Project:	**Design/Engineering Services – BPCPC Mechanical System Upgrade**	**Date:**	**July 12, 2013**
Engineer:	**N/A**	**RE:**	**Addenda #1**
		# of Pages:	**26**

The following revisions and/or clarifications are to be made to the proposal documents for "(Insert project name)". They are a result of issues discussed at the pre-proposal conference held on ("insert date of pre-bid conference") and any questions received by close of business of same date (insert date again or insert correct date).

Clarifications:

1. **Attached is a portion of the report and recommendation performed by OLA**
2.
3.
4.

<u>**Questions:**</u> (answers to all question are shown in Italics immediately after the question) for example:

1.

By signing the line below, I am acknowledging that all pages of the addenda has been received reviewed and understood, and will be incorporated into the bid price submitted. This document must be attached to the proposal for consideration.

Print Name ____________ Signature ____________ Date

Number of pages received: ____________ <fill in>

Distributed to: All present and all prospective Proposers

1.0 Background

OLA has been retained by the Battery Park City Authority (BPCA) to perform this evaluation of the HVAC systems and geothermal well system that serve the building located at 75 Battery Place. The building is a 42,000 square foot facility built in 2009-10 for the Battery Park City Parks Conservancy's (BPCPC) headquarters.

The building site is located on the southern portion of Battery Park City. As shown in Figure 1, the city block is occupied by a multi–story structure containing the Battery Park City Parks Conservancy facility, (south and west side of the structure, floors 1 - 4). The Visionaire luxury condominiums on the north and east side, as well as two commercial businesses on north and west ground levels of the building. The BPCPC portion of the building site is bounded by Battery Place to the west and 2nd Place to the south.

The BPCPC portion of the structure has four floors containing various space types including vehicle maintenance facility, metal and woodworking workshops, locker rooms, storage, and office space. Although the building HVAC systems are independent from the adjoining Visionaire building, several of the BPCPC building systems are accessed from and located in the Visionaire building. The BPCPC building has HVAC exhaust equipment located on the 11th and 35th floors of the Visionaire building, and the geothermal well filters are in the Visionaire basement.

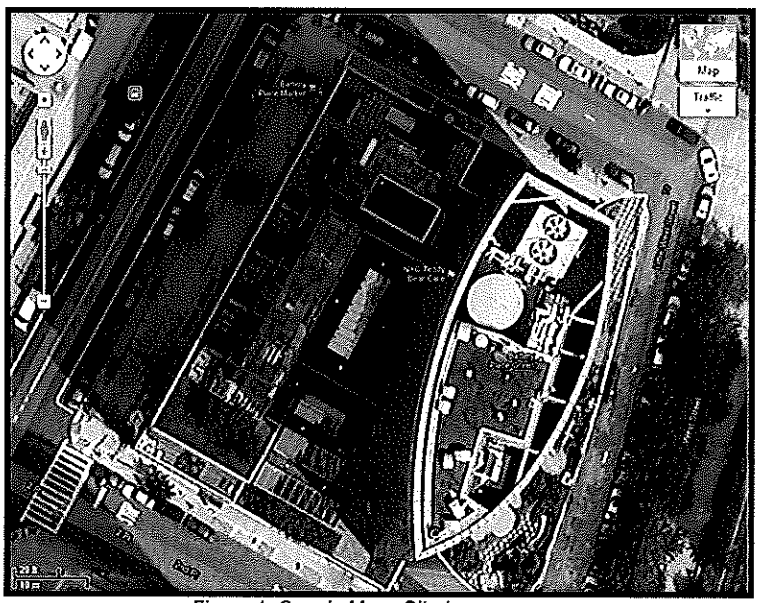

Figure 1. Google Maps Site Image

Since the building was constructed, it has experienced a number of operational and functional deficiencies, which has resulted in lack of occupant comfort, lack of adequate ventilation, and loss of building functionality. BPCA has requested this engineering investigation into the existing systems to inspect, analyze and identify the building's deficiencies and make recommendations for taking steps to help resolve the issues. Specifically, this study will make recommendations to achieve the following stated goals:

- Correct comfort conditions
- Improve indoor air quality
- Reduce frequency of HVAC system failures
- Achieve practical system maintenance
- Provide reasonable service life of the mechanical systems

OLA Consulting Engineers utilized Avcon Engineering and Langan Engineering, Environmental, Surveying and Landscape Architecture, DPC as sub-consultants during this project to complement the engineering team. During the course of this study, the engineering team made several site visits to the building, conducted field testing of HVAC equipment, collected water samples for analysis, evaluated the existing conditions of HVAC equipment, and met with building operators and occupants to solicit their input.

The following report was developed by the combined engineering team and provides our initial evaluation of the HVAC and geothermal systems as requested. Section 2 provides a detailed account of the existing conditions observed and tested during the investigation phase of the study. Section 3 contains a preliminary analysis of the heating/cooling loads and review of the design drawings. Section 4 contains our recommendations to address each deficiency noted as well as the review of the repair suggestions of the original engineer of record, as requested. Section 5 contains an Implementation Plan for the corrective measures along with order of magnitude cost estimates for each corrective measure.

2.0 Existing Conditions and Site Observations

Through our conversations with the BPCPC maintenance personnel during our site visits, and from the background information provided at the bid walkthrough, OLA and Avcon were provided with information concerning the many problems experienced with the HVAC and geothermal systems at the existing building. The following is our understanding of the specific problems currently being experienced and a summary of our observations of the existing conditions and initial testing done.

2.1 Geothermal Wells Evaluation

2.1.1 Review of Existing System

Per our discussions with the building maintenance staff, the geothermal wells have a history of overheating during cooling operation, reaching temperatures near 100°F. Two (2) geothermal wells are installed on the site, and were originally used to provide a source of heating and cooling to three (3) water-to-water heat pumps. The heated or chilled fluid is distributed to the building using separate hot water and chilled water pumps. Refer to mechanical sketch MSK.1 in Appendix E for a partial schematic of the existing situation.

At the time of our site visits, the wells were no longer in operation and their use has been discontinued. Cooling is currently provided by the temporary 60 ton chiller (located on the 2nd floor), and heating is currently provided by the existing gas fired boiler. At the time of our site visit the heat exchanger HX-1, which was originally intended for free-cooling, was disassembled. Per the building staff, it had corroded from the inside and was no longer usable.

As per the original design, the well water flows directly into the heat pump condensers. At the time of the site visit, the heat pumps were also no longer in operation. Building maintenance staff report that the heat pumps have a history of shutting down due to high pressure. This indicates there may have been a lack of sufficient flow, possibly due to fouling.

The well water supply piping has several small strainers installed. It was noted by the operators that whenever the automatic filter blowdown valves would open, the water-to-water heat pumps would shut-down. This is likely due to loss of flow to the heat pumps, as the blowdown line would 'starve' the system of water.

Upon initiating this study, Langan made a Freedom of Information Law (FOIL) request to obtain the "Well Drilling and Completion Report" and "Well Drilling Permit" from the New York State Department of Environmental Conservation – Division of Mineral Resources for the two standing column wells (SCWs) that were installed at the site in connection with the geothermal HVAC system. A copy of the Completion Reports and Well Permits for SCW-2A and SCW-3A is attached (See Appendix A). The completion report was filed by P.W. Grosser Consulting, Inc. of Bohemia, New York.

Per the completion reports, both SCW-2A and SCW-3A were completed in early 2008 to a depth of 1,517 feet each. Each of the wells is fitted with a solid schedule 40 PVC well shroud or casing that is perforated over a 40 foot interval to allow water to flow into the well from a depth of 1,457 to 1,497 feet. The wells are drilled into the Manhattan Schist, a very competent crystalline rock. Per the completion reports, SCW-2A and SCW-3A yield less than 2 gallons per minute (gpm) and ½ gpm respectively, and are therefore considered very low water yielding wells.

Because water yield and thermal conductivity are somewhat proportional, these wells exhibit low or poor thermal conductive capacities and therefore are likely only capable of supporting 15 tons each of heat exchange. Similarly constructed wells in higher water bearing formations are capable of upwards of 40 tons each of heat exchange capacity. The connected cooling capacity of the heat pumps served by these wells is approximately 90 tons, per the original design documents. The two SCWs combined are not capable of providing heat exchange to support a 90 ton HVAC system. This is consistent with the experiences of the building operators.

2.1.2 Geothermal Wells Site Visit

On November 29, 2012 Langan Engineering visited the Site at 75 Battery Place, NY, NY. The two SCWs are located on the southeast side of the building, adjacent to Little West Street and 2nd Place. The two SCWs are situated in a landscaped area adjacent to The Visionaire condominium portion of the building. The supply/return piping are located in the trash compaction room of the basement of The Visionaire.

Photo 1 shows the piping from the SCWs and the sample spigot from which a groundwater sample was obtained for laboratory analyses. Photo 2 shows the well water filters. It is unknown from which of the two wells the sample was drawn as a well location map was not available at the time of the sampling.

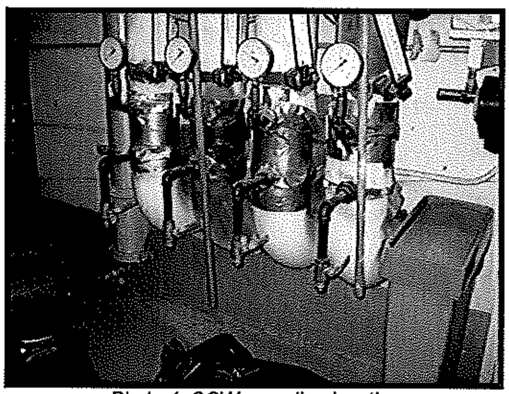

Photo 1. SCW sampling location

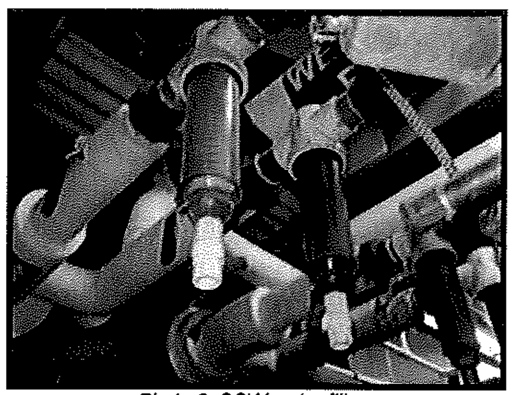

Photo 2. SCW water filters

2.1.3 Sampling and Analysis

A groundwater sample reflecting water quality from one of the wells was obtained during the site visit. The sample, designated "P-1", was submitted to Hampton-Clarke-Veritech Laboratories, a New York Environmental Lab Accredited Program (ELAP) certified lab, of Fairfield, New Jersey. The sample was analyzed for the following parameters to evaluate the potential for scaling or corrosion:

- Total dissolved solids (TDS)
- Temperature (field measurement)
- pH (field measurement)
- alkalinity (as CaCO3)
- calcium (Ca as CaCO3)
- chloride (Cl)
- sulfate (SO4)
- total iron (not required by AWWA, but useful for water quality evaluation)
- total manganese (not required by AWWA, but useful for water quality evaluation)

The water that first flowed from the sample spigot was black, with a slight brackish odor (Photo 3). The water contained fine black sediment and was tepid to the touch. The discharging water did not clear after approximately 10 minutes of pumping. After an hour of circulated water a sample was collected that was clear with minor rusty orange suspended particles and had no odor.

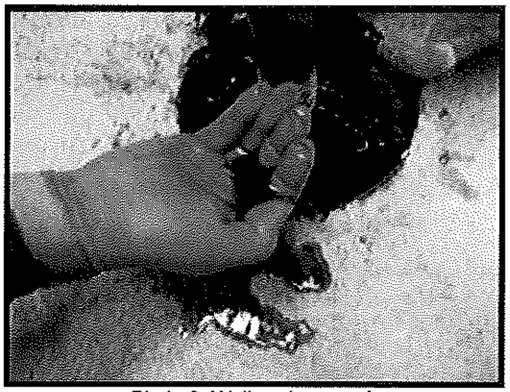

Photo 3. Well water sample

The analytical results were evaluated for corrosion and scale using both the Ryznar Stability Index and Langelier Index which produced values of 8.4 and 0.33, respectively. These values indicate that the water has heavy corrosion potential and some scale potential (see index sheets in Appendix B).

We can conclude from the well completion reports and the analytical results that the SCW portion of the geothermal HVAC system is not capable of providing sufficient heat exchange with the earth to support the 90 tons of peak load demand. The two SCWs combined are more likely capable of providing heat exchange to support approximately 30 tons of peak load demand. The groundwater quality results indicate, based on the Ryznar Stability Index of 8.4, that the water is aggressive or capable of heavy corrosion.

2.2 Water Source Heat Pumps

The building heating and cooling was originally provided by three water source heat pumps (water-to-water heat pumps). The heat pumps were not in service at the time of the site visits.

OLA contacted the heat pump manufacturer's representative (Florida Heat Pump) during the study to obtain additional information regarding the heat pumps. OLA obtained the submittal data sheets for the existing heat pumps. The submittal data obtained is provided in Appendix C. The submittals confirmed the installed capacity of the heat pumps is approximately 90 tons (30 tons each) at the 50° F entering well water conditions expected. The connected chilled water load is approximately 60 tons, implying that per the original design, only (2) heat pumps were required to cool the building.

Per our discussions with the manufacturer, it was confirmed that the heat pumps were provided with cupro-nickel condensers, which is the highest metallurgy condenser they can provide. Given what is known now about the water quality at the site, the manufacturer does not recommend circulating well-water directly through the heat pumps in the future.

2.3 Plate and Frame Heat Exchangers (HX-1/HX-2)

Heat exchanger HX-1 was originally intended to provide free cooling to the AHU-1 free cooling coil and the radiant floors for free cooling. Per our discussions with the operators, the radiant floor free cooling system never operated satisfactory in that condensate formed on the floors making the system unusable. In addition, the heat exchanger plates were severely corroded by contact with the well water and eventually failed (Photo 4). At the time of our site visits, HX-1 had already been disassembled and taken out of service.

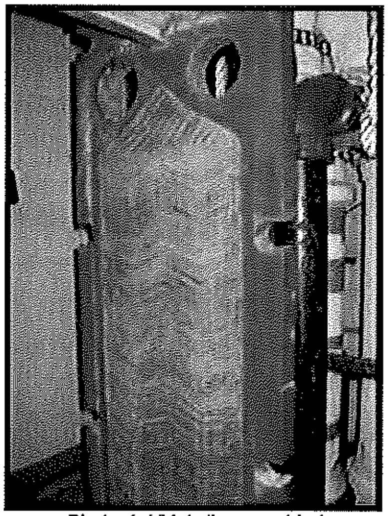

Photo 4. HX-1 disassembled

HX-2 is used to transfer heat from the boiler loop to the radiant floor heating water loop. This heat exchanger appears to be functioning well and has no apparent issues. As well water does not appear to have come into contact with this heat exchanger, it is not considered necessary to disassemble HX-2 at this time for further inspection.

2.4 Air Handling Unit Systems Evaluation (AHU-1 to AHU-5, FAI-1/SX-1)

2.4.1 AHU-1 System Observations / Field Testing

AHU-1 is the largest air handling unit in the building (15,400 cfm) and provides ventilation to the majority of the 1st and 2nd floors (Photo 5). This unit was designed to operate with about 85% outside air. AHU-1 system was designed to provide minimal cooling or tempered air with discharge air temperatures of 68 - 69°F for the 1st floor truck maintenance, garage areas, and 2nd floor work and storage areas, and it was designed to provide the NYC code required air changes for garage and maintenance areas. AHU-1 provides the minimum amount of outside air (13,800 CFM) at all times. This unit was intended to operate with exhaust fans EF-1, and GX-1 to maintain the required air changes at all times.

The building operators indicated that AHU-1 could not be activated currently because when activated, it would starve all the other air handling units of fresh air, since they all share a common fresh air intake riser duct which terminates at the 11th floor roof level.

OLA and Avcon conducted field testing to observe the problems. It was observed that when AHU-1 is activated it implodes/collapses the fresh air intake (FAI) ductwork that is connected to the mixed air plenum box of the other air handling units. AHU-1 is operating at a 2" negative pressure at the intake plenum box. OLA confirmed during an operational test that when AHU-1 is active, the other air handling units all exhibit backwards airflow through the fresh air intake ducts. This results in loss of ventilation to the rest of the building. It was also noted that the outside air intake duct to AHU-4 was imploded and in need of repair. (Photo 6)

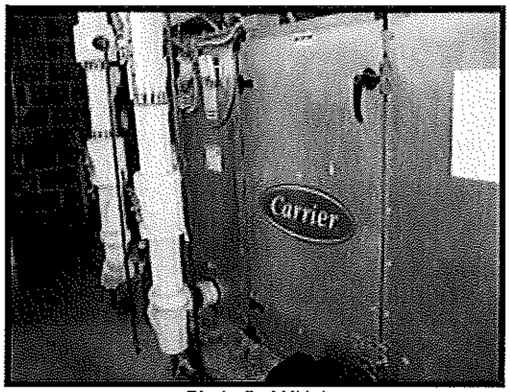

Photo 5. AHU-1

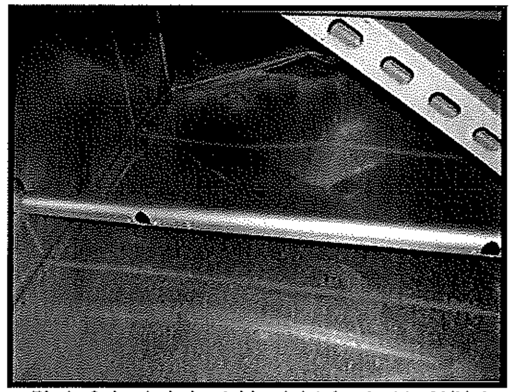

Photo 6. Imploded outside air intake duct to AHU-4

At the time of our site visits, the fresh air fan (FAI-1) had been taken out of service, the ductwork disconnected, and the air intake duct was left open to the 11th floor roof mechanical shed area. (Photos 7 & 8) It was not clear why the original FAI fan was taken out of service. It is possible that it was taken out of service due to the generator exhaust being recirculated in the fan, but this could not be confirmed (refer to Section 2.5).

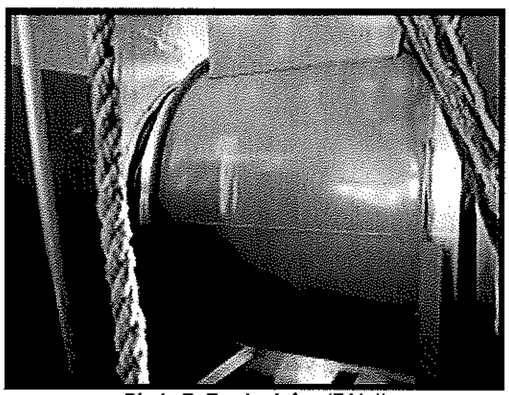

Photo 7. Fresh air fan (FAI-1)

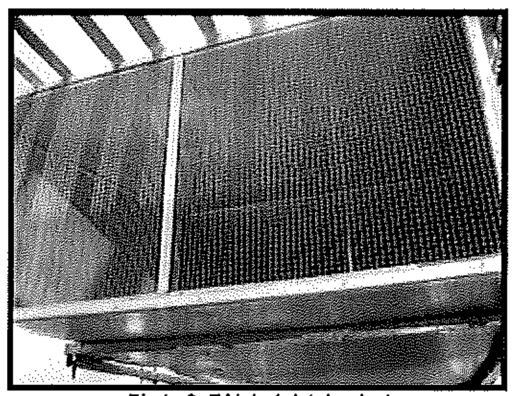

Photo 8. FAI-1 air intake duct

2.4.2 AHU System Analysis

Per the design documents provided, this system was originally designed with a combined fresh air intake / smoke exhaust (FAI/SX-1) fan to deliver outside air to AHU-1, and the four (4) other air handling units (AHUs). Per the original design, this fan would have a dual function as a smoke exhaust fan as well. However, the FAI-1 fan has been deactivated, and is not operational, minimizing the amount of outside air that can be introduced to AHU-1 by gravity, or by pulling thru the existing fresh air riser ductwork.

The required ventilation air (cfm) for minimum outside air is scheduled for 18,540 CFM, and the total air required for 100% OA economizer cycle is scheduled for 30,150 CFM, for all AHU's. The FAI/SX-1 fan located on the 11th Floor roof was originally scheduled, and installed for 26,000 CFM. This fan was also designed to exhaust air for the building smoke purge system using a common duct riser and damper arrangement to either supply FAI to

AHU's or exhaust for the smoke purge mode. (refer to original design Sequence of Operation, Section 15130, page 29, Par. 'S'.)

The 80"x20" duct riser from the FAI/SX-1 fan on the 11th Floor down to the 4th Floor, is sized for a maximum of 18,000 CFM at a velocity of 2,000 CFM. Therefore, the 80"x20" duct appears undersized for full economizer operation. In addition, fan FAI/SX-1 was never installed in accordance with the design documents. The as-built sheet metal drawings indicate two fans have been installed – (1) FAI-1 and (1) SX-1 fan, each sized for 26,000 CFM, connected into the common 80" x 20" duct riser down to the 4th Floor. (See drawing No. SK# Roof-11 of the sheet metal shop drawings.)

It has also been observed that the fresh air intake ductwork and return air ductwork to AHU-1 is sized for the minimum outside air requirements and not for the total air required to accomplish economizer cooling, and is therefore also undersized. In addition, it was also observed that the FAI ductwork, mixed & return air ductwork connections to the AHUs 2 thru 5 appear undersized and may require modifications.

The smoke exhaust fan SX-1 was sized for 26,000 cfm according to the design documents and fan nameplate. This quantity of exhaust appears in accordance with the 6 air changes (ACH) required by the 1968 NYC Code for atrium smoke purge. The SX-1 fan was not tested as part of this study.

2.5 Generator Exhaust

The existing supply fan FAI-1 was taken out of service and the ductwork disconnected, which has created an additional problem related to the generator exhaust. The symptoms stated by the building operators are that when the emergency generator is operating, the odors are drawn into the common fresh air intake duct and these odors disperse throughout the building. This is not surprising since the discharge of the generator exhaust is in very close proximity to the fresh air intake (less than 15'-0" apart). It should also be noted that the fresh air intake duct termination is also in close proximity to other building exhausts which discharge inside the 11th floor mechanical shed area (Photo 9).

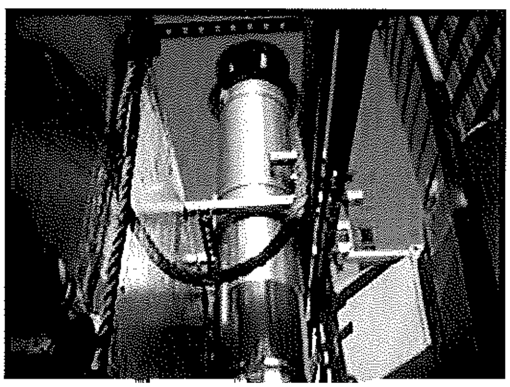

Photo 9. Generator Exhaust

2.6 Radiant Ceiling Panels (RCPs)

2.6.1 RCP System Observations / Field Testing

The radiant ceiling panels provide perimeter heating to much of the building, including the 4th floor office areas. These areas were noted by the building occupants to suffer from cold temperatures during the winter season. It was noted during the initial surveys that the water temperature being supplied to the RCPs ranges from 110 – 120°F. Temperature measurements in the building indicated a panel temperature of 110°F.

During the investigation phase of the study, OLA recommended the building operators increase the hot water supply temperature to at least 160°F to achieve additional heat output. It was observed on subsequent visits that although the boiler temperature had been increased to 160°F, the water temperature reaching the panels was only 135°F - 140°F. It was discovered that this is due to the incorrect boiler piping installation (refer also to Section 2.7 on the heating system).

During the site visits the following locations were emphasized as being deficient in heating capacity:

- The 4th floor offices and the corner conference room in particular. Electrical space heaters were in use during the site visits.
- The mezzanine dock master's office.
- The 4th floor toilet was not provided with any heating element.

2.6.2 RCP System Analysis

An analysis was conducted to determine if the rated heating output from the RCPs meets the original design intent, and if the rated output is sufficient to theoretically heat the building if the water temperature is increased. OLA was able to obtain submittal data for the existing RCPs from the original equipment supplier/manufacturer (Carrier/Sterling). The following are the results of the analysis:

- It was found that the submitted RCP heat output does not match the design drawings for heat output requirements at the design temperature of 120 °F. This can be seen in Figures 2 and 3 showing the schedule data and the submittal data respectively. The scheduled capacity of 115 Btu/h/sq ft corresponds to 230 Btu/h/linear ft. of panel for the 2 ft wide panels. The submittal data (Figure 3) indicates a panel capacity of only 163 Btu/h/linear ft at the same temperature.

RADIANT CEILING PANEL SCHEDULE

	PERFORMANCE DATA					
					WATER	
TYPE	ROOM AIR (°F) DB	OUTPUT (BTU/HR/SQ. FT) SINGLE ROW	LENGTH (FT-IN)	MEAN TEMP. (°F)	GPM	PDFT/100FT TUBE
RCP-1	70	115	10'-0"	120	1.2	3.0
RCP-2A	70	115	19'-0"	120	1.2	3.0
RCP-2B	70	115	49'-0"	120	1.2	3.0
RCP-2C	70	115	22'-0"	120	1.2	3.0
RCP-3	70	115	23'-0"	120	1.2	3.0
RCP-4	70	115	4'-0"	120	1.2	3.0
RCP-5	70	115	12'-0"	120	1.2	3.0
RCP-6A/6B	70	115	56'-0"	120	1.2	3.0
RCP-7	70	115	8'-0"	120	1.2	3.0
RCP-8	70	115	12'-0"	120	1.2	3.0

Figure 2: RCP Design Drawing Schedule

LINEAR PANEL IMPERIAL OUTPUTS

PASSES	1	2	2	2	4	3	4	4	5	6
PANEL WIDTHS * (INCHES)	6	8	10	12	16	18	20	24	30	36
MEAN WATER TEMPERATURE (°F)										
120	54	63	-	78	94	109	-	163	196	224
125	62	73	-	93	111	128	-	188	226	258
130	71	85	-	106	129	148	-	213	256	292
135	79	94	-	121	147	166	-	238	285	327
140	87	104	125	134	165	186	227	263	315	361
145	96	114	137	149	185	205	245	288	345	394
150	104	124	151	162	202	225	264	313	376	428
155	112	134	163	177	219	246	282	338	406	463
160	121	145	177	190	238	263	301	363	436	497
165	129	154	189	205	255	282	320	389	466	531
170	137	164	203	218	276	302	340	413	496	565
175	146	175	215	233	292	320	360	438	525	599
180	154	186	229	246	312	340	380	463	555	633
185	162	197	241	261	329	359	404	488	586	668
190	171	207	255	275	348	379	427	513	615	702
195	179	216	267	289	365	397	452	538	645	736
200	187	226	281	303	384	417	471	563	675	771
205	195	236	293	317	401	436	490	588	705	805
210	204	248	307	330	420	456	509	613	735	839
215	212	258	319	345	439	474	527	638	764	874

OUTPUTS EXPRESSED IN BTUH/LINEAL FOOT OF PANEL AND ARE BASED ON 70°F ROOM TEMPERATURE. FOR EVERY 1°F DECREASE IN ROOM TEMPERATURE BELOW 70°F, THE OUTPUT INCREASES BY 0.9%. FOR EVERY 1°F INCREASE IN ROOM TEMPERATURE ABOVE 70°F, THE OUTPUT DECREASES BY 0.9%.

Figure 3: RCP Submittal Data

- A preliminary load calculation was performed for a typical location on the 4th floor. This location is considered a worst case due to the high floor-to-floor height (19 ft) and the large amount of glazing. As can be seen in the results summarized in Table 1, the rated output of the submitted RCP at the design temperature is 50% of what was calculated as minimum required. However, the RCP heating output is increased to the desired level when the mean water temperature (MWT) is raised to 160 °F.

Table 1: RCP Heating Capacity Comparisons

Location	Ceiling Height	Glazing Height	Perimeter Heat Loss*	RCP Capacity at 120F MWT		RCP Capacity at 160F MWT	
	ft	ft	Btuh/ft	Btuh/ft	% of required	Btuh/ft	% of required
Typical Perimeter wall 4th Floor	19	9	335	163	49%	363	108%

- As a result of the analysis, it appears that the current design and installation is deficient in RCP heating surface in several areas. Notably, all the corner rooms on the south side of the building appear deficient since the designers failed to provide RCPs on both exterior walls. Formal Load calculations are recommended prior to any remedial work to confirm the requirements.

2.7 Hot Water Heating System

The heating system is currently being served by the existing Aerco boiler (860 MBH). The performance of the existing hot water heating system that serves air handling units, fan coil units, radiant ceiling and floor panel heating throughout the building has been compromised as a result of elimination of the geothermal heat pump system. With the reduction of heating from this system, the present hot water boiler has marginal capacity to support the building hot water heating system loads (Refer to Section 3.0 for additional detail on this subject).

It was also noted during the surveys that the hot water boiler piping is not connected properly to the main hot water loop. The main hot water supply piping from the boiler is short circuited and is presently connected to the common return line and does not feed directly to the building; this piping arrangement needs to be corrected. This is the reason boiler water supply temperature cannot be provided to the RCPs. In addition, our review of the drawings provided revealed that the original design drawing H400 shows the boiler piping to be connected in this incorrect way. The original design schematic H300 however does show a correct boiler piping connection, but the piping was not installed this way.

As a result of the unconventional boiler connection, hot water has to be directed through one of the inactive heat pumps in order to return water to the pumps. This may have resulted in damage to that heat pump or at least loss of refrigerant charge. Refer to mechanical sketch MSK.1 in Appendix E for a partial schematic of the existing situation.

2.8 Hot / Chilled Water Pumps (Electrical Deficiency)

It has been observed and reported by the operators, that the hot and chilled water pump motor wiring connections are operating very hot and above design temperatures, and motor connection wire temperatures have at times reached 168°F. One pump motor recently overheated & burned out and had to be replaced. Its our understanding that this is the second time one of the motors had to be replaced.

We provided detailed pump motor information to the pump manufacturer, Patterson Pump Co. however they did not find any visible reason for motor overheating. Avcon/OLA tested the motor amperage during one of the site visits and it was within the operating limits of the motor.

A site visit by Mitsubishi Electric, the VFD manufacturer was coordinated and conducted during this study. They performed a series of measurements, and similar to Avcon/OLA findings, they did not find anything abnormal. The current draw was normal (~ 19A, ~37Hz, ~130V as observed at the drive keypad and commanded by the BMS). Motor phase currents were measured using an inductive meter and were in agreement with the nominal current; there was no noteworthy imbalance. There was no significant ground current. Motor supply leads all appeared to be (and were stated by the electrician to be) the proper 6-gauge wire.

Because all the heating appeared to take place only directly at the point of connection, it is reasonable to conclude at this time that the cause is inadequate connection quality among the conductors at each point, with an elevated impedance causing the heating.

This item was still under further investigation at time of this report, and it is our intention to follow up with a memo on this subject.

2.9 IT Room AC Units (AC-1,2,3)

According to our discussions with the building operators, AC-1, 2, & 3 are not performing to optimum conditions and have trouble maintaining space temperatures. Units AC-1 & 2, serving the passenger and freight elevator machine rooms maintain an average space temperature of 80°F to 82°F in the summer. Unit AC-3 serves the IT/server room on the 4th Floor. This area, according to the IT operations, is very hot (80°F) at times. It was noted during the surveys that the intake and exhaust air for the AC unit condensers are close together. They are located on the 4th floor catwalk area and have intake and exhaust from the same louver albeit with a baffle in between. The present installation appears to be recirculating exhaust air from the condenser back into the intake, raising the condensing air temperatures in the units, and diminishing performance.

2.10 Vehicle Exhaust Capture System

It was noted by the operators that the existing vehicle capture exhaust system is not working properly. From our inspection of the design drawings, it appears that the location of the exhaust fan EF-3 is not correct and must be relocated downstream of all the hose reels in order for the system to work correctly. In addition, it was noted that the existing hose reels do not have end-caps to close off hoses that are not currently being used (Photo 10).

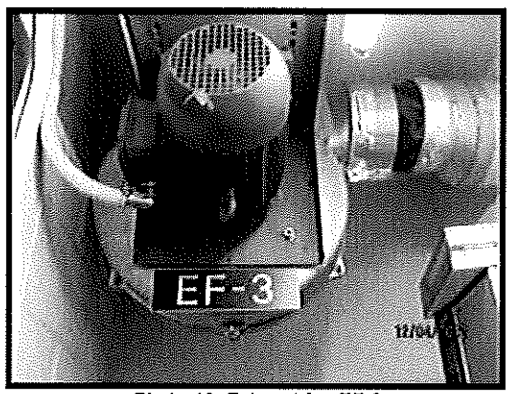

Photo 10. Exhaust fan EF-3

2.11 Metal Shop Welding System (2nd Floor)

Presently it is not possible to do any welding in the Second Floor Metal Shop. The existing air systems are insufficient and do not have adequate make-up air and exhaust air to perform welding indoors. In addition, there is no local exhaust system to support a welding operation. It was discussed at our site visits that an exhaust system is desired by the building staff. A welding exhaust system must also be isolated from the base building supply, return, and exhaust systems that serve adjacent spaces on the Second Floor.

2.12 Main Lobby Air Conditioning (1st Floor)

Presently, the air conditioning for the main lobby produces temperatures that are too hot in the summer, and too cold in the winter, indicating that cooling and heating capacities may be inadequate. Air conditioning is provided from fan coil unit FCU-2 (Photo 11). Ventilation air is provided from AHU-1 that is designed to supply air at 68°F, essentially compromising the lower temperature supplied from FCU-2. Heating is provided from a wall cabinet unit heater CUH-A (17 MBH). It was also observed that the horizontal fan coil unit FCU-2 is located in the garage maintenance area, thus pulling garage air into the Lobby.

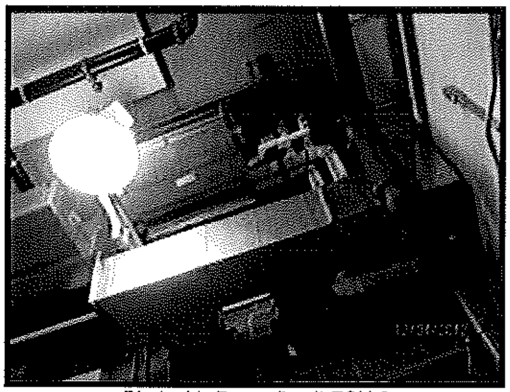
Photo 11. Fan coil unit FCU-2

2.13 Offices Air Conditioning (4th Floor)

During our walk through of the building, BPCPC operating personnel indicated that the general office areas on the 4th Floor are very warm during the summer, with some offices reaching temperatures as high as 80°F. They also noted that ventilation in these areas is poor. It was observed that the inactive grilles/louvers around the perimeter of the atrium at the 4th Floor are open to the hung ceiling allowing air from the atrium system to permeate in the office hung ceilings. Since the atrium area air temperatures run in excess of 85°F in the summer, the open grilles allow this air to flow above the office ceilings and eventually back to the respective AH-unit, thus affecting the return and mixed air temperatures to the unit. Additionally, there appears to be minimal return air flow going back to the AHU which serves the 4th Floor offices.

2.14 Dockmaster's Office (Mezzanine Level)

The existing Dock Master's office located on the Mezzanine Floor is experiencing infiltration of fumes from the adjacent garage area. It appears that there are no outside air ventilation connections from the building supply air systems. Occupants have complained that the office is also cold in the winter. The heating is provided from radiant ceiling panel RCP-1, and air conditioning appears adequate, served from fan coil unit FCU-1.

3.0 Heating and Cooling Loads Review

OLA reviewed the available HVAC design drawings for the building and geothermal well system. The geothermal heat pump design capacities were retrieved from the manufacturer's submittal data. The scheduled equipment capacities were used as a basis for load estimating and cross-checked for order of magnitude based on rule of thumb type sizing criteria. A formal load calculation was beyond the scope of this study.

3.1 Heating Capacities

Using a combination of the provided schedule data and calculations where schedule data was not available, an estimate of building heating loads was developed. The results of this calculation are shown in Table 2 below. As expected, the existing boiler does not have enough capacity to serve all the building heating loads under peak conditions. When AHU-1 is active, it contributes 815 MBH to the peak heating load, which is a significant portion of the total load. This is reflected in the summary below.

The estimated total heat required per square foot of building area is 48 Btu/Sq Ft. This metric is consistent with what we would expect for a building in this climate zone, and with the large amount of make-up air. Note that the below summary reflects an increase to the radiant ceiling panel output by increasing the operating temperature to 160 °F (mean water temperature). In order to compensate for the limited capacity of the existing boiler, a new boiler with a minimum capacity of 1,168 MBH is required. Refer to the Recommendations in Section 4.0 of this report for further details.

Table 2: Total Heating Loads Summary

Systems	**MBH**	**GPM**
Radiant Floors	440.51	47.8
Radiant Ceilings	98.4	13.2
AHU PHCs	1304.5	130.7
CUHs	108	10
FCUs *(estimated)*	*33.5*	*3.3*
RHC *(estimated)*	*43.2*	*4.3*
Total Boiler Load (MBH)	**2,028**	**209**
Building Area (Sq Ft)	42,000	
BTU/Sq Ft	48.3	

Existing Boiler Output (MBH)	860
Additional Boiler Output Required (MBH)	1,168

Proposed New Boiler (Based on Aerco BMK 1500)	
Gas Input (MBH)	1,500
Efficiency @ 140 F EWT	86.6%
Output (MBH)	**1,299**

Refer to Appendix D for additional details of the heating requirement calculations.

3.2 Cooling Capacities:

Using a combination of the provided schedule data and calculations where schedule data was not available, an estimate of building cooling loads was developed. The results of this calculation are shown in Tables 3 and 4 below. The cooling load was developed for two cases: including the AHU-1 cooling coil, and excluding the AHU-1 cooling coil. This is because AHU-1 was not designed to provide conventional comfort cooling for the spaces served. Rather it was designed to temper the incoming air, (which is mostly fresh air), to 68 °F. The typical temperature required for true air conditioning is usually about 55 °F. In addition, the source of cooling for AHU-1 was originally designed as free cooling from the well water and not by using a refrigeration cycle. Therefore, it is logical to consider the cooling load with and without this system included for decision making purposes.

As shown in Table 4, the total connected cooling load is about 90 tons. The metric of 455 sq ft/ton of cooling is in the range expected for this type of building in this climate zone. .Without AHU-1 cooling coil, the total connected load is about 60 tons. As stated previously, the geothermal wells have a limited capacity estimated in the 30 tons range at best indicated by their low yield rates.

Table 3: Total Cooling Loads Summary (w/o AHU-1)			
Systems	**MBH**	**Tons**	**GPM**
AHUs*	679	56.6	140.8
FCUs (*estimated)*	33.5	2.8	6.7
Total Chiller Load, MBH	**712**	**59**	**147**
Building Area	42,000		
SqFt/ton	707.4		

*(Excludes AHU-1 free cooling coil)

Table 4: Total Cooling Loads Summary (w/ AHU-1)			
Systems	**MBH**	**Tons**	**GPM**
AHUs*	1,074.5	89.5	219.8
FCUs (*estimated)*	33.5	2.8	6.7
Total Chiller Load, MBH	**1,108**	**92**	**226**
Building Area	42,000		
SqFt/ton	454.9		

*(Includes AHU-1 cooling coil)

4.0 Recommendations and Conclusions

Based on our analysis of the existing conditions, the engineering team has developed the following list of proposed solutions, corrective measures and recommendations to address the numerous building deficiencies identified during the course of this study. In addition, this section includes commentary on the sketches provided by the original design engineer as requested in the scope of work.

4.1 Cooling System

Based on our evaluation of the existing geothermal system contained in this report, we believe the system has insufficient capacity to serve the heating and cooling loads of the existing building. In order to reliably air condition the building, it is our recommendation to install a new chiller plant sized to provide at least 72 tons to meet the requirement for air conditioning from AHU-1 – 4, and partial cooling would be available for the AHU-1 system.

The engineering team investigated several options for a replacement cooling plant. It was determined that the most logical and feasible approach is to install a modular, air-cooled chiller plant somewhere in the building as described below. There are several limitations which impacted the sizing and selection of the proposed chiller plant:

- Limited floor area to install a chiller inside the building.
- Practically no locations on the building roof to place cooling/heat rejection equipment. (We were advised that the BPCA/BPCPC does not own the roof space and that aesthetic concerns of the base building would certainly take precedence).
  - In addition, working inside existing shafts to run piping to the roof may be impractical and undesirable to the BPCPC.
- Limited locations on the building exterior to install intake and exhaust air louvers for an air-cooled chiller.

With all of the above considerations taken into account, we believe the best choice for this building is an air-cooled chiller plant installed indoors as described below. Due to the limitations described above, we estimate that the maximum total cooling capacity that can be installed is 72 tons.

4.1.1 Recommended Chiller Plant – Option #1

Our recommendation is to install four (4) x 18 ton, packaged air-cooled Multistack chiller units. The proposed location of these chillers would be located in a new 4th floor Mechanical Equipment Room located above the open atrium area on the 4th Floor, below the skylight, and adjacent to the existing 4th floor catwalk (Photo 12). Other locations may be proposed by the BPCPC but would require floor space inside the building in a location accessible to the outside for fresh air/exhaust air.

Photo 12. Proposed location for new chillers

This location was selected because it allows ready access to the exterior to provide condenser cooling air and exhaust air. Intake air louvers would need to be located in place of the storefront windows along the Second Place side of the building. The estimated size of the louvers are approximately 120 sq ft. of new louver area for intake air. These new louvers would be installed so that air can be ducted into the new Mechanical Equipment Room, with ductwork running through the existing 4th floor catwalk space. In order to provide exhaust air from the new chillers, we propose to utilize the existing skylight with a louvered exhaust penthouse, effectively removing the exhaust air from the chillers through the existing skylight opening. Modifications to the skylight and roof will be required. New piping will be run from the new chiller units to the existing chilled water main piping on the 2nd floor. New chilled water pumps will need to be provided to circulate water to all existing air handling units, and fan coil units. New electric power wiring and equipment will be required, and revisions to the building control sequence of operation will be required to incorporate the new equipment. In addition, further investigation into the adequacy of the building electric service will be needed during the design phase. It is recommended to engage in metering of the electric service to confirm the load on the existing electric distribution.

Refer to HVAC Schematic MSK.2 in Appendix E for a representation of the proposed system. Also refer to MSK.6 and MSK.7 for concept sketches of the proposed modifications included with Option #1.

4.1.2 Chiller Plant – Option #2

At the request of BPCPC, alternate locations for the chiller plant were investigated, since the location proposed under Option #1 was not preferred by BPCPC. The only feasible alternate location identified was to locate the chiller plant on the 2nd floor balcony, approximately where the temporary chiller is currently located. OLA developed several variations of this location based on different modular chiller configurations, resulting in different footprints and space requirements for consideration. The variations are as follows:

- Option #2A – (4) 18 ton chiller modules arranged linearly. (Refer to MSK.12 in Appendix E).
- Option #2B – (4) 18 ton chiller modules arranged in a rectangle. (Refer to MSK.13 in Appendix E).
- Option #2C – (3) 26 ton chiller modules arranged in "L" pattern. (Refer to MSK.14 in Appendix E).

Under this option, the design concept is to locate air cooled chiller inside the atrium/garage, and use louvers to pull in the required cooling air through the lower portion of the atrium, and discharge it into the upper part of the atrium space and allow the hot air to escape through the existing skylight louvers. For this option, we propose to infill a portion of the atrium floor opening to provide additional floor space for the chiller plant and surrounding area. In addition, if this option is pursued, we would recommend enclosing the chillers in a louvered screen wall for sound attenuation and to protect the equipment.

While this option preserves the visual aspects of the 4th floor of the atrium, the downside of this option is that it will make it difficult, if not impossible, to air condition the atrium. However, this may be acceptable to BPCPC since the atrium was never designed to have full air conditioning originally. The AHU-1 system was intended to provide ventilation and tempering only. In this case, it may be acceptable to consider the atrium as a semi-outdoor space and use it as proposed under this option. It is our expectation that the lower portions of the atrium which are occupied can be maintained at the same temperatures as the outdoors during the summer conditions, while the upper portion (the unoccupiable space) would be stratified with the hot discharge air.

In addition to the mechanical design features described under Option #1, additional design considerations that should be addressed under this option are:

- Using the existing ceiling fans to improve the dissipation of hot air by interlocking their operation with the chiller.
- It may be necessary to add exhaust fans to select portions of the skylight louvers to improve hot air dissipation.
- Enlarging the existing louvers to the outside at the lower portion of the atrium may be required. Alternately, installing overhead garage screen doors or gates for summer time use may be desirable or required.
- Sound attenuation for the chiller MER and discharge silencers for chillers should be considered.

4.1.3 Cooling System – Alternate A

Although the geothermal well system cannot support the entire cooling load of the existing building, there is an option to utilize the existing well system for 'free-cooling' utilizing a new heat exchanger. While we do not recommend relying only on this source of cooling for the air-conditioned spaces of the building, it is possible the geothermal wells would have enough capacity to provide tempered air cooling to AHU-1 only using the existing free-cooling coil. OLA has provided a heat exchanger manufacturer the water quality test results, and the recommendation from the manufacturer is that a titanium plate/frame heat exchanger would provide satisfactory equipment life along with a high quality filtration system. This option would include the following design features:

- Reactivation and retro-commissioning of the well pumps. Possible replacement if existing pumps are not serviceable.
- New Titanium Plate/Frame HX-1 (30 tons)
- New well-water filtration system to provide longevity of HX-1 life.
- New 3-way valve to allow bypass of HX-1 during winter time.
- New controls and BMS programming to support free cooling operation.
- Reactivation/Retro-commissioning of AHU-1, 30 ton free-cooling coil.
- Replace corroded well water piping in mechanical rooms with plastic or corrosion proof pipe (PE or PVC) wherever possible.

The benefits of this optional part of the cooling system are that AHU-1 would receive free-cooling as originally intended, making more of the chiller capacity available to the rest of the building. In addition, this system would only be needed in the summer months when the outside air temperature is above 65°F, reducing the wear-and-tear on the well pumps, thus extending their useful life.

The drawback of this option is that the existing well cooling capacity, although estimated to be in the 30 ton range, is still unknown and cannot be exactly calculated. Refer to HVAC Schematic MSK.3 in Appendix E for a representation of this proposed alternate system.

4.1.4 Cooling System – Alternate B

A second alternate was developed to provide partial cooling to the spaces served by AHU-1. This option uses return water from the new chilled water system to cool the AHU-1 supply air, again using the existing "free-cooling" coil. This scenario does not make use of the existing geothermal wells. Under this option, the existing coil is used as a conventional cooling coil only with warm return water. It is recommended to use the chilled water return for AHU-1 since the original system design was for tempered air and not full air conditioning. This design increases the return water temperature to the chillers, providing a slight overall boost in cooling capacity from the plant.

It should be noted that this proposed option cannot provide the full 30 ton load of AHU-1 under peak conditions. The new chiller plant is limited to a total capacity of 72 tons due to limited air flow, but the option will still provide partial cooling to AHU-1. A control algorithm would be developed to allow the system to take advantage of system diversity when possible to increase the cooling available to AHU-1. The proposed option also intends to make use of the existing secondary water pumps (SWWP-1,2) to circulate chilled return water to the AHU-1 coil, minimizing the amount of piping work required.

This option would include the following design features:

- Provide new piping and chilled water control valves to connect chilled water system to SWWP-1,2.
- New 3-way valve to control water temperature to AHU-1 (this is provided to prevent AHU-1 from 'stealing' all the flow from the main chilled water loop or overtaxing the chiller plant at the expense of the air-conditioned spaces).
- Additional changeover valves to allow system to automatically switch from heating mode to cooling mode.

Refer to HVAC Schematic MSK.4 in Appendix E for a representation of this proposed alternate system.

4.1.5 Cooling System – Alternate C

A third alternate was developed which makes use of the existing geothermal wells in order to capture some energy savings and the original investment of the existing system without compromising the reliability of the entire cooling system. The existing cooling system has not been operational for several months, and there is strong reason to believe the well-water piping, and geothermal heat pumps, etc. have been fouled as severe corrosion of the piping and equipment in the system were evident. Under this option, one (1) of the existing 30 ton water-to-water heat pumps would be refurbished and made operational again, as would the geothermal well pumps. This heat pump would be used to pre-cool the chilled water return before it is cooled by the new air-cooled chiller plant. The existing chilled water pumps would be used to circulate chilled water into the new primary chilled water system using a primary/secondary configuration. The effect of this is to reduce the load on the air-cooled chillers and utilize the higher efficiency of the heat pumps for not more than 30 tons of the building load. Under some part load conditions, the heat pump may be able to satisfy the entire building load. In order to improve the reliability of the system, this option would use a titanium heat exchanger and water filtration system to protect the refurbished heat pump condenser coil. It is assumed that all four (4) of the condenser coils would need to be replaced as part of the refurbishment. Prior to engaging in this option, the well water pumps would also need to be flow tested to confirm that they can provide the required 75 gpm of circulation to the refurbished heat pump.

This option would also incorporate all the recommendations from Alternate B so that AHU-1 can receive the benefits of cooling from the new chiller plant and the refurbished heat pump.

This option would include the following design features:

- Reactivation and retro-commissioning of the well pumps. Possible replacement if existing pumps are not serviceable.
- New Titanium Plate/Frame HX-1 (30 tons)
- New heat-pump condenser water circulation pump. (75 gpm)
- New well-water filtration system to provide longevity of HX-1 life.
- Provide new piping to connect existing chilled water pumps to new primary chilled water loop.
- All features of Alternate B above to provide cooling to AHU-1.
- Replace corroded well water piping in mechanical rooms with plastic or corrosion proof pipe (PE or PVC) wherever possible.
- Replace condenser coils, refurbish, and retro-commission WSHP-1.

Refer to HVAC Schematic MSK.5 in Appendix E for a representation of this proposed alternate system.

4.2 Heating Plant

Based on our evaluation of the existing heating systems contained in this report, we have concluded that the existing boiler is inadequate to serve all the existing and future heating loads of the building. In addition, the geothermal well system is not of sufficient capacity to heat the entire building. An additional boiler is recommended for the building as discussed previously. In addition, the boiler piping must be modified to correct the 'short-circuiting' that was originally installed which is effectively reducing the temperature of the hot water that is delivered to the building, and therefore the heating output of all terminal systems.

Our recommendations are summarized as follows:

- Immediately correct the boiler plant piping to correct the recirculation issue and provide boiler water directly to the building. (This can be done in a temporary fashion prior to installing the new boiler). Limit the existing hot water pump to 150 gpm using the VFD, so as not to exceed the maximum flow of the existing boiler.
- Provide a new boiler B-2 sized for at least 1300 MBH output. (The recommended boiler is an Aerco BM1.5 or equal)
- OLA reviewed the existing gas booster system, and it appears to be of sufficient capacity. However, the new loads will need to be submitted to and coordinated with the gas utility company (ConEdison).
- Provide a new boiler breeching in the boiler room up to the point of connection to the existing 8" diameter flue.
- Provide a new modulating induced draft fan system at the top of the existing chimney, sized to provide sufficient draft to the new boiler and the existing boiler.
- Provide new boiler piping connection as shown schematically in MSK.2 in Appendix E.
- Increase the peak hot water output temperature of the boiler plant to about 170 °F and rebalance the entire hot water system. This is intended to achieve the required 160 °F mean water temperature to the radiant ceiling panels.

Refer to HVAC Schematic MSK.2 in Appendix E for a representation of this recommendation.

4.3 Air Handling Unit Systems Evaluation (AHU-1 to AHU-5, FAI-1/SX-1)

4.3.1. Fresh Air Intake Fan FAI-1/SX-1 System

Our recommendations to correct the deficiencies identified with this air system are as follows:

- Remove the existing FAI-1 fan and related ductwork at the 11th Floor roof. Patch and seal the existing duct riser. This duct riser shall be used exclusively for smoke purge in the future.
- Continue to use the SX-1 fan and duct riser for smoke purge. Interlock SX-1 fan to operate with the purge mode as indicated in the control sequence accordingly. Perform testing and balancing to confirm if SX-1 is capable to provide the required smoke exhaust volume of 26,000 cfm. The SX-1 fan may need to be replaced if it is not capable.
- Install new FAI louver approximately sized at 55 sq ft in place of the two (2) existing windows behind the building ornamental fascia in the high bay storage area on the Battery Place side of the building. Provide a new 30,000 cfm make-up air fan, ductwork, power and controls, run new ductwork and interface with the existing AHUs 1-5 intake air plenums. (This option must be further investigated, reviewed, and approved by the building owner and Battery Park City Authority.) This modification will eliminate all air intake problems and would allow continuous operation of AHU-1 at all times, and it would also make space available in the 11th Floor roof mechanical enclosure. In addition, this new louver location can also provide make-up air for the welding shop, as further discussed in this report. In addition, relocation of the make-up air to this location will eliminate the recirculation issue with generator exhaust and the general exhaust.
- A service platform would be provided at the 2nd floor level in the high bay storage to provide access to the new fan and intake plenum for maintenance. An access door to the service platform can be provided from the existing metal shop, or alternately a ladder can be provided for access from the 1st floor.

Refer to HVAC sketches MSK.8 and MSK.11 in Appendix E for a representation of this recommendation.

4.3.2. AHU-1 to AHU-5 Systems:

Our recommendations to correct the deficiencies identified with these air systems are as follows:

- Provide new required fresh air intake (FAI) ductwork to the AHUs, modify and/or increase the FAI, return and mixed air duct connections to the AHUs and the existing mixed air plenums.
- Provide adequate cross bracing for the existing FAI ductwork per SMACNA requirements. Replace sections of imploded fresh air intake duct where necessary.
- Consider in-line return air fans and ductwork in order to improve return air (RA) flow to AHUs 2 - 5. The 4th Floor office unit appears to be in need of a return fan and the others should be reviewed.
- Provide testing and balancing for AHUs, including balancing to meet the economizer conditions.
- Revise control systems and sequence of operations to interlock new FAI and return air fans with AHU-1 and other AHUs.

4.4 Generator Exhaust

Our recommendations outlined under Section 4.3.1 above will also correct the deficiency with generator exhaust recirculation, by moving the fresh air intake to the Battery Place side of the building

4.5 Radiant Ceiling Panels (RCPs)

As mentioned previously in this report, the RCP heating capacity is insufficient in several areas. Our recommendations to correct these deficiencies can be summarized as follows:

- Increase the peak hot water output temperature of the boiler plant to about 170 °F and rebalance the entire hot water system. This is intended to achieve the required 160 °F mean water temperature to the radiant ceiling panels and increase their output the required level.
- Install additional radiant ceiling panels (or finned tube radiation) in all the southwest corner spaces.
- Install additional radiators in the dockmaster's office. This can be fin tube radiation or RCP as desired. (see section on dockmaster's office below).
- Install a new radiant ceiling panel, hot water piping and control valve in the 4th floor toilet. Install new finned tube radiation in the 3rd floor janitors closet and 1st floor storage areas that have no heating (if desired by the Owner).
- During the design phase, a detailed load calculation will be performed and any additional perimeter spaces identified to be deficient in terminal heating capacity identified.

4.6 Hot / Chilled Water Pumps (Electrical Deficiency)

This item was still under further investigation at time of this draft report.

4.7 IT Room AC Units (AC-1,2,3)

Our recommendations to correct the deficiencies identified with these air conditioning systems are to modify the intake and exhaust duct connections as follows:

- Increase intake duct connection size & transition from the condenser intake collar to a 24"x16" connection to louver.
- Increase spacing between the intake and exhaust air connections to the louver by a minimum distance of 2'-6". The present installation is re-circulating exhaust air from the condenser back into the intake, raising the condensing air temperatures in the units.
- Adjust balance and/or increase condenser air fan capacity.
- The reconfiguration of the exhaust/intake for these air conditioners could be integrated into the new louvers/exhaust plenum as part of the air-cooled chiller plant.

4.8 Vehicle Exhaust Capture System

Our recommendations to correct the deficiencies identified with the exhaust system are as follows:

- Remove the existing EF-3 fan from its present location on the 1st Floor and install a new exhaust fan with additional capacity on the 3rd Floor. Reconnect new high volume/static exhaust fan to the main 14x10 exhaust duct riser.
- Modify controls, and reconnect electric power to the fan.
- Rebalance air system to determine if all vehicle maintenance air outlets are exhausting the scheduled CFM.
- Provide removable end caps on all existing vehicle hose ends, removing them only when respective system is in use.

Refer to HVAC sketch MSK.9 in Appendix E for a representation of this recommendation.

4.9 Metal Shop Welding System (2nd Floor)

The proposed solution to provide for welding in the metal shop is as follows. The present welding work bench location should be separated from the main area of the Metal Shop. It appears possible to construct a concrete block or sheetrock wall with metal double doors separating the welding area from the rest of the shop. Install the following measures:

- Install a new 5'-0"x4'-0" sheet metal canopy hood over the welding work bench
- Provide new inline exhaust fan sized for approximately 1800 CFM, with new ductwork, electric power wiring and interlocks
- Prove a new discharge louver approximately 3.5 sq ft. installed in the window of the Metal Shop.
- Install new air handling unit with heating coil, filters, controls, piping, and ductwork to provide make-up air to the room when welding is performed. Interlock AHU with new exhaust fan.

Refer to HVAC sketches MSK.10 and MSK.11 in Appendix E for a representation of this recommendation.

4.10 Main Lobby air conditioning (1st Floor)

Our recommendations to correct the deficiencies identified with the lobby air conditioning system are as follows:

- Disconnect and remove existing fan coil unit FCU-2 from the present location. Install a new fan coil unit with additional heating and cooling capacity. Disconnect the existing supply air duct from the 16x6 main supply from AHU-1, and cap the end.
- Remove the existing return air linear diffuser and ductwork. Patch ceiling.
- Install a new 3"Wx48"L linear in the side wall above the existing supply air ductwork and linear. Connect the new return air ductwork directly to the back of the new FCU-2; also connect an 8x6 section of ductwork with motorized damper from AHU-1 into the back of the new FCU-2 to provide outside air in order to meet the NYC building code requirements for ventilation.
- The existing cabinet unit heater CUH-A can remain; however, increase fan speed and air capacity if possible. Modify system control sequences.

4.11 Offices Air Conditioning (4th Floor)

Our recommendations to correct the deficiencies identified with these systems are as follows:

- Blank off all inactive open grilles along the perimeter above the 4th Floor atrium with insulated panels to keep air from flowing into the 4th Floor hung ceilings.
- Install new in-line return air fan and ductwork in order to improve return air flow back to AHU– 4 (As previously described in this report).
- Provide electric power and interlock return air fan with respective AHU No's. 4. Modify control sequence of operation as required for return fan operation.

4.12 Dockmaster's Office (Mezzanine Level)

Our recommendations to correct the deficiencies identified with these systems are as follows:

- Install a new 10" x 8" supply air duct with grille and motorized damper (300 CFM). Connect to existing 16"x16" supply air duct from AHU-1. This would provide adequate ventilation and pressurization for this office, and eliminate infiltration of garage air fumes into the office.
- Provide retro-commissioning for FCU -1 and RCP-1. Provide additional hot water heating capacity in the form of finned tube radiation or an additional RCP.

4.13 Testing and Balancing

This recommendation is general in nature and applies to the whole building. Given the history of the building systems, it is our recommendation to engage a Testing and Balancing (TAB) firm to measure and benchmark all the airflows and water flows in the existing HVAC systems prior to beginning any new design and construction remedial work. This will help inform the design, and confirm the existing conditions. In addition, the entire HVAC system will need to be tested and balanced after any remedial work is completed.

4.14 Retro-Commissioning

This recommendation is general in nature and applies to the whole building. Retro-commissioning is the systematic process of verifying that all building systems perform interactively according to design intent, that operational needs of the owner are met, and that operation and maintenance staff are properly trained. Typical results of retro-commissioning of building systems are improvements in system performance, energy efficiency, occupant comfort and indoor environment quality.

The recommended measures contained in this report will all involve extensive modifications to the existing Building Management System (BMS) and controls. While the original system sequence of operation and programming may be adequate for select systems, its operation should be re-verified through a retro-commissioning process that includes a detailed Functional Testing process.

Given the history of the building systems, it is our recommendation to commission all of the building HVAC systems as they are either replaced or modified, and retro-commission any HVAC systems that are to remain as is after the remedial work is completed.

4.15 Review of Design Engineer Sketches

This section is provided as requested in the scope of work to comment on the repair suggestions by the original project engineer:

4.15.1. Metal Shop Welding – AKF Sketches SKM-1, 2, 3 / SKE-3,4,5

These sketches indicated using the existing general relief fan RF-1 as an exhaust fan for welding operations. The original intention of RF-1 is provide relief air from the buildings when the AHUs are in economizer mode (100% outside air). The sketches describe installing relief air louvers from the office space to the atrium instead of using RF-1.

- We do not recommend the approach outlined in the AKF sketches. Please refer to Section 4.9 for our recommendations for welding exhaust.

4.15.2. AKF Sketches SKM-4, 5 / SKE-1,2

The proposed modifications outlined in these sketches are similar to the approach outlined Section 4.8 of this report to correct the Vehicle Exhaust issues. However, we recommend providing a new fan so that its size/horsepower can be confirmed. This sketch also shows providing ventilation to the dockmaster's office and lobby from AHU-1, similar to our recommendations in Sections 4.12 and 4.10 respectively. However, we recommended additional ventilation air be provided to the dockmaster's office to pressurize that room relative to the vehicle maintenance areas.

4.15.3. Fresh Air Intake Fan FAI-1 – AKF Sketches SKM-6,7

These sketches indicate the removal of FAI-1 and replacement with ductwork, apparently eliminating the fan from the system. This work appears to have been partially done. As indicated earlier in this report, its not clear to us why this fan was taken out of service. We do not believe the ventilation system could have worked without the use of a fresh air intake fan since the outside air intake ductwork is common to all air handlers. This deficiency is addressed by the recommendations in Section 4.3 of this report.