS240615
8x8 Rectangular Cab Op Damper	54051	CODS080803	54052	CODS080805	54053	CODS080808	54054	CODS080810	54055	CODS080815
10x8 Rectangular Cab Op Damper	54056	CODS100803	54057	CODS100805	54058	CODS100808	54059	CODS100810	54060	CODS100815
12x8 Rectangular Cab Op Damper	54061	CODS120803	54062	CODS120805	54063	CODS120808	54064	CODS120810	54065	CODS120815
14x8 Rectangular Cab Op Damper	54066	CODS140803	54067	CODS140805	54068	CODS140808	54069	CODS140810	54070	CODS140815
16x8 Rectangular Cab Op Damper	54071	CODS160803	54072	CODS160805	54073	CODS160808	54074	CODS160810	54075	CODS160815
18x8 Rectangular Cab Op Damper	54076	CODS180803	54077	CODS180805	54078	CODS180808	54079	CODS180810	54080	CODS180815
20x8 Rectangular Cab Op Damper	54081	CODS200803	54082	CODS200805	54083	CODS200808	54084	CODS200810	54085	CODS200815
22x8 Rectangular Cab Op Damper	54086	CODS220803	54087	CODS220805	54088	CODS220808	54089	CODS220810	54090	CODS220815
24x8 Rectangular Cab Op Damper	54091	CODS240803	54092	CODS240805	54093	CODS240808	54094	CODS240810	54095	CODS240815
10x10 Rectangular Cab Op Damper	54096	CODS101003	54097	CODS101005	54098	CODS101008	54099	CODS101010	54100	CODS101015
12x10 Rectangular Cab Op Damper	54101	CODS121003	54102	CODS121005	54103	CODS121008	54104	CODS121010	54105	CODS121015
14x10 Rectangular Cab Op Damper	54106	CODS141003	54107	CODS141005	54108	CODS141008	54109	CODS141010	54110	CODS141015
16x10 Rectangular Cab Op Damper	54111	CODS161003	54112	CODS161005	54113	CODS161008	54114	CODS161010	54115	CODS161015
18x10 Rectangular Cab Op Damper	54116	CODS181003	54117	CODS181005	54118	CODS181008	54119	CODS181010	54120	CODS181015
20x10 Rectangular Cab Op Damper	54121	CODS201003	54122	CODS201005	54123	CODS201008	54124	CODS201010	54125	CODS201015
22x10 Rectangular Cab Op Damper	54126	CODS221003	54127	CODS221005	54128	CODS221008	54129	CODS221010	54130	CODS221015
24x10 Rectangular Cab Op Damper	54131	CODS241003	54132	CODS241005	54133	CODS241008	54134	CODS241010	54135	CODS241015
12x12 Rectangular Cab Op Damper	54136	CODS121203	54137	CODS121205	54138	CODS121208	54139	CODS121210	54140	CODS121215
14x12 Rectangular Cab Op Damper	54141	CODS141203	54142	CODS141205	54143	CODS141208	54144	CODS141210	54145	CODS141215
16x12 Rectangular Cab Op Damper	54146	CODS161203	54147	CODS161205	54148	CODS161208	54149	CODS161210	54150	CODS161215
18x12 Rectangular Cab Op Damper	54151	CODS181203	54152	CODS181205	54153	CODS181208	54154	CODS181210	54155	CODS181215
20x12 Rectangular Cab Op Damper	54156	CODS201203	54157	CODS201205	54158	CODS201208	54159	CODS201210	54160	CODS201215
22x12 Rectangular Cab Op Damper	54161	CODS221203	54162	CODS221205	54163	CODS221208	54164	CODS221210	54165	CODS221215
24x12 Rectangular Cab Op Damper	54166	CODS241203	54167	CODS241205	54168	CODS241208	54169	CODS241210	54170	CODS241215

***Dimension shown is for the cable casing. The actual core wire is slightly longer.**

CSI #: 23 09 13.43

SUBMITTAL RECORD
JOB _____
LOCATION _____
SUBMITTED TO _____
SUBMITTAL PREPARED BY _____
APPROVED BY _____
DATE _____

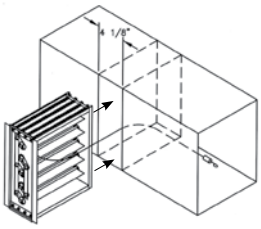
DURO DYNE®

Submittal Form

Rectangular Opposed Blade
Internal Cable Operated Damper

DESCRIPTION:

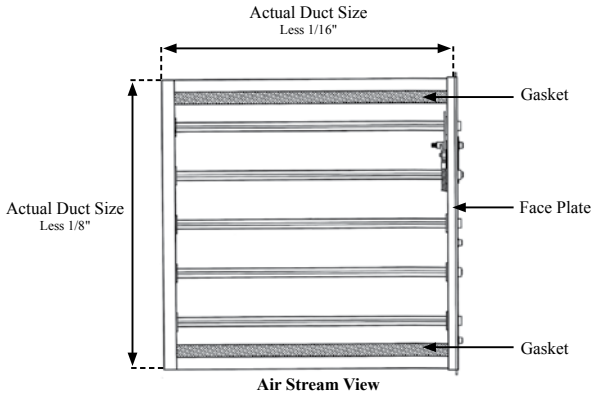
Duct systems are designed to supply a specific volume of air to a space. However, air flow adjustment is sometimes required to achieve original design parameters. Installation of a cable operated balancing damper allows the balancing contractor a convenient way to adjust air volume without entering the ceiling space. The cable operated damper is inserted through a slot in the side of the duct upstream of the diffuser. The adjustment cable is typically passed through the neck of the air device, in the airstream and is accessible for adjustment through the face of the air device. Once the air volume is satisfactory, the cable position is locked with a set screw and the cable is pushed into the neck of the air device, hidden from view.



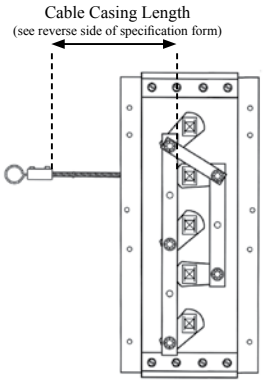
SUGGESTED SPECIFICATIONS:

Rectangular Opposed Blade Internal Cable Operated Dampers shall be Duro Dyne CODS type dampers. Damper blades and frames shall be manufactured of extruded aluminum. Cable case shall be galvanized steel; solid core control wire shall be stainless steel. Installation shall be as described in the Duro Dyne cable operated damper instructions. Sizes and locations shall be as indicated on the mechanical drawings.

Internal Cable Operated Damper



Air Stream View
(Damper Open)



Face Plate View

Damper Specifications			
Damper Component	**Material**	**Width**	**Depth**
Frame	Extruded Aluminum	4-1/16"	1/2"
Face Plate	Extruded Aluminum	5-9/16" (includes two 3/4" flanges)	5/16"
Blade	Extruded Aluminum	2-3/4"	3/32"
Gasket (on even heights only)	Vinyl Nitrile	3/4"	1/2"
Bushings for blades are nylon 5/8" outside diameter with a 3/8" square hole			
All blade linkage is 16 gage galvanized steel			

Cable Specifications			
Case O.D.	**Case I.D.**	**Casing Material**	**Solid Core Wire Size**
.187	**.080**	**Galvanized Steel**	**.055 Stainless Steel**

Duro Dyne East Division, Bay Shore, NY 631-249-9000 Fax: 631-249-8346
Duro Dyne Midwest Division, Fairfield, OH 513-870-6000 Fax: 513-870-6005
Duro Dyne West Division, Fontana, CA 562-926-1774 Fax: 562-926-5778
Duro Dyne Canada, Lachine, Quebec, Canada 514-422-9760 Fax: 514-636-0328
www.durodyne.com E-mail: durodyne@durodyne.com

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SUBMITTAL RECORD
JOB _____
LOCATION _____
SUBMITTED TO _____
SUBMITTAL PREPARED BY _____
APPROVED BY _____
DATE _____

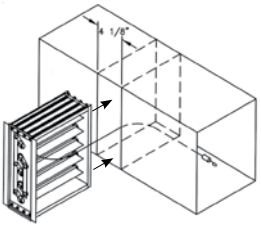
DURO DYNE®

Submittal Form

Rectangular Opposed Blade
Internal Cable Operated Damper

DESCRIPTION:

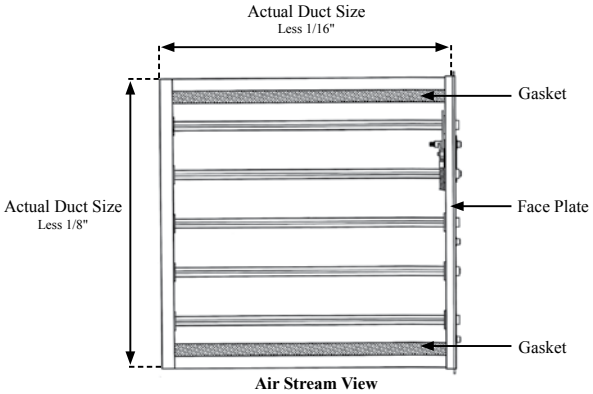
Duct systems are designed to supply a specific volume of air to a space. However, air flow adjustment is sometimes required to achieve original design parameters. Installation of a cable operated balancing damper allows the balancing contractor a convenient way to adjust air volume without entering the ceiling space. The cable operated damper is inserted through a slot in the side of the duct upstream of the diffuser. The adjustment cable is typically passed through the neck of the air device, in the airstream and is accessible for adjustment through the face of the air device. Once the air volume is satisfactory, the cable position is locked with a set screw and the cable is pushed into the neck of the air device, hidden from view.



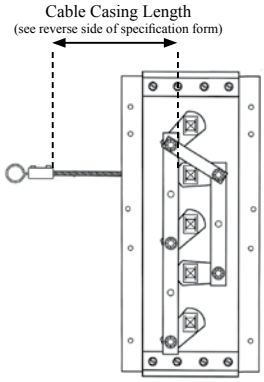
SUGGESTED SPECIFICATIONS:

Rectangular Opposed Blade Internal Cable Operated Dampers shall be Duro Dyne CODS type dampers. Damper blades and frames shall be manufactured of extruded aluminum. Cable case shall be galvanized steel; solid core control wire shall be stainless steel. Installation shall be as described in the Duro Dyne cable operated damper instructions. Sizes and locations shall be as indicated on the mechanical drawings.

Internal Cable Operated Damper



Air Stream View
(Damper Open)



Face Plate View

Damper Specifications			
Damper Component	**Material**	**Width**	**Depth**
Frame	Extruded Aluminum	4-1/16"	1/2"
Face Plate	Extruded Aluminum	5-9/16" (includes two 3/4" flanges)	5/16"
Blade	Extruded Aluminum	2-3/4"	3/32"
Gasket (on even heights only)	Vinyl Nitrile	3/4"	1/2"
Bushings for blades are nylon 5/8" outside diameter with a 3/8" square hole			
All blade linkage is 16 gage galvanized steel			

Cable Specifications			
Case O.D.	**Case I.D.**	**Casing Material**	**Solid Core Wire Size**
.187	**.080**	**Galvanized Steel**	**.055 Stainless Steel**

Duro Dyne East Division, Bay Shore, NY 631-249-9000 Fax: 631-249-8346
Duro Dyne Midwest Division, Fairfield, OH 513-870-6000 Fax: 513-870-6005
Duro Dyne West Division, Fontana, CA 562-926-1774 Fax: 562-926-5778
Duro Dyne Canada, Lachine, Quebec, Canada 514-422-9760 Fax: 514-636-0328
www.durodyne.com E-mail: durodyne@durodyne.com

DURO DYNE®

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CSI #: 23 09 13

SUBMITTAL RECORD
JOB _____
LOCATION _____
SUBMITTED TO _____
SUBMITTAL PREPARED BY _____
APPROVED BY _____
DATE _____

DURO DYNE®

Submittal Form
Round Internal Cable Operated Damper

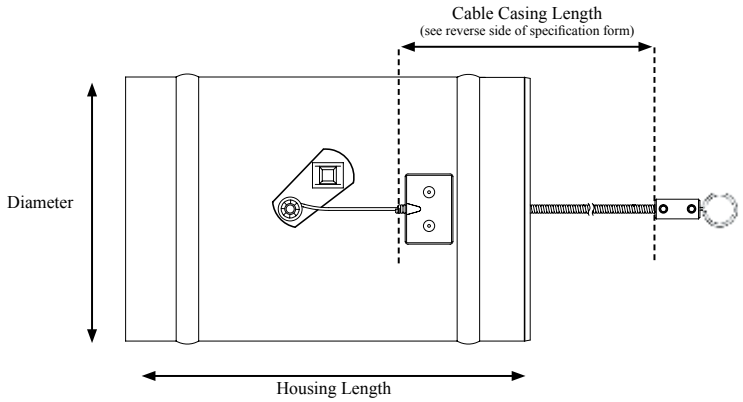
DESCRIPTION:

Duct systems are designed to supply a specific volume of air to a space. However, air flow adjustment is sometimes required to achieve original design parameters. Installation of a cable operated balancing damper allows the balancing contractor a convenient way to adjust air volume without entering the ceiling space. The cable operated damper is mounted upstream of the air device. The adjustment cable is passed through the neck of the air device, in the airstream and is accessible for adjustment through the face of the air device. Once the air volume is satisfactory, the cable position is locked with a set screw and the cable is pushed into the neck of the air device, hidden from view.

SUGGESTED SPECIFICATIONS:

Round Internal Cable Operated Dampers shall be Duro Dyne CODR type dampers. Dampers shall be manufactured of G60 or better galvanized steel. Cable case shall be galvanized steel, solid core control wire shall be stainless steel. Installation shall be as described in the Duro Dyne cable operated damper instructions. Sizes and locations shall be as indicated on the mechanical drawings.

Internal Cable Operated Damper



Damper Specifications														
Item Code	CODR04	CODR05	CODR06	CODR07	CODR08	CODR09	CODR10	CODR12	CODR14	CODR16	CODR18	CODR20	CODR22	CODR24
Housing Length	9	9	9	9	9	11	11	14	14	16	19	20	24	24
Diameter	4	5	6	7	8	9	10	12	14	16	18	20	22	24
Housing Gage	24 gage	24 gage	24 gage	24 gage	24 gage	22 gage	22 gage	22 gage	22 gage	22 gage	22 gage	22 gage	22 gage	22 gage

Cable Specifications			
Case O.D.	**Case I.D.**	**Casing Material**	**Solid Core Wire Size**
.187	**.080**	**Galvanized Steel**	**.055 Stainless Steel**

Duro Dyne East Division, Bay Shore, NY 631-249-9000 Fax: 631-249-8346
Duro Dyne Midwest Division, Fairfield, OH 513-870-6000 Fax: 513-870-6005
Duro Dyne West Division, Fontana, CA 562-926-1774 Fax: 562-926-5778
Duro Dyne Canada, Lachine, Quebec, Canada 514-422-9760 Fax: 514-636-0328
www.durodyne.com E-mail: durodyne@durodyne.com

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BO040001

CSI #: 23 09 13

DuroZone®

A Division Of DURO DYNE®

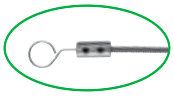
Cable Operated Damper

Internal Mounted Cable

Cable operated dampers are the most convenient and economical way to balance air flow through the face of a diffuser. The damper is installed upstream of the diffuser with the control cable inside the airstream and accessible from the diffuser grill. The air flow is adjusted by simply pushing or pulling on the core wire which changes the damper blade position. Once the adjustment has been made, it is locked by tightening the set screw nearest to the looped end. Then the cable is removed from view by tucking it back into the neck of the diffuser.

Features

- Adjust airflow without accessing the ceiling.
- Available with cable lengths of up to 15'.
- Damper sizes from 4" through 24".
- One edge crimped for ease of installation.



Looped end of adjustment cable with two set screws

Ordering Information - INTERNAL Cable

Description	3 foot Cable*		5 foot Cable*		8 foot Cable*		10 foot Cable*		15 foot Cable*	
	Item #	Code	Item #	Code	Item #	Code	Item #	Code	Item #	Code
4" Rd Cable Operated Damper	53010	CODR0403	53011	CODR0405	53012	CODR0408	53013	CODR0410	53014	CODR0415
5" Rd Cable Operated Damper	53016	CODR0503	53017	CODR0505	53018	CODR0508	53019	CODR0510	53020	CODR0515
6" Rd Cable Operated Damper	53022	CODR0603	53023	CODR0605	53024	CODR0608	53025	CODR0610	53026	CODR0615
7" Rd Cable Operated Damper	53028	CODR0703	53029	CODR0705	53030	CODR0708	53031	CODR0710	53032	CODR0715
8" Rd Cable Operated Damper	53034	CODR0803	53035	CODR0805	53036	CODR0808	53037	CODR0810	53038	CODR0815
9" Rd Cable Operated Damper	53040	CODR0903	53041	CODR0905	53042	CODR0908	53043	CODR0910	53044	CODR0915
10" Rd Cable Operated Damper	53046	CODR1003	53047	CODR1005	53048	CODR1008	53049	CODR1010	53050	CODR1015
12" Rd Cable Operated Damper	53052	CODR1203	53053	CODR1205	53054	CODR1208	53055	CODR1210	53056	CODR1215
14" Rd Cable Operated Damper	53058	CODR1403	53059	CODR1405	53060	CODR1408	53061	CODR1410	53062	CODR1415
16" Rd Cable Operated Damper	53064	CODR1603	53065	CODR1605	53066	CODR1608	53067	CODR1610	53068	CODR1615
18" Rd Cable Operated Damper	53070	CODR1803	53071	CODR1805	53072	CODR1808	53073	CODR1810	53074	CODR1815
20" Rd Cable Operated Damper	53076	CODR2003	53077	CODR2005	53078	CODR2008	53079	CODR2010	53080	CODR2015
22" Rd Cable Operated Damper	53082	CODR2203	53083	CODR2205	53084	CODR2208	53085	CODR2210	53086	CODR2215
24" Rd Cable Operated Damper	53088	CODR2403	53089	CODR2405	53090	CODR2408	53091	CODR2410	53092	CODR2415

*Dimension shown is for the cable casing. The actual core wire is slightly longer.

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CSI #: 23 38 13

30" Undercabinet Hood

500 Series - Stainless Steel DUH30252UC

BOSCH
Invented for life

DUH30252UC
Stainless Steel

Quickly and quietly clears the air of smoke and odors.

Features & Benefits
Allows you to adjust the performance of your hood to match the type of cooking.
Efficiently filters grease and other solid particles out of the extracted air.
Flexible design gives the ability to recirculate the air back into the kitchen.

General Properties	
Operating mode	Convertible: ducted / recirculating
Maximum CFM	400 CFM
Number of speed settings	4-stage
Motor location	Integrated motor in hood body
Number of lights	2 (Not Included)
Bulb type	Halogen
Total power of the lamps (W)	100 W
Damper included	Yes
Grease filter material	Aluminum
Grease filter type	Multilayer cassette
Technical Details	
Volts (V)	120 V
Frequency (Hz)	60 Hz
Plug type	No plug

Dimensions & Weight	
Overall appliance dimensions (width of canopy included) (HxWxD) (in.)	5" x 30" x 20"
Required distance above cooktop/range cooking surface	30" Electric / 30" Gas
Diameter of air duct (in.) top	7"
Diameter of air duct (in.) back	3 1/4" x 10" Rectangular
Net weight (lbs)	42 lbs
Accessories–Optional	
Replacement charcoal filter	DHZ3002UC

For help and assistance with Bosch accessories please visit: www.bosch-eshop.com/eshop/bosch/us or call 1-800-944-2904 Mon-Fri 5am to 6pm PST Sat 6am to 3pm PST

Notes: All height, width and depth dimensions are shown in inches. Please refer to installation instructions prior to making cutout. BSH reserves the absolute and unrestricted right to change product materials and specifications, at any time, without notice. Consult the product's installation instructions for final dimensional data and other details. Applicable product warranty can be found in accompanying product literature or you may contact your account manager for further details.

Warranties: Bosch warrants that the Product is free from defects in materials and workmanship for a period of three hundred and sixty-five (365) days from the date of purchase. The foregoing timeline begins to run upon the date of purchase, and shall not be stalled, tolled, extended, or suspended, for any reason whatsoever. This Product is also warranted to be free from cosmetic defects in material and workmanship (such as scratches of stainless steel, paint/porcelain blemishes, chip, dents, or other damage to the finish of the Product, for a period of thirty (30) days from the date of purchase or closing date for new construction. This cosmetic warranty excludes slight color variations due to inherent differences in painted and porcelain parts, as well as differences caused by kitchen lighting, product location, or other similar factors. This cosmetic warranty specifically excludes any display, floor, "As Is", or "B" stock appliances.

For more information on our entire line of products, go to www.bosch-home.com/us or call 1-800-944-2904

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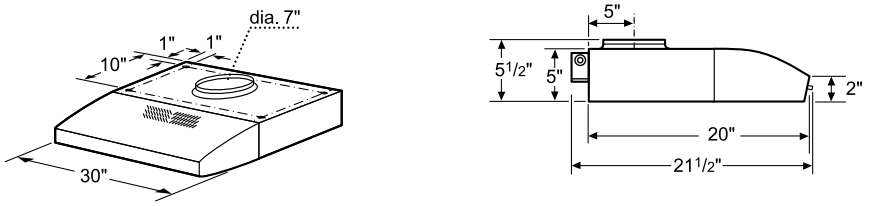
CSI #: 23 38 13

30" Undercabinet Hood

500 Series - Stainless Steel DUH30252UC

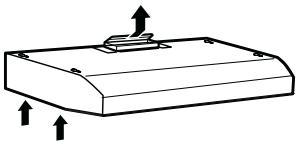
BOSCH
Invented for life

Installation Details

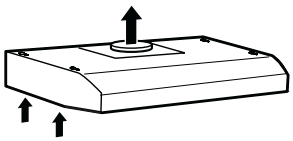


Dimensions in inches

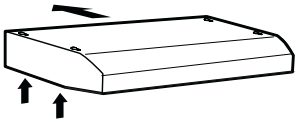
Vertical discharge:
Use a rectangular duct 3 1/4" x 10".....



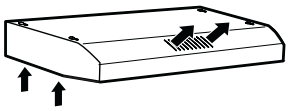
....or use a round 7" duct



Horizontal discharge:
Use a rectangular duct 3 1/4" x 10"



Recirculating (non vented ductless)



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CSI #: 23 82 41

FLOJET
a xylem brand

"TRIPLEX DIAPHRAGM"
3426 / 3526 / 3626 SERIES
AUTOMATIC WATER SYSTEM PUMP

FEATURES
- Self–Priming
- Dry Running
- Soft Noise Absorbing Mounts
- Snap–in Port Fittings
- Built-in Bypass : Less Pulsation
- Reduces need for accumulator tank
- Corrosion Resistant Materials
- Meets ISO 8846 (Ignition protection)

SPECIFICATIONS
Motor: Permanent Magnet, Ball Bearing Totally Enclosed. CE Models are fully suppressed.

Pump: Three chamber diaphragm design Self-priming up to 9 feet suction lift; Pump able to run dry without damage

Model 3426 / 3526 / 3626 Series

Dimensions English (SI)

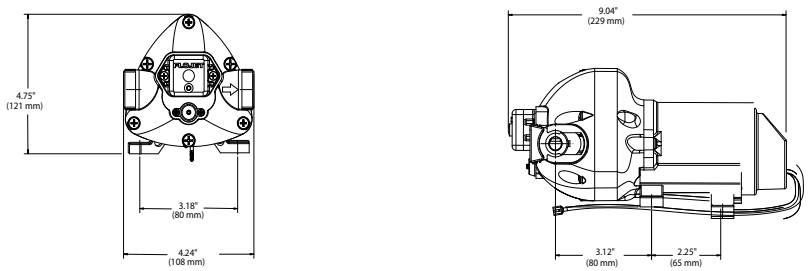
Pump Series	Height inches (mm)	Length inches (mm)	Width inches (mm)	Weight Lb (Kg)
3X26XXX	4.75 (121)	9.00 (229)	6.00 (152)	3.50 (1.59)

MODEL*	VOLTS	AMP DRAW @10 psi (0.7 bar)	FLOW GPM (LPM)	PRESSURE SWITCH Max psi (bar)	BYPASS
03526144	12V dc	4.4	2.9 (11)	50 (3.4)	Yes
R3626344	24V dc	2.2	2.9 (11)	40 (2.8)	Yes
R3426144	12V dc	4.4	2.9 (11)	25 (1.7)	Yes
R3426344	24V dc	2.2	2.9 (11)	25 (1.7)	Yes
R3426148	12V dc	3.5	2.0 (8)	25 (1.7)	Yes
R3426348	24V dc	1.7	2.0 (8)	25 (1.7)	Yes

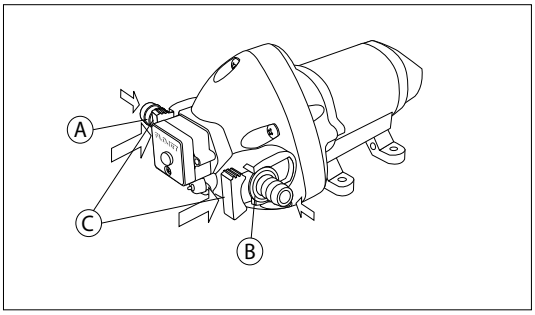
*CE fully suppressed models are identified by a prefix "R" and a CE mark on the label.(i.e. R3626144).
Self Declaration Of Conformance (SDOC) is available upon request.

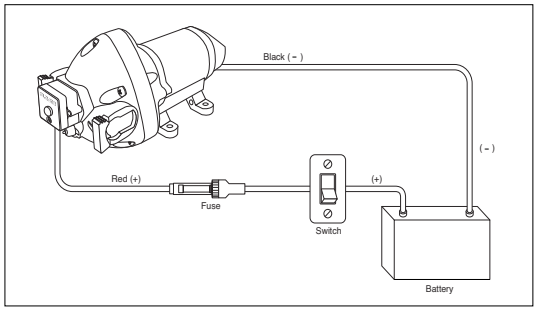
OPERATION
With pump switch off and battery fully charged, fill water tank, open all faucets, then turn pump switch on. Water will begin to flow. When the water is free of air, turn faucets off. Remember, you are filling the water heater and the toilet and shower lines. When all valves are shut-off, pump will stop. Should pump fail to stop, turn switch off and see the trouble shooting guide. **CAUTION -** Pump surface will get hot to the touch if operated for extended periods of time under pressurized conditions.

DIMENSIONAL DRAWING



CSI #: 23 82 41





INSTALLATION

STEP 1
Remove shipping plugs from pump ports. Some water from factory testing may spill out.

STEP 2
Connect fittings supplied with the pump to the RV's plumbing. Use 1/2' I.D. Flexible hose (preferably braided or reinforced) to reduce vibration through the plumbing system as shown on Fig. 1. Use hose clamps on the slip-on barb hose connectors.

STEP 3
Slide rubber mounts fully into 4 mounting tracks.

STEP 4
Mount pump vertically, with pump head down or horizontally in an accessible location. If mounting vertically, motor up, attach motor mounts first then pump head mounts, while supporting weight of pump.

STEP 5
Install inlet A and discharge B port connectors. Firmly push slide clips C forward to lock port connectors in place.

STEP 6
Install a Flojet strainer in an accessible location (for inspection and cleaning) between the tank and pump inlet. This strainer or equivalent is required for pump warranty to be valid.

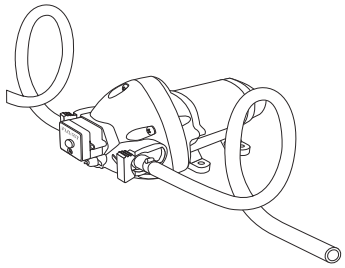
WIRING

STEP 1
Use 14 gauge stranded wire to 20', 12 gauge to 50', from power source.

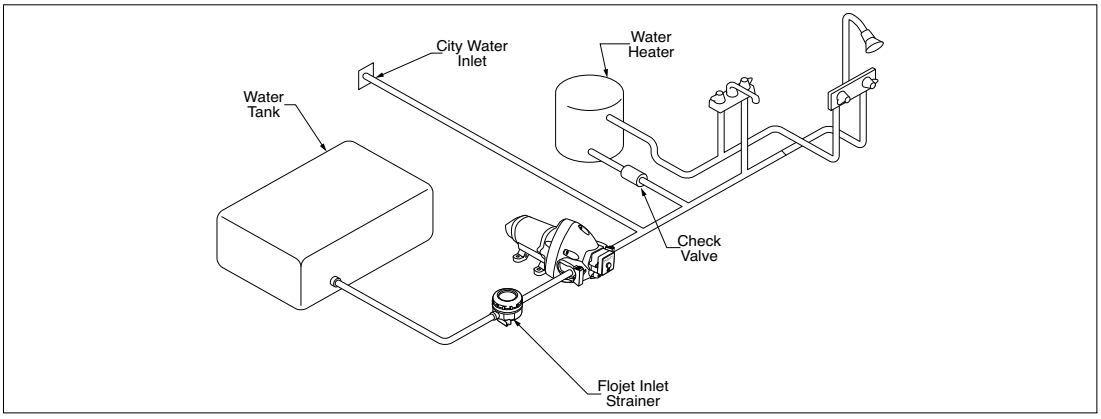
STEP 2
Use a 10-15 amp rated on-off switch on the (+) positive (red) motor lead.

STEP 3
Install a 10 amp fuse protection on the positive lead.

FIG. 1



Note: To help reduce noise and vibration of the pump through the system use flexible lines on the inlet and outlet of the pump as shown above. Be sure to use lines rated to not collapse under pump vacuum.



CSI #: 23 82 41

TROUBLESHOOTING

WARNING: BEFORE SERVICING PUMP, TURN OFF PUMP AND DRAIN WATER FROM SYSTEM!!

Failure to Prime - Motor operates, but no pump discharge
- Restricted intake or discharge line
- Air leak in intake line
- Debris in pump
- Punctured pump diaphragm (pump leaks)
- Crack in pump housing

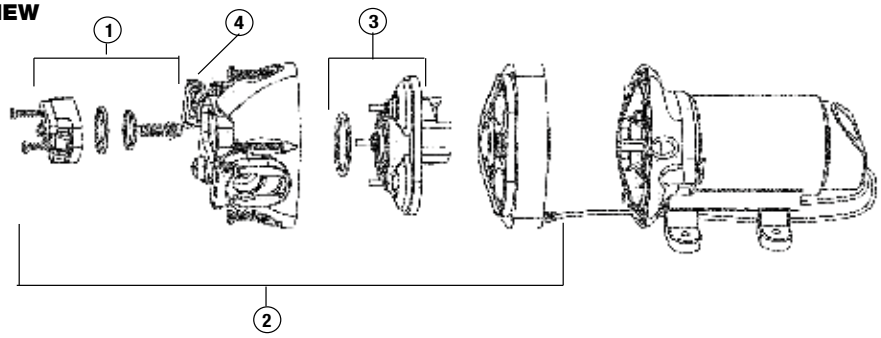
Motor falls to turn on
- Loose wiring connection
- Pump circuit has no power
- Blown fuse
- Pressure switch failure
- Defective motor

Pulsating Flow
- Restricted pump delivery. Check discharge lines, fittings and valves for clogging or undersizing

Pump Fails to Turn Off After All Fixtures Are Closed
- Empty water tank
- Insufficient voltage to pump (low battery)
- Punctured pump diaphragm (pump leaks)
- Discharge line leak
- Defective pressure switch

Low Flow and Pressure
- Air leak at pump intake
- Accumulation of debris inside pump and plumbing
- Worn pump bearing (excessive noise)
- Punctured pump diaphragm (pump leaks)
- Defective motor

EXPLODED VIEW

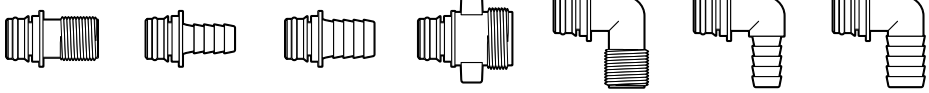


AUTOMATIC WATER SYSTEM PUMP SERVICE PARTS

KEY#	DESCRIPTION	3426XXX	3526XXX	3626XXX
1	Pressure Switch	2091025	2091050	2091040
2	Pumphead Assembly	20406047A (2.9 gpm) 20406048A (2.0 gpm)	20406045A	20406046A
3	Check Valve Assembly	20407034	20407034	20407034
4	Slide Clips (Pair)	21000407A	21000407A	21000407A

ACCESSORIES

QUICK CONNECT PORT SYSTEM



20381-000	20381-002	20381-006	20381-007	20381-008	20381-009	20381-010
QUAD PORT x 1/2" MALE QEST. STRAIGHT	QUAD PORT x 1/2" HOSE BARB STRAIGHT	QUAD PORT x 3/4" HOSE BARB STRAIGHT	QUAD PORT x GARDEN HOSE STRAIGHT	QUAD PORT x 1/2" MALE QEST. 90° ELBOW	QUAD PORT x 1/2" HOSE BARB 90° ELBOW	QUAD PORT x 3/4" HOSE BARB 90° ELBOW

- The above part numbers are packaged with 2 fittings per bag.

STRAINERS	Pump Series	Strainer Number	Inlet	Outlet	Screen
	3X26XXX	1740012	1/2 Barb	Quad Port	40 Mesh
		1740002	1/2 Barb	1/2 Barb	40 Mesh
		1740004	1/2 M Qest	1/2 M Qest	40 Mesh
		1740014	1/2 M Qest	Quad Port	40 Mesh

CSI #: 23 82 41

SYSTEM CARE AND MAINTENANCE

Winterizing

Allowing water to freeze in the system may result in damage to the pump and plumbing system.

Non-Toxic antifreeze for potable water may be used with Flojet pumps. Follow manufacturers recommendations.

Refer to coach or equipment manufacturers instructions for their specific winterizing and drainage procedures.

Do not use automotive antifreeze to winterize potable water systems. These solutions are highly toxic and may cause serious injury or death if ingested.

1. Drain the water tank. Open tank drain valve and plumbing drain valves if applicable. You may use the pump to drain the tank by opening all the faucets in the system. Allow the pump to operate until the tank is empty. Do not operate the pump more than 15 minutes continuously.
2. Open all faucets and flush the toilet to purge all the water from the pump and the plumbing system. Run the pump until no water is coming through the faucets. Turn power to the pump off. Be sure that all the water from the drain lines are drained.
3. Remove quick connect inlet and outlet fittings from the pump and turn the pump on to pump out remaining water from the pump head. Be sure to have a catch pan or a rag under the pump to prevent water from spilling on to the RV. Turn the pump off once the plumbing is empty. Leave the fittings disconnected from the pump until the system is ready to be used again. Make a note on your tank filler that the plumbing is not connected.
4. Be sure that all faucets are left open to protect against damage to the plumbing.

Sanitizing

Portable water systems require periodic maintenance to deliver a consistent flow of fresh water. Depending on use and the environment the system is subject to, sanitizing is recommended prior to storing and before using the water system after a period of storage.

Systems with new components, or ones that have been subjected to contamination, should also be disinfected as follows:

NOTE: The sanitizing procedure is in conformance with the approved procedures of RVIA ANSI A119.2 and the

US Public Health Service.

1. Use of the following methods to determine the amount of common household bleach needed to sanitize the tank.
   A) Multiply “gallons of tank capacity” by 0.13; the result is the ounces of bleach needed to sanitize the tank.
   B) Multiply “Liters of tank capacity” by 1.0; the result is the milliliters of bleach needed to sanitize the tank.
2. Mix into solution the proper amount of bleach within a container of water
3. Pour the solution (water/bleach) into the tank and fill the tank with potable water.
4. Open ALL faucets (hot and cold) allowing the water to run until the distinct odor of chlorine is detected.
5. The standard solution must have four (4) hours of contact time to disinfect completely. Doubling the solution concentration allows for contact time of one (1) hour.
6. When the contact time is completed, drain the tank. Refill with potable water and purge the plumbing of all sanitizing solution.

WARRANTY

FLOJET warrants this product to be free of defects in material and/or workmanship for a period of two years after purchase by the customer from FLOJET. During this two warranty period, FLOJET will at its option, at no charge to the customer, repair or replace this product if found defective in material or workmanship, with a new or reconditioned product, but not to include costs of removal or installation.

This is only an overview of our Limited Warranty. If you would like a copy of our warranty, please call or write FLOJET.

RETURN PROCEDURE

Prior to returning any product to FLOJET, call customer service for an authorization number. This number must be written on the outside of the shipping package. Place a note inside the package with an explanation regarding the reason for return as well as the authorization number. Include your name, address and phone number.

www.xylemflowcontrol.com

FLOJET
a xylem brand

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Division 25

Integrated Automotion

Division 26
Electrical

Division 26 Electrical specifications missing, including raceways, boxes, conductors, wiring devices, lighting, lighting control, identification, enclosed circuit breakers, grounding, hangers & supports, sleeves & seals, seismic controls, etc.

CSI #: 26 24 16

Product data sheet
Characteristics

QO142M200
LOADCTR QO MB 240V 200A 1PH 42SP NEMA 1

Product availability: Stock - Normally stocked in distribution facility

Price*: 1109.00 USD

Main

Commercial Status	Commercialised
Product or component type	Load Center
Range of product	QO
Load center type	Convertible Mains (breaker)
[In] rated current	200 A
Number of spaces	42
Short-circuit current	22 kA
Number of circuits	42
Number of tandem circuit breakers	0
Network number of phases	1 phase
[Ue] rated operational voltage	120/240 V AC

Complementary

AWG gauge	4...300 AWG/kcmil aluminium/copper
NEMA degree of protection	NEMA 1 indoor
Cover type	Order separately
Device composition	Grounding bar (ordered separately)
Electrical connection	Lugs
Wiring configuration	3-wire
Material	Tin plated copper busbar
Product certifications	UL listed

Ordering and shipping details

Category	00001 - QO 1PH LC,12-42 CKT,NEMA1
Discount Schedule	DE3A
GTIN	00785901394907
Nbr. of units in pkg.	1
Package weight(Lbs)	22.85
Product availability	Stock - Normally stocked in distribution facility
Returnability	Y
Country of origin	US

Offer Sustainability

Sustainable offer status	Not Green Premium product
RoHS	Will be Compliant on 3Q2014
REACh	Reference not containing SVHC above the threshold
Product end of life instructions	Need no specific recycling operations

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein.
This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications.
It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof.
Neither Schneider Electric Industries SAS nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. *Prices are indicative

CSI #: 26 31 00

Sunmodule® Protect
SW 275 MONO

SOLARWORLD
REAL VALUE

TUV Power controlled:
Lowest measuring tolerance in industry

Every component is tested to meet
3 times IEC requirements

Designed to withstand heavy
accumulations of snow and ice

Sunmodule Protect:
Positive performance tolerance

30-year linear performance warranty
and 10-year product warranty

Glass with anti-reflective coating

World-class quality
Fully-automated production lines and seamless monitoring of the process and material ensure the quality that the company sets as its benchmark for its sites worldwide.

Innovative glass technologies make extremely weather-resistant and robust solar modules possible. The Sunmodule Protect offers higher mechanical resilience and a longer service life, and still weighs the same as the Sunmodule Plus.

The positive power tolerance guarantees utmost system efficiency. Only modules achieving or exceeding the designated nominal power in performance tests are dispatched. The power tolerance ranges between -0 Wp and +5 Wp.

SolarWorld is setting new standards with the ground-breaking 30-year linear performance guarantee: a maximum degradation of just 0.35% p.a. provides guaranteed module performance of 90% after 21 years, and 86.85% after 30 years.*

- Qualified, IEC 61215
- Safety tested, IEC 61730
- Periodic Inspection
- Blowing sand resistant

- Ammonia resistance tested
- Periodic Inspection
- Power Controlled

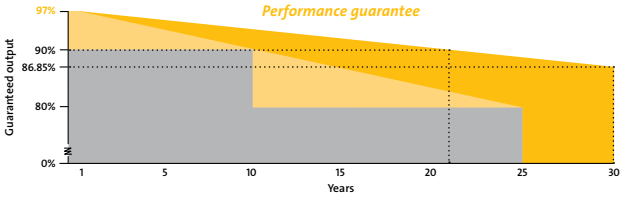
PERFORMANCE TESTED SALT MIST RESISTANT PHOTOVOLTAIC PRODUCT

UL 1703

ISO 9001
ISO 14001
Certified

30-year linear performance guarantee

- **Linear performance guarantee for SolarWorld Sunmodule Protect**
- Linear performance guarantee for SolarWorld Sunmodule Plus
- Competitor's tiered performance guarantee



*in accordance with the applicable SolarWorld Limited Warranty at purchase.
www.solarworld.com/warranty

solarworld.com

MADE IN USA OF US AND IMPORTED PARTS

CSI #: 26 31 00

Sunmodule® Protect
SW 275 MONO

SOLARWORLD
REAL VALUE

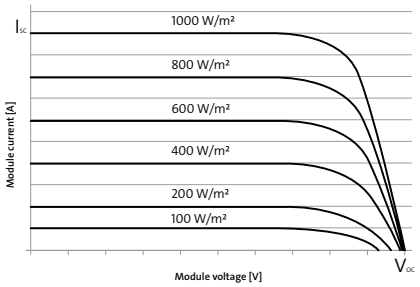
PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

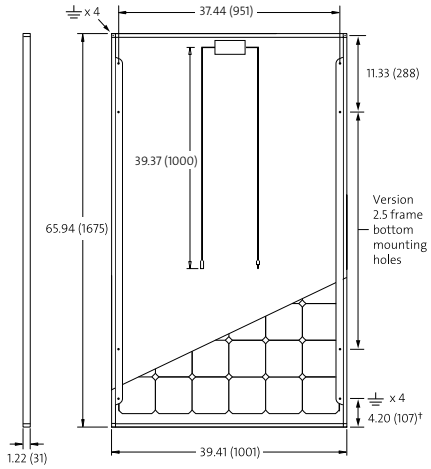
Maximum power	P_{max}	275 Wp
Open circuit voltage	V_{oc}	39.4 V
Maximum power point voltage	V_{mpp}	31.0 V
Short circuit current	I_{sc}	9.58 A
Maximum power point current	I_{mpp}	8.94 A
Module efficiency	η_m	16.40 %

*STC: 1000 W/m², 25°C, AM 1.5
1) Measuring tolerance (P_{max}) traceable to TUV Rheinland: +/- 2% (TUV Power Controlled).

THERMAL CHARACTERISTICS

NOCT	46 °C
TC I_{sc}	0.04 %/°C
TC V_{oc}	-0.30 %/°C
TC P_{mpp}	-0.41 %/°C
Operating temperature	-40°C to 85°C





PERFORMANCE AT 800 W/m², NOCT, AM 1.5

Maximum power	P_{max}	205.0 Wp
Open circuit voltage	V_{oc}	36.1 V
Maximum power point voltage	V_{mpp}	28.4 V
Short circuit current	I_{sc}	7.75 A
Maximum power point current	I_{mpp}	7.22 A

Minor reduction in efficiency under partial load conditions at 25°C: at 200 W/m², 100% (+/-2%) of the STC efficiency (1000 W/m²) is achieved.

COMPONENT MATERIALS

Cells per module	60
Cell type	Mono crystalline
Cell dimensions	6.14 in x 6.14 in (156 mm x 156 mm)
Front	Heat treated (EN 61215)
Frame	Clear anodized aluminum
Weight	46.7 lbs (21.2 kg)

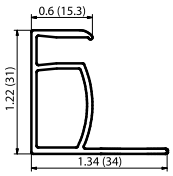
SYSTEM INTEGRATION PARAMETERS

Maximum system voltage SC II / NEC		1000 V
Maximum reverse current		16 A
Number of bypass diodes		3
*Design Loads**	*Two rail system*	113 psf downward 64 psf upward
*Design Loads**	*Three rail system*	170 psf downward 71 psf upward
*Design Loads**	*Edge mounting*	30 psf downward 30 psf upward

* Please refer to the Sunmodule installation instructions for the details associated with these load cases.

ADDITIONAL DATA

Power sorting[1]	-0 Wp / +5 Wp
J-Box	IP65
Module leads	PV wire per UL4703 with H4 connectors
Module type (UL 1703)	3
Glass	Low iron tempered with ARC



VERSION 2.5 FRAME
- Compatible with both "Top-Down" and "Bottom" mounting methods
- Grounding Locations:
  - 4 corners of the frame
  - 4 locations along the length of the module in the extended flange†

All units provided are imperial. SI units provided in parentheses.
SolarWorld AG reserves the right to make specification changes without notice.

SW-01-6045US 08-2014

Division 27
Communications

Division 28

Electronic Safety and Security

Division 31
Earthwork

Division 32

Exterior Improvements

Division 33
Utilities

CSI #: 33 16 19

ATL "Flex-Tank"
SPECIFICATIONS
COLLAPSIBLE FABRIC STORAGE BLADDERS
PILLOW STYLE FLEX-TANKS
SERVING:
Defense
Industry
Environment
Exploration
Energy
Agriculture
Utilities
Homeland Security
Relief Organizations
Toll Free In North America:
1-800-526-5330
www.pillowtanks.com
Aero Tec Laboratories Inc. USA • Aero Tec Laboratories Ltd. UK
PETRO-FLEX
AQUA-FLEX
CHEM-FLEX
CARGO-FLEX

CSI #: 26 31 00

LEVEL 1 EXPENDABLE LOW COST AQUA-FLEX® WATER TANKS see DS-460

Nominal Capacity U.S. Gal.	Nominal Capacity 1000L/M³	Full Dimensions, Nominal Max. FT	Full Dimensions, Nominal Max. M	AQUA-FLEX® TYPE-G	Potable Water, Waste Water, Pool Water, Emergency Water Fill/Discharge FNPT	Vent FNPT	"Full" Signal	SHIPPING Wt. Lbs. Approx.	SHIPPING Wt. Kg Approx.	SHIPPING Cube Ft³ Approx.	SHIPPING Cube M³ Approx.
200	0.8	7' x 5' x 1'	2.1m x 1.5m x .3m	#109716	(1) 1"(25mm)	1"(25mm)	N	11	5	6	.2
250	1.0	7' x 6' x 1'	2.1m x 1.8m x .3m	109717	(1) 1"(25mm)	1"(25mm)	N	13	6	6	.2
500	2.0	11' x 6' x 1'	3.3m x 1.8m x .3m	109722	(1) 1"(25mm)	1"(25mm)	N	24	11	10	.3
1,000	4.0	11' x 9' x 1.5'	3.3m x 2.7m x .4m	109730	(1) 1"(25mm)	1"(25mm)	N	36	16	10	.3
2,000	8.0	11' x 11' x 1.8'	3.3m x 3.3m x .6m	109732	(1) 2"(50mm)	1"(25mm)	Y	54	25	10	.3
4,000	16	22' x 11' x 1.8'	6.7m x 3.3m x .6m	109737	(1) 2"(50mm)	1"(25mm)	Y	80	36	10	.3
8,000	32	22' x 22' x 1.8'	6.7m x 6.7m x .6m	109744	(1) 2"(50mm)	1"(25mm)	Y	124	56	10	.3
12,000	48	33' x 22' x 1.8'	10m x 6.7m x .6m	109750	(2) 2"(50mm)	1"(25mm)	Y	210	95	10	.3

LEVEL 3 PETRO-FLEX® RANGE EXTENSION BLADDER TANKS (GASOLINE OR DIESEL) see DS-539

Nominal Capacity U.S. Gal.	Nominal Capacity 1000L/M³	Full Dimensions, Nominal Max. FT	Full Dimensions, Nominal Max. M	PETRO-FLEX® RANGE EXT.	Rail Bladder for Gasoline and Diesel Fuels Fill FNPT	Vented Safety Cap	Outlet Discharge	SHIPPING Wt. Lbs. Approx.	SHIPPING Wt. Kg Approx.	SHIPPING Cube Ft³ Approx.	SHIPPING Cube M³ Approx.
25	.1	2.5' x 3.0' x 0.50'	0.8 m x 0.9m x .15m	#105405	2"(50mm)	Y	1/2"(13mm)	25	11	4	.1
50	.2	4.6' x 3.0' x 0.75'	1.4 m x 0.9m x 0.2m	105410	2"(50mm)	Y	1/2"(13mm)	30	14	6	.2
75	.3	4.6' x 3.8' x 1.00'	1.4 m x 1.2m x 0.3m	105413	2"(50mm)	Y	1/2"(13mm)	34	15	6	.2
100	.4	4.6' x 4.5' x 1.00'	1.4 m x 1.3m x 0.3m	105415	2"(50mm)	Y	1/2"(13mm)	35	16	6	.2
150	.6	4.6' x 6.0' x 1.25'	1.4 m x 1.8m x 0.4m	105420	2"(50mm)	Y	1/2"(13mm)	40	18	10	.3
200	.8	5.0' x 6.8' x 1.25'	1.5 m x 2.0m x 0.4m	105425	2"(50mm)	Y	1/2"(13mm)	45	20	10	.3
300	1.2	7.5' x 7.0' x 1.5'	2.3 m x 1.8m x 0.5m	105430	2"(50mm)	Y	1/2"(13mm)	55	25	10	.3

LEVEL 3 HEAVY DUTY CARGO-FLEX™ TRANSPORT TANKS see DS-544

*FOR USE WITH D.O.T. WAIVER ONLY - Consult an ATL Sales Engineer

Nominal Capacity U.S. GAL.	Nominal Capacity 1000L/M³	Fill Frequency (Days)	EMPTY DIMENSIONS NOMINAL MAX. FT	EMPTY DIMENSIONS NOMINAL MAX. M	Underline	Number of Ratchet Tie-Downs Included	Fill/Discharge 1" = 25mm	CARGO-FLEX™ TYPE-P2 *Gasoline, Diesel Jet Fuel, Oil	CARGO-FLEX™ TYPE-W2 Drinking Water FDA, NSF 61	CARGO-FLEX™ TYPE-C2 *Chemicals Brines, Effluents	SHIPPING Wt. Lbs. Approx.	SHIPPING Wt. Kg Approx.	SHIPPING Cube Ft³ Approx.	SHIPPING Cube M³ Approx.
1,000	3.8	3	10' x 7.4'	3.0m x 2.25m	Y	2	2"	#105830	#156830	#160830	100	45	14	.4
1,200	4.6	3	12' x 7.4'	3.7m x 2.25m	Y	2	2"	105833	156833	160833	125	57	14	.4
1,500	5.8	3	15' x 7.4'	4.6m x 2.25m	Y	4	2"	105837	156837	160837	150	68	14	.4
2,000	7.7	3	20' x 7.4'	6.1m x 2.25m	Y	4	2"	105841	156841	160841	175	80	20	.6
3,000	11.5	3	30' x 7.4'	9.2m x 2.25m	Y	4	4"	105850	156850	160850	200	91	20	.6
4,000	15.4	3	40' x 7.4'	12.3m x 2.25m	Y	4	4"	105856	156856	160856	220	100	20	.6
4,600	17.7	3	45' x 7.4'	13.7m x 2.25m	Y	4	4"	105862	156862	160862	240	109	20	.6
5,000	19.3	3	48' x 7.4'	14.6m x 2.25m	Y	6	4"	105870	156870	160870	260	118	20	.6
6,000	24.2	3	55' x 7.4'	15.6m x 2.25m	Y	6	4'	105884	156884	160884	300	136	20	.6

Stakeholders & Flatbeds

CSI #: 26 31 00

ATL Aqua-Flex® water bladders are your best water storage choice for short or long-term, on-site water storage:

- **Clean, Sanitary POTABLE Water Storage**
- **Fast, Economical NON-POTABLE Water Storage**

Aqua-Flex® bladders offer the most desirable characteristics:

- **Light, Strong & Flexible**
- **Instant set-up, Just Unfold & Fill**
- **Collapsible to Only 4% of Full Volume**
- **Meets Mil-T-53029, U.S. DOD Specs ATPD-2265 and NSF-Std61**

Available in two grades to suit your application:

HEAVY DUTY: LEVEL 3 Aqua-Flex®
Heavy-Duty, Military-Industrial Style Rubberized Nylon Water Tanks. U.S. DOD Specs ATPD-2265, Mil-T-53029 and NSF-Std 61 for Potable (drinking) water, deionized water, "ROPU" water and cistern water.

MEDIUM DUTY: LEVEL 2 Aqua-Flex®
Light-Duty, Commercial-Style Polyester Reinforced Water Tanks. "FDA" type for drinking water and aqueous solutions. *(Not suitable for transport use)*

AQUA-FLEX® **Technical Specifications**

RATED CAPACITY		APPROXIMATE DIMENSIONS		HEAVY-DUTY	MEDIUM-DUTY	NOM. WT.		NOM. CUBE	
GAL.	M3	FEET	METERS	LEVEL 3	LEVEL 2	LBS.	KG.	FT3	M3
25	0.1	3.5 x 2.5 x 0.50	1.1 x 0.8 x 0.15	156707	125707	25	11	4	0.1
50	0.2	4.2 x 3.3 x 0.75	1.3 x 1.0 x 0.2	156712	125712	30	14	6	0.2
100	0.4	5.3 x 4.2 x 1.00	1.6 x 1.3 x 0.3	156714	125714	35	16	6	0.2
150	0.6	6.6 x 4.2 x 1.25	2.0 x 1.3 x 0.4	156715	125715	40	18	10	0.3
200	0.8	7.9 x 4.9 x 1.25	2.4 x 1.5 x 0.4	156716	125716	45	20	10	0.3
250	1	8.7 x 4.9 x 1.5	2.7 x 1.5 x 0.5	156717	125717	50	23	10	0.3
300	1.2	8.7 x 5.8 x 1.5	3.0 x 1.5 x 0.5	156718	125718	55	25	10	0.3
500	2	9.3 x 7.5 x 1.75	2.8 x 2.3 x 0.5	156722	125722	60	27	10	0.3
750	3	11.5 x 7.5 x 1.75	3.4 x 2.4 x 0.5	156725	125725	75	34	10	0.3
1,000	4	11.6 x 9.8 x 2.0	3.5 x 3.0 x 0.6	156730	125730	90	41	10	0.3
1,500	6	12.8 x 11.0 x 2.5	3.9 x 3.4 x 0.7	156731	125731	115	52	10	0.3
2,000	8	14.2 x 12.3 x 2.75	4.3 x 3.7 x 0.8	156732	125732	145	66	20	0.6
2,500	10	14.8 x 13.25 x 3.0	4.5 x 4.0 x 0.9	156733	125733	150	68	20	0.6
3,000	12	15.3 x 14.8 x 3.25	4.7 x 4.5 x 1.0	156735	125735	165	75	20	0.6
4,000	16	17.4 x 15.5 x 3.5	5.3 x 4.7 x 1.1	156737	125737	185	84	20	0.6
5,000	20	18.7 x 17.2 x 3.75	5.7 x 5.2 x 1.1	156739	125739	205	93	20	0.6
6,000	24	18.8 x 17.7 x 4.0	5.7 x 5.4 x 1.2	156740	125740	245	111	20	0.6
7,500	30	19.8 x 19.3 x 4.25	6.0 x 5.9 x 1.3	156743	125743	295	134	20	0.6
10,000	40	22.1 x 21.0 x 4.5	6.7 x 6.4 x 1.4	156745	125745	375	170	44	1.3
15,000	60	24.7 x 24.6 x 4.75	7.5 x 7.5 x 1.4	156755	125755	490	223	44	1.3
20,000	80	30.8 x 24.6 x 5.0	9.4 x 7.5 x 1.5	156770	125770	530	241	44	1.3
25,000	100	37.0 x 24.6 x 5.25	11.3 x 7.5 x 1.6	156775	125775	745	339	44	1.3
40,000	160	56.6 x 24.6 x 5.5	17.3 x 7.5 x 1.7	156781	125781	1200	545	90	3
50,000	200	66.9 x 24.6 x 5.5	20.4 x 7.5 x 1.7	156785	125785	1500	682	90	3
100,000	400	86.4 x 35.3 x 6.0	26.3 x 10.8 x 1.8	156789	N.A.	2250	1023	120	3.5

CHEM-FLEX® *For Mild Liquid Chemicals* - Technical Specifications

www.atlinc.com/pillow.html#C2

Division 34
Transportation

Division 35

Waterway and Marine Construction

Division 40

Process Integration

Division 41

Material Processing and Handling Equipment

Division 42

Process Heating, Cooling, and Drying Equipment

Division 43

Process Gas and Liquid Handling,Purification, and Storage Equipment

Division 44

Pollution Control Equipment

Division 45

Industry Specific Manufacturing Equipment

Division 48

Electrical Power Generation

CSI #: 48 01 10

Tigo energy®

Tigo Energy® Gateway (GTWY) Data Sheet

The Tigo Energy Maximizer System provides more energy, active management, and enhanced safety for utility, commercial and residential solar arrays. Tigo Energy's innovative combination of hardware and software increases the output of solar arrays by up to 20 percent, enables module-level monitoring and alerts, and improves safety with module-level deactivation – all provided by a system with industry-leading cost, efficiency, and reliability. The versatile architecture works seamlessly with all standard photovoltaic modules and inverters.

The Tigo Energy Gateway provides wireless communications with each of the Tigo Energy Module Maximizers. Gateways are installed in the center of the arrays with which they are communicating, and can be conveniently mounted either to the back of a module, or to the racking.

Green Business Bay Area

Tigo Energy, Inc. I 420 Blossom Hill Road | Los Gatos, California 95032 USA | P. +1.408.402.0802 | F. +1.408.358.6279 | www.tigoenergy.com

CSI #: 48 01 10

Tigo Energy® Gateway (GTWY)

One Gateway is shipped standard with each Maximizer Management Unit (MMU), packaged in the same box. For larger installations, additional Gateways can be ordered separately. Multiple Gateways can be daisy-chained into a single MMU (up to seven Gateways for a single MMU).

Gateway (GTWY) Technical Specifications

	GTWY
Communications with Maximizer	Wireless (802.15)
Communication with Maximizer Management Unit	RS-485 cable connection; in series with other Gateways
Mounting Location	Center of array
Mounting Method	Mounted to module frame or rack. Clips included for frame mounting
Wireless Range	50ft (15m) line-of-sight
Maximum number of Modules per Gateway	120
Mechanical Data	
Dimensions (W x H x D)	141.3 x 48.5 x 33.3mm (with bracket)
Weight	900gm
Operating temperature range	-30°C +70°C
Enclosure environmental rating	IP 65

Specifications subject to change. Always check the table on the Tigo Energy Module Maximizer label for specifications as supported by that particular unit.

Optimize the energy harvest of your PV system using the Tigo Energy Maximizer System to:

- accelerate system payback
- maximize the power output of individual modules
- reconsider previously rejected projects because of unfavorable shade or orientation
- maintain best-in-class conversion efficiency
- manage the system with module-level data to minimize operational costs and keep the system at peak performance throughout its lifetime
- introduce an unprecedented level of safety for new and existing PV solar installations

GTWY-10.22.12-Eng

Tigo Energy, Inc.
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CSI #: 48 01 10

Tigo Energy® Maximizer™ Management Unit

Tigo energy

Tigo Energy® Maximizer™ Management Unit (MMU)

Data Sheet

For residential, commercial and utility scale PV arrays, the Tigo Energy® Maximizer™ System optimizes power output per each module (solar panel); delivers module-level data for operational management and performance monitoring; and provides the ability to deactivate the high voltage DC bus for safer installation, maintenance or fire fighting. The Tigo Energy Maximizer Management Unit (MMU) communicates between the Module Maximizers and the Inverter, controls processes in real time and sends data to a remote server in order to allow multiple users to observe and interact with the monitoring system.

Each Tigo Energy Maximizer system (patented) includes one MMU per project, with the option of a second unit for system redundancy. The MMU has a manual user interface and LCD display housed in a NEMA3 enclosure for onsite programming. The MMU mounts near the inverter and communicates with each PV module in the system, provides management and control functions for the module Maximizers, and serves as a gateway to the Data Center. The Maximizer Management Unit is pre-configured with CAT-5 Ethernet access. The MMU can be used as a qualifying inverter and overall system performance monitoring interface for legacy installations.

The MMU includes the Tigo Energy® PV-SAFE™ button - a unique onsite safety feature located on the front of the Maximizer Management Unit. With one push of the red button, an onsite operator or emergency personnel can deactivate the entire array for maintenance or emergency purposes (patented). PV-Safe enables each module to be electrically removed from the high voltage DC cabling limiting the voltage exposure to the open-circuit voltage (Voc) of a single module. As part of the Tigo Energy system, this function can be activated with the safety button or via a remote management console. The system can be installed, maintained or approached by fire personnel without the exposure to voltage levels typically in excess of 400 volts.

Green Business Bay Area

Tigo Energy, Inc. I 420 Blossom Hill Road | Los Gatos, CA 95032 USA | P +1.408.402.0802 | F +1.408.358.6279 | www.tigoenergy.com

CSI #: 48 01 10

Tigo Energy® Maximizer™ Management Unit

Secure remote access to the MMU via the Tigo Energy MaxiManager software applications is available through any internet-enabled computer, with views available for system owners, installers, power plant operators and emergency services personnel. Simple, easy-to-understand graphics allow for quick analysis of the real-time output and historical performance of each system, and the ability to view and remedy system faults, error codes or alerts.

Ask your PV Distribution partner for the Tigo Energy Maximizer Management Unit for your new or existing PV Systems.

Maximizer Management Unit Technical Specifications

Electrical Specification

Single MMU supports up to 360 Modules
Single MMU supports up to 7 Tigo Gateways
Power Supply 100 - 240 VAC input/24 VDC output

Communication (MMU to Data Center)

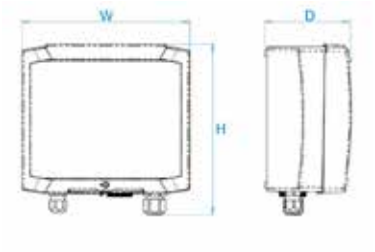
CAT-5 Ethernet

Mechanical Specifications

Dimensions (W x H x D)	225.5 x 226 x 125 mm
Weight	1000 gm
Environmental Rating	NEMA 3R
Operating Temperature	0˚ to +70˚ C

Optimize the energy harvest of your PV system using the Tigo Energy Maximizer to:

- accelerate system payback
- maximize the power output of individual modules
- reconsider previously unfavorable projects rejected because of shade or orientation
- maintain best-in-class conversion efficiency
- manage the system with module-level data to minimize operational costs and keep the system at peak performance throughout its lifetime
- introduce an unprecedented level of safety for new and existing PV solar installations (patented)
- simplify the balance-of-system design, especially for high Voc or thin-film modules



Tigo energy
Tigo Energy, Inc.
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MMU-10.14.13

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CSI #: 48 01 10

ENGLISH

Tigo® energy

Tigo Energy®
Dual Maximizer™- ES (MM-2ES)
Data Sheet

Optimize the energy harvest of your PV system using the Tigo Energy Maximizer to:

- Accelerate system payback
- Maximize the power output of the array under any condition
- Reconsider previously rejected projects because of unfavorable shade or orientation
- Maintain best-in-class conversion efficiency
- Manage the system with module-level data to minimize operational costs and keep the system at peak performance throughout its lifetime
- Introduce an unprecedented level of safety for new and existing PV solar installations
- Simplify the balance-of-system design, especially for high Voc or thin-film modules

Green Business Bay Area

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CSI #: 48 01 10

The Tigo Energy Dual Maximizer is designed to integrate seamlessly with the industry-leading Tigo Energy Maximizer System. Each unit can be used with either one or two PV modules, giving system designers added flexibility. In addition, the Dual Maximizer can be mixed with Smart Modules in the same system – they can be connected on the same string, and can use the same MMU and Gateway communications system simultaneously.

Dual Maximizer - ES Technical Specifications

	MM-2ES 50	MM-2ES 75
Electrical Ratings		
Input	**Per Input**	**Per Input**
Nominal Input Power	375W	375W
Absolute Maximum Input Voltage (Voc)	52Vdc	75Vdc
MPPT Operating Voltage Range (Vmp)	16-48Vdc	30-65Vdc
Maximum Input Current (Isc)	10A	7.5A
Maximum Continuous Input Current (Imp)	9.5A	6.5A
Output	**Per Device**	**Per Device**
Maximum Output Power	750W	750W
Maximum Output Current	9.5A	7.5A
Operating Output Voltage	0-104V	0-150V
Mechanical		
Ambient temperature range	-40°C to +70°C (-40°F to +158°F)	
Storage temperature range	-40°C to +70°C (-40°F to +158°F)	
Cooling method	Natural convection	
Dimensions (with bracket)	142.3 x 29.3 x 1631 mm (5.60" x 1.15" x 64.21")	
Weight	950 gr (2.10 LB)	
Enclosure rating	IP65, NEMA 3R	
Cabling		
Cabling Type	PV1-F, PV Wire	PV1-F, PV Wire
Cable length	ST: 1300 mm (51.18") XL: 2100 mm(82.68")	ST: 1300 (51.18") XL: 2100 mm (82.68")
Connector	MC4 / MC3 / Tyco	MC4 / MC3 / Tyco
UV resistance	500 hr with UV light between 300-400nm@65C 500 hr with UV light	
Maximum string Voltage	600V/1000V dual rated	600V/1000V dual rated
Cable Outer Diameter	6.9 ± 0.2 mm	6.9 ± 0.2 mm
Wire cross section	4.0mm² (12AWG)	4.0mm² (12AWG)
Compliance		
Safety	CSA C22.2 No. 107.1-01, UL 1741 2nd Edition (January 28th 2010), EN 62109-1: 2010, Protection Class II	
EMC	CE Council Directives 2004/108/EC, VCCI Japan Council /CISPR22 FCC Part 15B, Radio Approval	
Environmental	Pollution Degree 3	
Installation	Application Class A, Over voltage (Installation) category III	
Additional	Tested with impulse voltage at 8kV, Flammability Class V-0	

Mechanical Dimensions:

Ordering Information:

MM - 2ES50 - MC4 - ST

50/75 *
Maximum Voltage must be highher than PV module Voc

MC4/MC3/TYCO
Connector type

XL **/ST
Output cable length

XL (2100mm / 82.68") for -

ST (1300mm / 51.18") for -

* MM2-ES75 is available only with MC4 connectors
** MM2-ES XL version is available only with MC4 connectors

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CSI #: 48 14 13

Sunmodule® Protect
SW 275 MONO

SOLARWORLD
REAL VALUE

TUV Power controlled:
Lowest measuring tolerance in industry

Every component is tested to meet
3 times IEC requirements

Designed to withstand heavy
accumulations of snow and ice

Sunmodule Protect:
Positive performance tolerance

30-year linear performance warranty
and 10-year product warranty

Glass with anti-reflective coating

World-class quality
Fully-automated production lines and seamless monitoring of the process and material ensure the quality that the company sets as its benchmark for its sites worldwide.

Innovative glass technologies make extremely weather-resistant and robust solar modules possible. The Sunmodule Protect offers higher mechanical resilience and a longer service life, and still weighs the same as the Sunmodule Plus.

The positive power tolerance guarantees utmost system efficiency. Only modules achieving or exceeding the designated nominal power in performance tests are dispatched. The power tolerance ranges between -0 Wp and +5 Wp.

SolarWorld is setting new standards with the ground-breaking 30-year linear performance guarantee: a maximum degradation of just 0.35% p.a. provides guaranteed module performance of 90% after 21 years, and 86.85% after 30 years.*

- Qualified, IEC 61215
- Safety tested, IEC 61730
- Periodic Inspection
- Blowing sand resistant

- Ammonia resistance tested
- Periodic Inspection
- Power Controlled

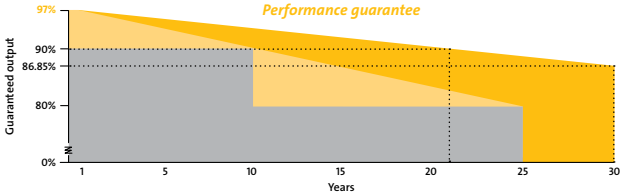
PERFORMANCE TESTED SALT MIST RESISTANT PHOTOVOLTAIC PRODUCT

UL 1703

ISO 9001
ISO 14001
Certified

30-year linear performance guarantee

- **Linear performance guarantee for SolarWorld Sunmodule Protect**
- Linear performance guarantee for SolarWorld Sunmodule Plus
- Competitor's tiered performance guarantee



*in accordance with the applicable SolarWorld Limited Warranty at purchase.
www.solarworld.com/warranty

solarworld.com

MADE IN USA OF US AND IMPORTED PARTS

CSI #: 48 14 13

Sunmodule® Protect
SW 275 MONO

SOLARWORLD
REAL VALUE

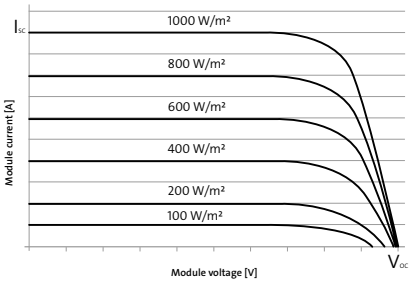
PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

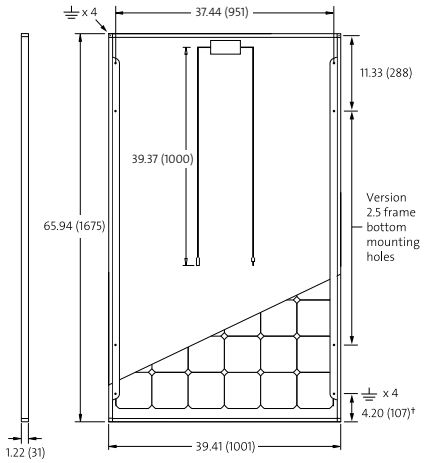
Maximum power	P_{max}	275 Wp
Open circuit voltage	V_{oc}	39.4 V
Maximum power point voltage	V_{mpp}	31.0 V
Short circuit current	I_{sc}	9.58 A
Maximum power point current	I_{mpp}	8.94 A
Module efficiency	η_m	16.40 %

*STC: 1000 W/m², 25°C, AM 1.5
1) Measuring tolerance (P_{max}) traceable to TUV Rheinland: +/- 2% (TUV Power Controlled).

THERMAL CHARACTERISTICS

NOCT	46 °C
TC I_{sc}	0.04 %/°C
TC V_{oc}	-0.30 %/°C
TC P_{mpp}	-0.41 %/°C
Operating temperature	-40°C to 85°C





PERFORMANCE AT 800 W/m², NOCT, AM 1.5

Maximum power	P_{max}	205.0 Wp
Open circuit voltage	V_{oc}	36.1 V
Maximum power point voltage	V_{mpp}	28.4 V
Short circuit current	I_{sc}	7.75 A
Maximum power point current	I_{mpp}	7.22 A

Minor reduction in efficiency under partial load conditions at 25°C: at 200 W/m², 100% (+/-2%) of the STC efficiency (1000 W/m²) is achieved.

COMPONENT MATERIALS

Cells per module	60
Cell type	Mono crystalline
Cell dimensions	6.14 in x 6.14 in (156 mm x 156 mm)
Front	Heat treated (EN 61215)
Frame	Clear anodized aluminum
Weight	46.7 lbs (21.2 kg)

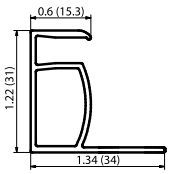
SYSTEM INTEGRATION PARAMETERS

Maximum system voltage SC II / NEC		1000 V
Maximum reverse current		16 A
Number of bypass diodes		3
*Design Loads**	*Two rail system*	113 psf downward 64 psf upward
*Design Loads**	*Three rail system*	170 psf downward 71 psf upward
*Design Loads**	*Edge mounting*	30 psf downward 30 psf upward

* Please refer to the Sunmodule installation instructions for the details associated with these load cases.

ADDITIONAL DATA

Power sorting[1]	-0 Wp / +5 Wp
J-Box	IP65
Module leads	PV wire per UL4703 with H4 connectors
Module type (UL 1703)	3
Glass	Low iron tempered with ARC



VERSION 2.5 FRAME
- Compatible with both "Top-Down" and "Bottom" mounting methods
- Grounding Locations:
  - 4 corners of the frame
  - 4 locations along the length of the module in the extended flange†

All units provided are imperial. SI units provided in parentheses.
SolarWorld AG reserves the right to make specification changes without notice.

SW-01-6045US 08-2014

CSI #: 48 19 16

SUNNY BOY 3000TL-US / 3800TL-US /4000TL-US / 5000TL-US / 6000TL-US / 7000TL-US / 7700TL-US

Certified
- UL 1741 and 1699B compliant
- Integrated AFCI meets the requirements of NEC 2011 690.11

Innovative
- Secure Power Supply provides daytime power during grid outages

Powerful
- 97.6% maximum efficiency
- Wide input voltage range
- Shade management with OptiTrac Global Peak MPP tracking

Flexible
- Two MPP trackers provide numerous design options
- Extended operating temperature range

SUNNY BOY 3000TL-US / 3800TL-US /4000TL-US / 5000TL-US / 6000TL-US / 7000TL-US / 7700TL-US

Setting new heights in residential inverter performance

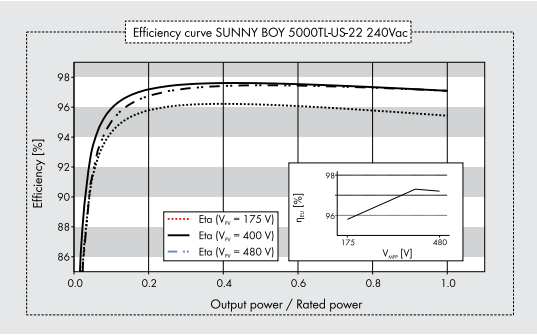
The Sunny Boy 3000TL-US/3800TL-US/4000TL-US/5000TL-US/6000TL-US/7000TL-US/7700TL-US represents the next step in performance for UL certified inverters. Its transformerless design means high efficiency and reduced weight. Maximum power production is derived from wide input voltage and operating temperature ranges. Multiple MPP trackers and OptiTrac™ Global Peak mitigate the effect of shade and allow for installation at challenging sites. The unique Secure Power Supply feature provides daytime power in the event of a grid outage. High performance, flexible design and innovative features make the Sunny Boy TL-US series the first choice among solar professionals.

MADE IN THE USA OF U.S. AND IMPORTED PARTS

CSI #: 48 19 16

Technical data	Sunny Boy 3000TL-US		Sunny Boy 3800TL-US		Sunny Boy 4000TL-US	
	208 V AC	240 V AC	208 V AC	240 V AC	208 V AC	240 V AC
Input (DC)						
Max. usable DC power (@ cos φ = 1)	3200 W		4200 W		4200 W	
Max. DC voltage	600 V		600 V		600 V	
Rated MPPT voltage range	175 – 480 V		175 – 480 V		175 – 480 V	
MPPT operating voltage range	125 – 500 V		125 – 500 V		125 – 500 V	
Min. DC voltage / start voltage	125 V / 150 V		125 V / 150 V		125 V / 150 V	
Max. operating input current / per MPP tracker	18 A / 15 A		24 A / 15 A		24 A / 15 A	
Number of MPP trackers / strings per MPP tracker	2 / 2					
Output (AC)						
AC nominal power	3000 W		3330 W	3840 W	4000 W	
Max. AC apparent power	3000 VA		3330 VA	3840 VA	4000 VA	
Nominal AC voltage / adjustable	208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●
AC voltage range	183 – 229 V	211 – 264 V	183 – 229 V	211 – 264 V	183 – 229 V	211 – 264 V
AC grid frequency; range	60 Hz / 59.3 – 60.5 Hz		60 Hz / 59.3 – 60.5 Hz		60 Hz / 59.3 – 60.5 Hz	
Max. output current	15 A		16 A		20 A	
Power factor (cos φ)	1		1		1	
Output phases / line connections	1 / 2		1 / 2		1 / 2	
Harmonics	< 4%		< 4%		< 4%	
Efficiency						
Max. efficiency	97.2%	97.6%	97.2%	97.5%	97.2%	97.5%
CEC efficiency	96.5%	96.5%	96.5%	97.0%	96.5%	97.0%
Protection devices						
DC disconnection device	●					
DC reverse-polarity protection	●					
Ground fault monitoring / Grid monitoring	● / ●					
AC short circuit protection	●					
All-pole sensitive residual current monitoring unit	●					
Arc fault circuit interrupter (AFCI) compliant to UL 1699B	●					
Protection class / overvoltage category	I / IV					
General data						
Dimensions (W / H / D) in mm (in)	490 / 519 / 185 (19.3 / 20.5 / 7.3)					
DC Disconnect dimensions (W / H / D) in mm (in)	187 / 297 / 190 (7.4 / 11.7 / 7.5)					
Packing dimensions (W / H / D) in mm (in)	617 / 597 / 266 (24.3 / 23.5 / 10.5)					
DC Disconnect packing dimensions (W / H / D) in mm (in)	370 / 240 / 280 (14.6 / 9.4 / 11.0)					
Weight / DC Disconnect weight	24 kg (53 lb) / 3.5 kg (8 lb)					
Packing weight / DC Disconnect packing weight	27 kg (60 lb) / 3.5 kg (8 lb)					
Operating temperature range	–40 °C ... +60 °C (–40 °F ... +140 °F)					
Noise emission (typical)	≤ 25 dB(A)		< 25 dB(A)		< 25 dB(A)	
Internal consumption at night	< 1 W		< 1 W		< 1 W	
Topology	Transformerless		Transformerless		Transformerless	
Cooling	Convection		Convection		Convection	
Electronics protection rating	NEMA 3R		NEMA 3R		NEMA 3R	
Features						
Secure Power Supply	●		●		●	
Display: graphic	●		●		●	
Interfaces: RS485 / Speedwire/Webconnect	o/o		o/o		o/o	
Warranty: 10 / 15 / 20 years	●/o/o		●/o/o		●/o/o	
Certificates and permits (more available on request)	UL 1741, UL 1998, UL 1699B, IEEE1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1-1					
NOTE: US inverters ship with gray lids						
Type designation	SB 3000TL-US-22		SB 3800TL-US-22		SB 4000TL-US-22	

CSI #: 48 19 16



Accessories

Speedwire/Webconnect interface
SWDM-US-10

RS485 interface
DM-485CB-US-10

Fan kit for SB 3000/3800/4000/5000TL-US-22
FANKIT02-10

● Standard feature o Optional feature – Not available
Data at nominal conditions

Sunny Boy 5000TL-US		Sunny Boy 6000TL-US		Sunny Boy 7000TL-US		Sunny Boy 7700TL-US	
208 V AC	**240 V AC**	**208 V AC**	**240 V AC**	**208 V AC**	**240 V AC**	**208 V AC**	**240 V AC**
5300 W		6300 W		7300 W		8000 W	
600 V		600 V		600 V		600 V	
175 – 480 V		210 – 480 V		245 – 480 V		270 – 480 V	
125 – 500 V		125 – 500 V		125 – 500 V		125 – 500 V	
125 V / 150 V		125 V / 150 V		125 V / 150 V		125 V / 150 V	
30 A / 15 A		30 A / 15 A		30 A / 18 A		30 A / 18 A	
2 / 2							
4550 W	5000 W	5200 W	6000 W	6000 W	7000 W	6650 W	7680 W
4550 VA	5000 VA	5200 VA	6000 VA	6000 VA	7000 VA	6650 VA	7680 VA
208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●
183 – 229 V	211 – 264 V	183 – 229 V	211 – 264 V	183 – 229 V	211 – 264 V	183 – 229 V	211 – 264 V
60 Hz / 59.3 – 60.5 Hz		60 Hz / 59.3 – 60.5 Hz		60 Hz / 59.3 – 60.5 Hz		60 Hz / 59.3 – 60.5 Hz	
22 A		25 A		29.2 A		32 A	
1		1		1		1	
1 / 2		1 / 2		1 / 2		1 / 2	
< 4%		< 4%		< 4%		< 4%	
97.2%	97.6%	97.0%	97.4%	96.8%	96.8%	96.8%	97.3%
96.5%	97.0%	96.5%	97.0%	96.5%	96.5%	96.5%	96.5%
●							
●							
● / ●							
●							
●							
●							
I / IV							
490 / 519 / 185 (19.3 / 20.5 / 7.3)							
187 / 297 / 190 (7.4 / 11.7 / 7.5)							
617 / 597 / 266 (24.3 / 23.5 / 10.5)							
370 / 240 / 280 (14.6 / 9.4 / 11.0)							
24 kg (53 lb) / 3.5 kg (8 lb)							
27 kg (60 lb) / 3.5 kg (8 lb)							
-40 °C ... +60 °C (-40 °F ... +140 °F)							
< 29 dB(A)		< 29 dB(A)		< 29 dB(A)		< 29 dB(A)	
< 1 W		< 1 W		< 1 W		< 1 W	
Transformerless		Transformerless		Transformerless		Transformerless	
Convection		Fan		Fan		Fan	
NEMA 3R		NEMA 3R		NEMA 3R		NEMA 3R	
●		●		●		●	
●		●		●		●	
o/o		o/o		o/o		o/o	
●/o/o		●/o/o		●/o/o		●/o/o	
UL 1741, UL 1998, UL 1699B, IEEE1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1-1							
SB 5000TL-US-22		SB 6000TL-US-22		SB 7000TL-US-22		SB 7700TL-US-22	

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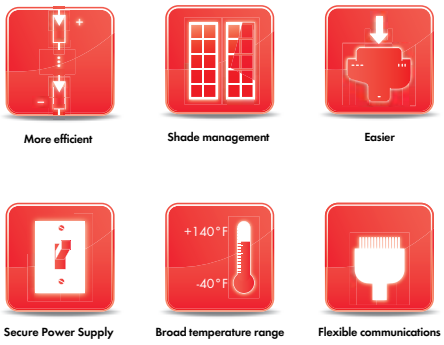

A NEW GENERATION OF INNOVATION

THE SUNNY BOY TL-US RESIDENTIAL SERIES HAS YET AGAIN REDEFINED THE CATEGORY.

Transformerless design

The Sunny Boy 3000TL-US / 3800TL-US / 4000TL-US / 5000TL-US / 6000TL-US / 7000TL-US / 7700TL-US are transformerless inverters, which means owners and installers benefit from high efficiency and lower weight. A wide input voltage range also means the inverters will produce high amounts of power under a number of conditions.

Additionally, transformerless inverters have been shown to be among the safest string inverters on the market. An industry first, the TL-US series has been tested to UL 1741 and UL 1699B and is in compliance with the arc fault requirements of NEC 2011.

Increased energy production

OptiTrac™ Global Peak, SMA's shade-tolerant MPP tracking algorithm, quickly adjusts to changes in solar irradiation, which mitigates the effects of shade and results in higher total power output. And, with two MPP trackers, the TL-US series can ably handle complex roofs with multiple orientations or string lengths.

An extended operating temperature range of -40 °F to +140 °F ensures power is produced in all types of climates and for longer periods of time than with most traditional string inverters.

Secure Power Supply

One of many unique features of the TL-US residential series is its innovative Secure Power Supply. With most grid-tied inverters, when the grid goes down, so does the solar-powered home. SMA's solution provides daytime energy to a dedicated power outlet during prolonged grid outages, providing homeowners with access to power as long as the sun shines.

Simple installation

As a transformerless inverter, the TL-US residential series is lighter in weight than its transformer-based counterparts, making it easier to lift and transport. A new wall mounting plate features anti-theft security and makes hanging the inverter quick and easy. A simplified DC wiring concept allows the DC disconnect to be used as a wire raceway, saving labor and materials.

The 3800TL-US and 7700TL-US models allow installers to maximize system size and energy production for customers with 100 A and 200 A service panels.

Leading monitoring and control solutions

The new TL-US residential line features more than high performance and a large graphic display. The monitoring and control options provide users with an outstanding degree of flexibility. Multiple communication options allow for a highly controllable inverter and one that can be monitored on Sunny Portal from anywhere on the planet via an Internet connection. Whether communicating through RS485, or SMA's new plug-and-play WebConnect, installers can find an optimal solution to their monitoring needs.

Wide power class range

Whether you're looking for a model to maximize a 100 A service panel or trying to meet the needs of a larger residential PV system, the Sunny Boy TL-US with Secure Power Supply has you covered. Its wide range of power classes—from 3 to 7.7 kW—offers customers the right size for virtually any residential application. The TL-US series is not only the smartest inverter on the planet, it's also the most flexible.

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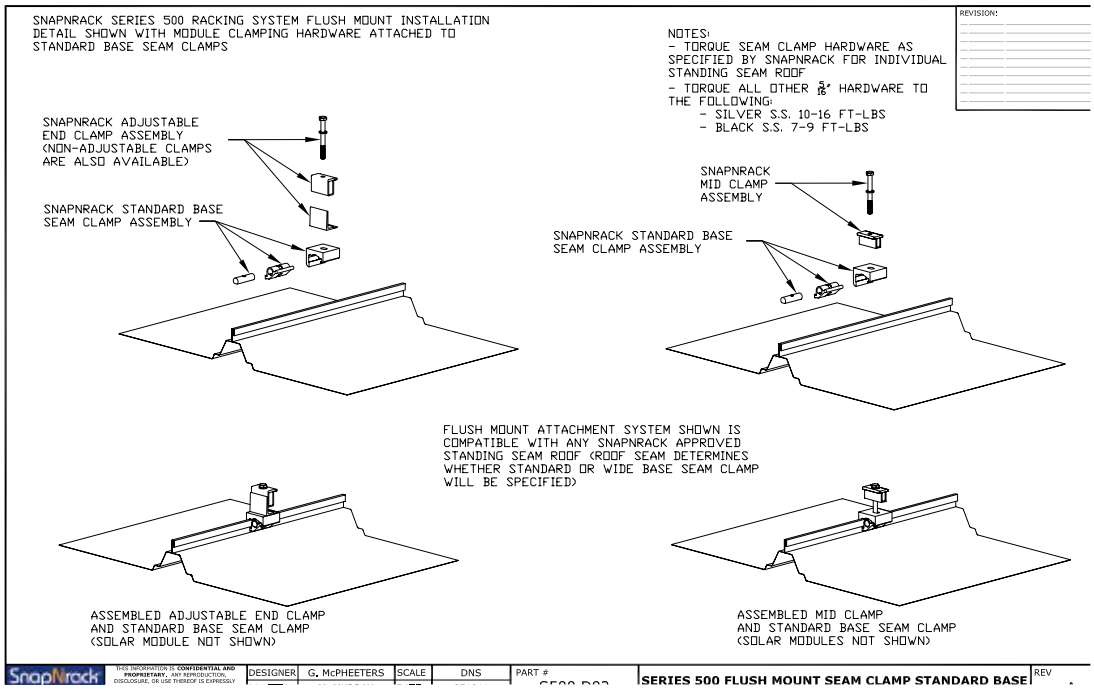
Toll Free +1 888 4 SMA USA
www.SMA-America.com

SMA America, LLC

CSI #: 48 19 19


SNAPNRACK SERIES 500 RACKING SYSTEM FLUSH MOUNT INSTALLATION DETAIL SHOWN WITH MODULE CLAMPING HARDWARE ATTACHED TO STANDARD BASE SEAM CLAMPS
REVISION:
NOTES:
- TORQUE SEAM CLAMP HARDWARE AS SPECIFIED BY SNAPNRACK FOR INDIVIDUAL STANDING SEAM ROOF
- TORQUE ALL OTHER 5/16" HARDWARE TO THE FOLLOWING:
- SILVER S.S. 10-16 FT-LBS
- BLACK S.S. 7-9 FT-LBS
SNAPNRACK ADJUSTABLE END CLAMP ASSEMBLY (NON-ADJUSTABLE CLAMPS ARE ALSO AVAILABLE)
SNAPNRACK STANDARD BASE SEAM CLAMP ASSEMBLY
SNAPNRACK MID CLAMP ASSEMBLY
SNAPNRACK STANDARD BASE SEAM CLAMP ASSEMBLY
FLUSH MOUNT ATTACHMENT SYSTEM SHOWN IS COMPATIBLE WITH ANY SNAPNRACK APPROVED STANDING SEAM ROOF (ROOF SEAM DETERMINES WHETHER STANDARD OR WIDE BASE SEAM CLAMP WILL BE SPECIFIED)
ASSEMBLED ADJUSTABLE END CLAMP AND STANDARD BASE SEAM CLAMP (SOLAR MODULE NOT SHOWN)
ASSEMBLED MID CLAMP AND STANDARD BASE SEAM CLAMP (SOLAR MODULES NOT SHOWN)
SnapNrack
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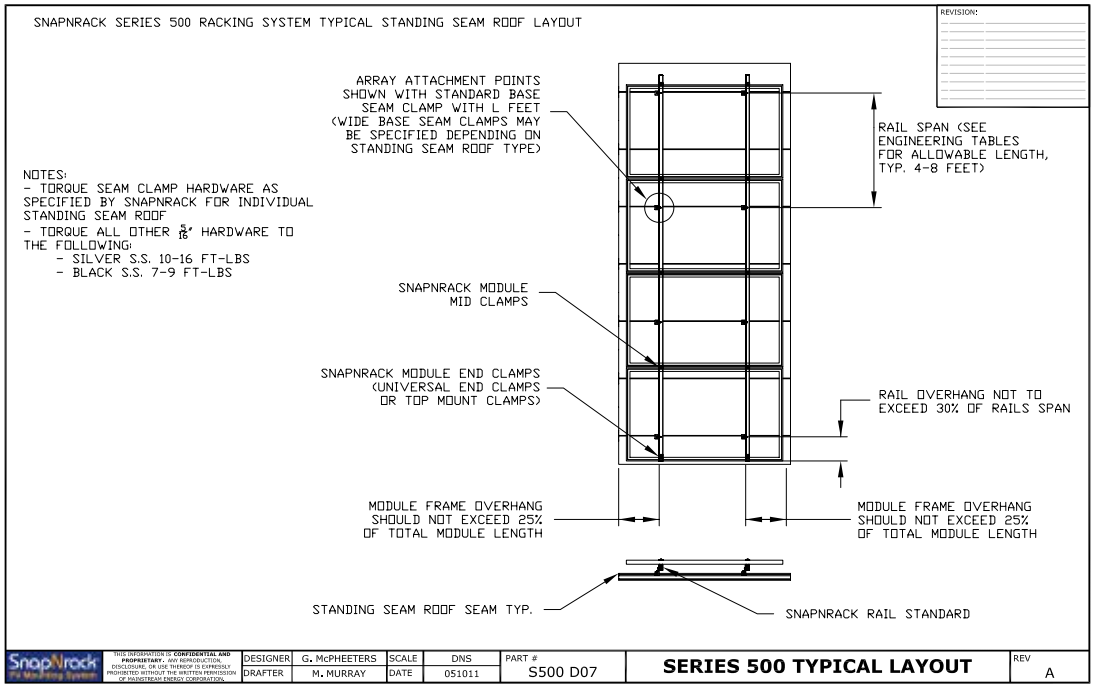
DESIGNER G. McPHEETERS
SCALE
DNS
PART #
SERIES 500 FLUSH MOUNT SEAM CLAMP STANDARD BASE
REV


SNAPNRACK SERIES 500 RACKING SYSTEM TYPICAL STANDING SEAM ROOF LAYOUT
REVISION:
ARRAY ATTACHMENT POINTS SHOWN WITH STANDARD BASE SEAM CLAMP WITH L FEET (WIDE BASE SEAM CLAMPS MAY BE SPECIFIED DEPENDING ON STANDING SEAM ROOF TYPE)
RAIL SPAN (SEE ENGINEERING TABLES FOR ALLOWABLE LENGTH, TYP. 4-8 FEET)
NOTES:
- TORQUE SEAM CLAMP HARDWARE AS SPECIFIED BY SNAPNRACK FOR INDIVIDUAL STANDING SEAM ROOF
- TORQUE ALL OTHER 5/16" HARDWARE TO THE FOLLOWING:
- SILVER S.S. 10-16 FT-LBS
- BLACK S.S. 7-9 FT-LBS
SNAPNRACK MODULE MID CLAMPS
SNAPNRACK MODULE END CLAMPS (UNIVERSAL END CLAMPS OR TOP MOUNT CLAMPS)
RAIL OVERHANG NOT TO EXCEED 30% OF RAILS SPAN
MODULE FRAME OVERHANG SHOULD NOT EXCEED 25% OF TOTAL MODULE LENGTH
MODULE FRAME OVERHANG SHOULD NOT EXCEED 25% OF TOTAL MODULE LENGTH
STANDING SEAM ROOF SEAM TYP.
SNAPNRACK RAIL STANDARD
SnapNrack
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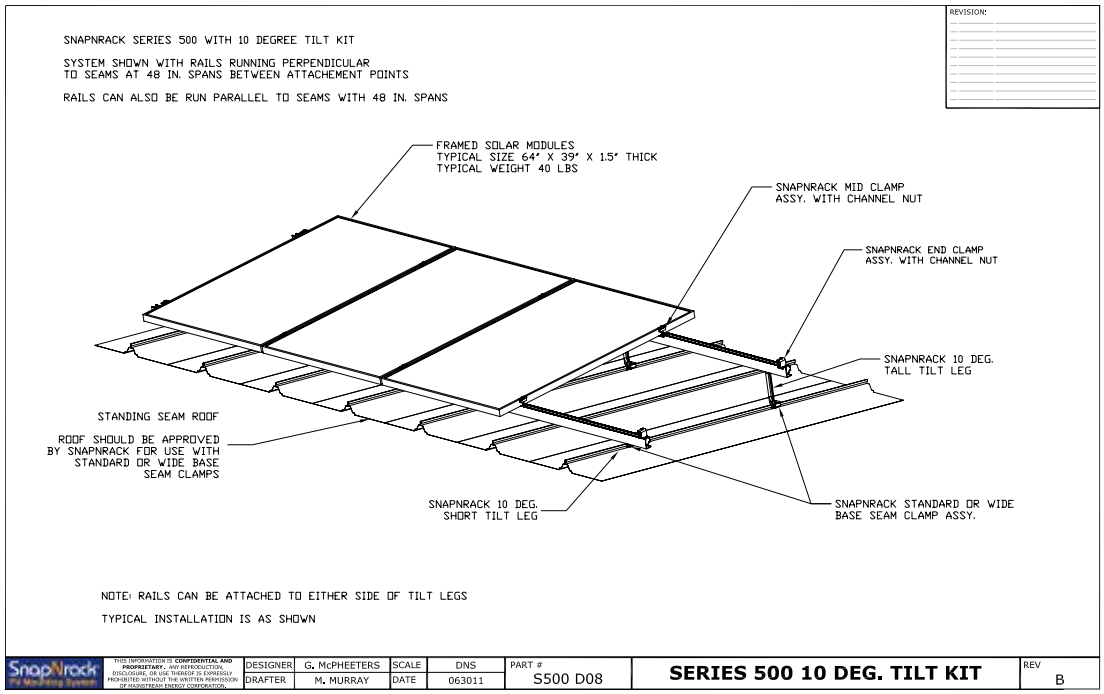
DESIGNER G. McPHEETERS
DRAFTER M. MURRAY
SCALE
DATE 051011
DNS
PART # S500 D07
SERIES 500 TYPICAL LAYOUT
REV A

CSI #: 48 19 19


REVISION:
SNAPNRACK SERIES 500 WITH 10 DEGREE TILT KIT
SYSTEM SHOWN WITH RAILS RUNNING PERPENDICULAR TO SEAMS AT 48 IN. SPANS BETWEEN ATTACHEMENT POINTS
RAILS CAN ALSO BE RUN PARALLEL TO SEAMS WITH 48 IN. SPANS
FRAMED SOLAR MODULES TYPICAL SIZE 64" X 39" X 1.5" THICK TYPICAL WEIGHT 40 LBS
SNAPNRACK MID CLAMP ASSY. WITH CHANNEL NUT
SNAPNRACK END CLAMP ASSY. WITH CHANNEL NUT
SNAPNRACK 10 DEG. TALL TILT LEG
STANDING SEAM ROOF
ROOF SHOULD BE APPROVED BY SNAPNRACK FOR USE WITH STANDARD OR WIDE BASE SEAM CLAMPS
SNAPNRACK 10 DEG. SHORT TILT LEG
SNAPNRACK STANDARD OR WIDE BASE SEAM CLAMP ASSY.
NOTE: RAILS CAN BE ATTACHED TO EITHER SIDE OF TILT LEGS
TYPICAL INSTALLATION IS AS SHOWN
SnapNrack
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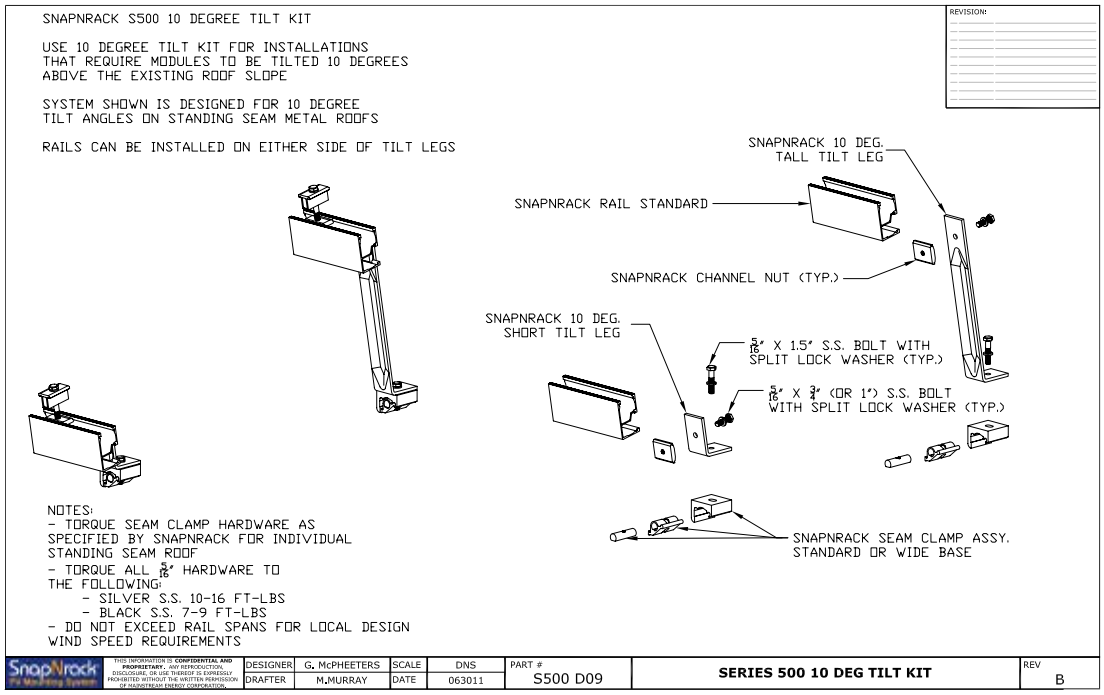
DESIGNER G. McPHEETERS
DRAFTER M. MURRAY
SCALE DNS
DATE 063011
PART # S500 D08
SERIES 500 10 DEG. TILT KIT
REV B


REVISION:
SNAPNRACK S500 10 DEGREE TILT KIT
USE 10 DEGREE TILT KIT FOR INSTALLATIONS THAT REQUIRE MODULES TO BE TILTED 10 DEGREES ABOVE THE EXISTING ROOF SLOPE
SYSTEM SHOWN IS DESIGNED FOR 10 DEGREE TILT ANGLES ON STANDING SEAM METAL ROOFS
RAILS CAN BE INSTALLED ON EITHER SIDE OF TILT LEGS
SNAPNRACK 10 DEG. TALL TILT LEG
SNAPNRACK RAIL STANDARD
SNAPNRACK CHANNEL NUT (TYP.)
SNAPNRACK 10 DEG. SHORT TILT LEG
5/16" X 1.5" S.S. BOLT WITH SPLIT LOCK WASHER (TYP.)
5/16" X 3/4" (OR 1") S.S. BOLT WITH SPLIT LOCK WASHER (TYP.)
SNAPNRACK SEAM CLAMP ASSY. STANDARD OR WIDE BASE
NOTES:
- TORQUE SEAM CLAMP HARDWARE AS SPECIFIED BY SNAPNRACK FOR INDIVIDUAL STANDING SEAM ROOF
- TORQUE ALL 5/16" HARDWARE TO THE FOLLOWING:
- SILVER S.S. 10-16 FT-LBS
- BLACK S.S. 7-9 FT-LBS
- DO NOT EXCEED RAIL SPANS FOR LOCAL DESIGN WIND SPEED REQUIREMENTS
SnapNrack
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DESIGNER G. McPHEETERS
DRAFTER M.MURRAY
SCALE DNS
DATE 063011
PART # S500 D09
SERIES 500 10 DEG TILT KIT
REV B