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International Gemini Observatory ▶  
NSF Kitt Peak National Observatory ▶  
NSF-DOE Vera C. Rubin Observatory ▶

## Gemini Hilo Base Facility

# HBF-X Cooling System Replacement Recommendation



NSF NOIRLab, the U.S. National Science Foundation center for ground-based optical-infrared astronomy, operates the International Gemini Observatory (a facility of NSF, NRC-Canada, ANID-Chile, MCTIC-Brazil, MINCYT-Argentina, and KASI-Republic of Korea), NSF Kitt Peak National Observatory (KPNO), NSF Cerro Tololo Inter-American Observatory (CTIO), the Community Science and Data Center (CSDC), and NSF-DOE Vera C. Rubin Observatory (in cooperation with DOE's SLAC National Accelerator Laboratory). It is managed by the Association of Universities for Research in Astronomy (AURA) under a cooperative agreement with NSF and is headquartered in Tucson, Arizona.

The scientific community is honored to have the opportunity to conduct astronomical research on I'oligam Du'ag (Kitt Peak) in Arizona, on Maunakea in Hawai'i, and on Cerro Tololo and Cerro Pachón in Chile. We recognize and acknowledge the very significant cultural role and reverence of I'oligam Du'ag (Kitt Peak) to the Tohono O'odham Nation, and Maunakea to the Kanaka Maoli (Native Hawaiians) community.

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## 1. Project Introduction and Summary

Gemini's Hilo Base Facility had an expansion completed in late 2008, a two-story facility mainly consisting of offices and conference rooms. These spaces are supported by two main split system air conditioning units with condensers located outside and Air Handling Units (AHU) placed in the roof truss space above the second floor. Downstream from the air handling units are Variable Air Volume (VAV) boxes that regulate the airflow to each space depending on the cooling requirements. There are two smaller supplemental air conditioners that support the electrical/server rooms when the main air handling units are not operational. These units have had repairs through the years and recently 3 of the 4 main refrigerant compressors were replaced. The outdoor equipment shows significant signs of decay while the indoor equipment shows minor signs. A building automation system controls all the buildings' air conditioning requirements including maintaining space temperatures, regulating the amount of outside air and controlling the building occupancy schedule.

A third party contractor provided an assessment report on October 17, 2025 noting the facility HVAC system condition. The current condensing units need replacement, but the existing condensers are believed to be oversized. The third party contractor has done a building cooling load calculation and agrees with this assessment.

## 2. Building Cooling Load Calculations

The third party contractor uses Carrier's Hourly Analysis Program (HAP) to calculate building heating and cooling loads. It can incorporate Heating Ventilation Air Conditioning (HVAC) loads generated by people, lights, electrical equipment, environmental loads through walls and windows including solar loads along with fan heat. A summary of input assumptions is as follows:

- A. Exterior walls – The first floor has 8” concrete block walls without insulation, the second-floor walls have been assumed to be wood stud with R-13 batt insulation. The effective wall insulation value is less than the R-13 value once stud allowance has been applied.
- B. Windows – Are clear single pane units.
- C. Roof – The roof does not have insulation, but insulation has been laid upon the 2nd floor T-bar ceiling tiles, assumed to be R-11. There is a concern that the insulation will be removed to gain access to the ceiling and not be replaced which will reduce insulation effectiveness and not meet the assumed R-value.
- D. Occupants – Most rooms have a single person per workstation applied, some offices had more people added as it was expected meetings would happen within the space.

See Appendix A for people space count. All people are assumed to be in the space all the time.

- E. Lights – Lights were estimated on a watts per square foot basis depending on the occupancy type. The lights are assumed to be on all the time.
- F. Equipment – Occupant workstations are considered to have a laptop, desktop workstation and two large monitors. Conference rooms considered an estimated number of laptop computers and large screen monitors. See Appendix A for equipment loads. All this equipment is assumed to be on 24/7.
- G. Outside Air – Calculated per 2018 International Mechanical Code. Considers the space occupancy type, and uses number of people based on people/sqft and default CFM/sqft, see Appendix B.

Using the above assumptions HAP has calculated the first floor will require 19.9 tons of cooling capacity while the second floor will require 19.4 tons, see Appendix C for calculations. This is less than the previous calculations that had 26.6 tons for the first floor and 24.4 for the second floor. See original drawing (M1.2.2) in Appendix D. While it is not possible to determine the differences between the two calculations, the revised calculations do support the theory that the current HVAC is oversized. This is especially true when you consider the building is currently occupied in the 30% to 40% range, the office lighting turns off when the room is not occupied, not all computers are on, and the outside air ventilation is modulated to meet demand not the maximum design value. The existing first floor condensing unit is rated at 25 tons and is oversized for the cooling load. The existing second floor condensing unit is rated at 21 tons and matches the maximum design load; it is not oversized.

The VAV boxes should have their maximum airflow rates adjusted to the new load calculation values and a minimum value should be set that maintains the AHU fan in a stable part of its fan curve. Most of this activity can be accomplished with changes to set points within the building automation system.

### **3. HVAC Equipment Replacement Solution**

As noted above, the condensers using R22 refrigerant need replacement. New units using this refrigerant are not available. R22 refrigerant was replaced by R410a, and R410a is being replaced by R-32 or R454B. Both new refrigerants are classified as an A2L refrigerant. The main concern with the new refrigerants is they have a low flammability rating which will require additional safety features or monitoring. Previous refrigerants were not considered flammable. A discharge of refrigerant into the occupied space is the main concern if it reaches an ignitable concentration. The solution noted below will require very little additional safety monitoring as a discharge will be spread throughout the building. Newer refrigerants operate at a higher pressure which necessitates the replacement of the R22 coils inside the existing AHU's.

### 3.1 Selected Solution – Replace the Existing Condensers and AHUs with Multiple Fan Coils

This solution would replace the 2 existing condensers with four 10-ton condensers and the two AHU's with four 10-ton fan coils. Two fan coils will replace each AHU. The fan coils are smaller in footprint and allow for the potential of running only one unit if building loads allow. This may result in energy savings and better dehumidification control. See Appendix F for conceptual demolition and new work plans. This design should enlarge the existing access hatch, so it is large enough to install or remove the new smaller fan coils as a complete unit.

In addition to the main cooling units one of the backup electrical room, 1.5-ton split systems should be replaced. Installation of the unit and fan coil is not expected to be as difficult as the two main AHU coil replacements.

#### Advantages

- Improved access for maintenance.
- Smaller equipment will be easier to replace.
- May be able to realize additional energy savings when the building is lightly loaded.
- Building will operate as currently designed with small modifications to the sequence of operation.

#### Disadvantages

- Modifications to duct in attic.
- Modification to roof structure for larger access hatch.

### 3.2 Additional Scope – Replace Underground Refrigerant Lines

The size of refrigerant liquid and suction lines must be matched to the system's requirements. It is important that the suction line be sized to maintain the correct gas return velocity, this aids in the proper oil return management. Currently there are 6 liquid and suction lines installed. If the new 10-ton condensers are ordered with dual circuits then an additional 4 liquid and suction lines will be required. This estimate has considered the cost to replace 6 liquid and suction lines. This cost may need to be added to Option 1, 2 and 3. See Appendix H for conceptual demolition and new work plans.

## Appendix A – Electrical Load Plan



**DURRANT<sup>®</sup>**  
 Media Five

Has professional certification under the A.P.E. Act of 1991, and is duly licensed to practice as a Professional Engineer in the State of Hawaii. He is a member of the Hawaii State Board of Professional Engineers, and is a member of the American Society of Professional Engineers, and the Hawaii Society of Professional Engineers. He is also a member of the Hawaii State Board of Professional Engineers, and is a member of the American Society of Professional Engineers, and the Hawaii Society of Professional Engineers.

CONSULTANT:

REVISIONS  
 A REVISED FLOOR PLAN

PROJECT NO.: 08951.0  
 DATE: 08/29/06  
 PROJECT DIRECTOR: MC  
 PROJECT PARTICIPANTS: JEM

SHEET CONTENTS  
 LOWER LEVEL FLOOR PLAN

SHEET

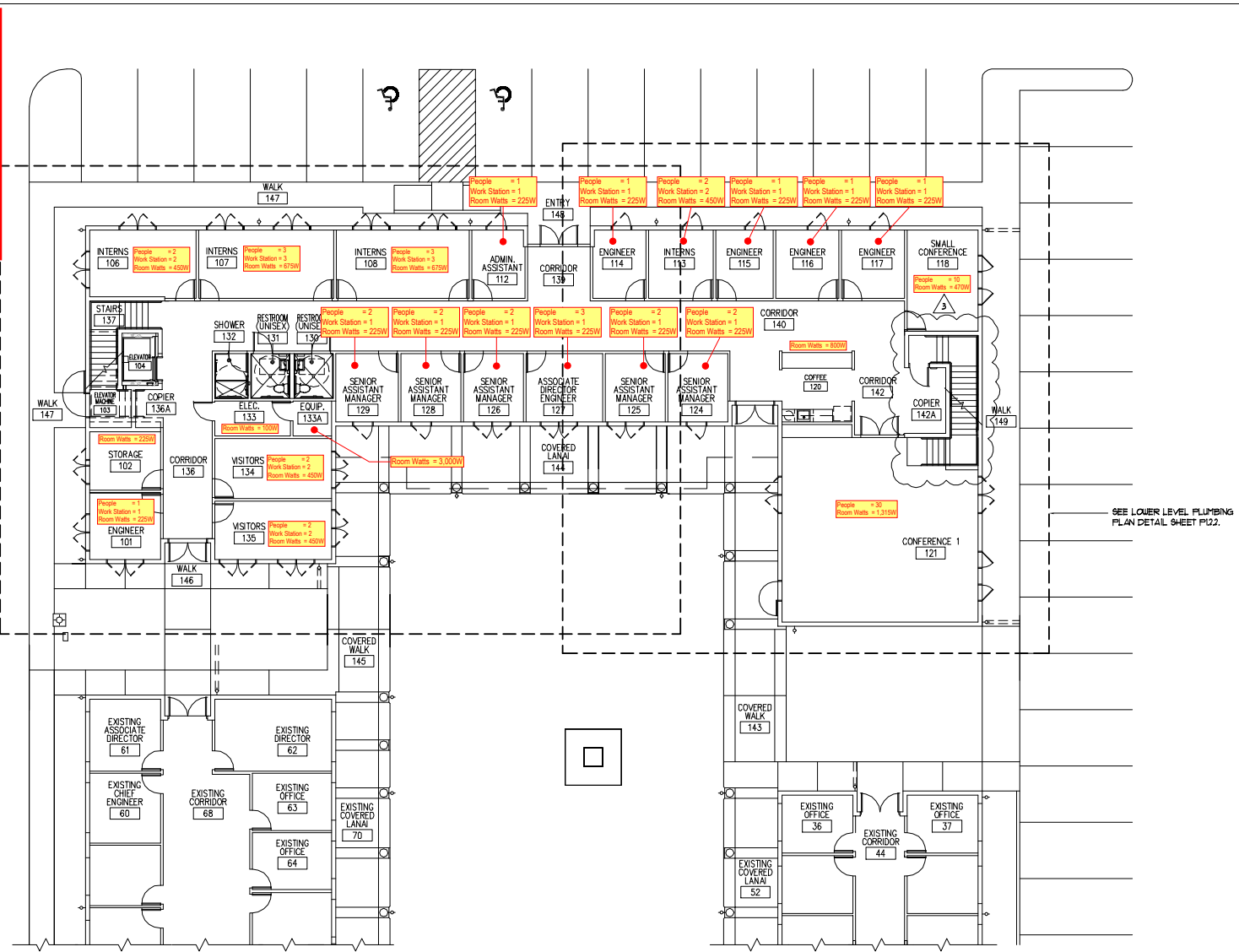
**P1.1.1**

**ELECTRICAL HEAT GAINS**

**Typical Work Station (Watts)**  
 (1) Work Station (desktop) 82 W  
 (1) Laptop 61 W  
 (2) Monitors @ 40W/ea 80 W  
 Total 223 W  
 Used Total 225 W

**Small Conference Heat Gain (Watts)**  
 (6) Laptop @ 61W/ea 366 W  
 (1) Monitor 100 W  
 Total 466 W  
 Used Total 470 W

**Large Conference Heat Gain (Watts)**  
 (15) Laptop @ 61W/ea 915 W  
 (4) Monitors @ 100W/ea 400 W  
 Total 1,315 W



SEE LOWER LEVEL PLUMBING PLAN DETAIL SHEET P12.1

SEE LOWER LEVEL PLUMBING PLAN DETAIL SHEET P12.2

OPERATOR: GEORGE  
 DATE/TIME: APR 27, 2006 10:30:05 AM  
 LOCATION: PROJECTS\08951.0 GEMINI BASE FACILITY EXPANSION  
 FILE: 08951.0 1003.00-PLUMB



**LOWER LEVEL PLUMBING PLAN**  
 SCALE 1/8" = 1'-0"



## Appendix B – Calculations

OUTDOOR AIR CALCULATION (INTERNATIONAL MECHANICAL CODE - 2018)										Ez: ZONE AIR DISTRIBUTION EFFECTIVENESS Per Table 403.3.1.1.2.3.2										Vot: OUTDOOR AIR INTAKE FLOW (CFM) Eq. 4-8 = Vou/Ev										User may input values in IP or SI units, Calculations are done per IMC in IP units									
AZ: ZONE FLOOR AREA (SQFT) OR # OF TOILETS										Pz: Zone population										Vpz: Zone primary airflow (CFM)																			
EA: REQUIRED EXHAUST AIR, PER TABLE 403.3.1.1 (CFM)										Ra: AREA OUTDOOR AIR RATE (CFM/SQFT)										Vou: Uncorrected outdoor air intake Eq 4-6 Vou=D*Sum(Rp*Pz)+Sum(Ra*Az)																			
Evz: ZONE VENTILATION EFFICIENCY. App A Eq A-1 = 1 + Vout / Vps - Voz / Vdz										Rp: PEOPLE OUTDOOR AIR RATE (CFM/PERSON)										Voz: Zone outdoor airflow = Vbz/Ez																			
Ev: =min(Evz)										Vbz: BREATHING ZONE OUTDOOR AIR FLOW (CFM) (Eq. 4-1) =Rp Pz+Ra Az										Vps: System primary airflow																			
BLDG UNIT	ROOM NUM.	ROOM NAME	Units	ft2	cfm	No.	Ez	Actual People	OCCUPANCY CLASSIFICATION	Default Area	Calc Area	Ra	Acfm	Pz	Rp	Rp*Pz	Vbz eq 6-1	Voz	Az	Vpz or Vdz	EA	EA2	Evz	Voz Zone Air	NOTES														
AHU-01	101	ENGINEERING OFFICE	134	393			0.8		Office Spaces	5	0.67	0.06	8.0	0.67	5.0	3.4	11.39	14.2	134.0	393.0			1.03	14.22															
	102	STORAGE	116	352			0.8		Storage Rooms, Occupiable For Dry Materials	2	0.23	0.06	7.0	0.23	5.0	1.2	8.11	10.1	116.0	352.0			1.04	10.13															
	104	ELEVATOR	57	17			0.8		Elevator Car										57.0	17.0	57	57	1.07																
	106	INTERN OFFICE	202	683			0.8		Office Spaces	5	1.01	0.06	12.1	1.01	5.0	5.1	17.17	21.5	202.0	683.0			1.04	21.44															
	107	INTERN OFFICE	254	786			0.8		Office Spaces	5	1.27	0.06	15.2	1.27	5.0	6.4	21.59	27.0	254.0	786.0			1.03	26.96															
	108	INTERN OFFICE	250	776			0.8		Office Spaces	5	1.25	0.06	15.0	1.25	5.0	6.3	21.25	26.6	250.0	776.0			1.03	26.53															
	112	ADMIN. ASSISTANT OFFICE	101	270			0.8		Office Spaces	5	0.51	0.06	6.1	0.51	5.0	2.6	8.61	10.8	101.0	270.0			1.03	10.75															
	113	INTERN OFFICE	124	347			0.8		Office Spaces	5	0.62	0.06	7.4	0.62	5.0	3.1	10.54	13.2	124.0	347.0			1.03	13.16															
	114	ENGINEERING OFFICE	103	276			0.8		Office Spaces	5	0.52	0.06	6.2	0.52	5.0	2.6	8.78	11.0	103.0	276.0			1.03	10.96															
	115	ENGINEERING OFFICE	110	270			0.8		Office Spaces	5	0.55	0.06	6.6	0.55	5.0	2.8	9.35	11.7	110.0	270.0			1.03	11.68															
	116	ENGINEERING OFFICE	122	281			0.8		Office Spaces	5	0.61	0.06	7.3	0.61	5.0	3.1	10.37	13.0	122.0	281.0			1.02	12.95															
	117	ENGINEERING OFFICE	122	280			0.8		Office Spaces	5	0.61	0.06	7.3	0.61	5.0	3.1	10.37	13.0	122.0	280.0			1.02	12.95															
	118	SMALL CONFERENCE RM.	200	594			0.8		Conference Rooms	50	10	0.06	12.0	10.00	5.0	50.0	62.00	77.5	200.0	594.0			0.94	77.42															
	121	CONFERENCE RM.	961	1,388			0.8		Conference Rooms	50	48.05	0.06	57.7	48.05	5.0	240.3	297.91	372.4	961.0	1,388.0			0.80	372.00															
	124	SR ASSISTANT MGR. OFFICE	116	177			0.8		Office Spaces	5	0.58	0.06	7.0	0.58	5.0	2.9	9.86	12.3	116.0	177.0			1.00	12.31															
	125	SR ASSISTANT MGR. OFFICE	114	225			0.8		Office Spaces	5	0.57	0.06	6.8	0.57	5.0	2.9	9.69	12.1	114.0	225.0			1.02	12.10															
	126	SR ASSISTANT MGR. OFFICE	114	224			0.8		Office Spaces	5	0.57	0.06	6.8	0.57	5.0	2.9	9.69	12.1	114.0	224.0			1.02	12.10															
	127	AS. DIRECTOR ENG.	145	237			0.8		Office Spaces	5	0.73	0.06	8.7	0.73	5.0	3.7	12.35	15.4	145.0	237.0			1.00	15.42															
	128	SENIOR ASSISTANT MGR.	114	169			0.8		Office Spaces	5	0.57	0.06	6.8	0.57	5.0	2.9	9.69	12.1	114.0	169.0			1.00	12.10															
	129	SENIOR ASSISTANT MGR.	120	197			0.8		Office Spaces	5	0.6	0.06	7.2	0.60	5.0	3.0	10.20	12.8	120.0	197.0			1.00	12.74															
	130	RESTROOM UNISEX	50	5	1		0.8		Toilet Rooms - Public (Per Wc)										50.0	5.0	70	70	1.07																
	131	RESTROOM UNISEX	52	4	1		0.8		Toilet Rooms - Public (Per Wc)										52.0	4.0	70	70	1.07																
	132	SHOWER	45	4	1		0.8		Shower Room (Per Shower Head)										45.0	4.0	50	50	1.07																
	28	ELECTRICAL	75	28			0.8		Electrical Equipment Rooms			0.06	4.5				4.50	5.6	75.0	28.0			0.87	5.62															
	133A	EQUIPMENT	40	622			0.8		Electrical Equipment Rooms			0.06	2.4				2.40	3.0	40.0	622.0			1.06	3.00															
	134	VISITOR	194	198			0.8		Office Spaces	5	0.97	0.06	11.6	0.97	5.0	4.9	16.49	20.6	194.0	198.0			0.97	20.59															
	135	VISITOR	190	558			0.8		Office Spaces	5	0.95	0.06	11.4	0.95	5.0	4.8	16.15	20.2	190.0	558.0			1.03	20.17															
	137	STAIRS	102	236			0.8		Corridors			0.06	6.1				6.12	7.7	102.0	236.0			1.04	7.64															
	573	CORRIDOR	1,750	573			0.8		Corridors			0.06	105.0				105.00	131.3	1,750.0	573.0			0.84	131.11															
	141	STAIRS	147	222			0.8		Corridors			0.06	8.8				8.82	11.0	147.0	222.0			1.02	11.01															
<b>Totals</b>				6,224	10,392														6,224	10,392	247	247	0.80																

--Y to Include ASHRAE + 30% airflow  
 P Total Zone Occupants (to determine occupant Diversity)  
 Outdoor air per person 12.7 cfm/person

Minimum O.A. for Un-Occupied bldg -->cfm 361.0  
 Occupant Diversity = P / SumPz = 100%  
 Outdoor air as % of design primary supply air 9%  
 O.A per unit floor area 0.15 cfm/ft2

<V <sub>ou</sub> >	<V <sub>ps</sub> >	O.A.(Vot)	897.06	eq 6-8
			897.06 cfm min required	
		SCHED	910	cfm

OUTDOOR AIR CALCULATION (INTERNATIONAL MECHANICAL CODE - 2018)										Ez: ZONE AIR DISTRIBUTION EFFECTIVENESS Per Table 403.3.1.1.2.3.2										Vot: OUTDOOR AIR INTAKE FLOW (CFM) Eq. 4-8 = Vou/Ev										User may input values in IP or SI units. Calculations are done per IMC in IP units									
Az: ZONE FLOOR AREA (SQFT) OR # OF TOILETS										Pz: Zone population										Vpz: Zone primary airflow (CFM)																			
EA: REQUIRED EXHAUST AIR, PER TABLE 403.3.1.1 (CFM)										Ra: AREA OUTDOOR AIR RATE (CFM/SQFT)										Vou: Uncorrected outdoor air intake Eq 4-6 Vou=D*Sum(Rp*Pz)+Sum(Ra*Az)																			
Evz: ZONE VENTILATION EFFICIENCY, App A Eq A-1 = 1 + Vout / Vps - Voz / Vdz										Rp: PEOPLE OUTDOOR AIR RATE (CFM/PERSON)										Voz: Zone outdoor airflow = Vbz/Ez																			
Ev: =min(Evz)										Vbz: BREATHING ZONE OUTDOOR AIR FLOW (CFM) (Eq. 4-1) =Rp Pz+Ra Az										Vps: System primary airflow																			
BLDG UNIT	ROOM NUM.	ROOM NAME	Area	Flow Rate	No.	Ez	Actual People	OCCUPANCY CLASSIFICATION	Default Area	Calc Area	Ra	Acfm	Pz	Rp	Rp*Pz	Vbz eq 6-1	Voz	Az	Vpz or Vdz	EA	EA2	Evz	Voz Zone Air	NOTES															
AHU-02	104	ELEVATOR	66	16		0.8		Elevator Car										66.0	16.0	66	66	1.05																	
	137	STAIRS	103	111		0.8		Corridors			0.06	6.2					6.18	7.7	103.0	111.0		0.98	18.02																
	141	STAIRS	175	154		0.8		Corridors			0.06	10.5					10.50	13.1	175.0	154.0		0.97	30.61																
	201	DATA REDUCTION	134	426		0.8		Office Spaces	5	0.67	0.06	8.0	0.67	5.0	3.4		11.39	14.2	134.0	426.0		1.02	33.20																
	202	ASSISTANT SCIENTIST	138	325		0.8		Office Spaces	5	0.69	0.06	8.3	0.69	5.0	3.5		11.73	14.7	138.0	325.0		1.01	34.19																
	203	FELLOWS	200	532		0.8		Office Spaces	5	1	0.06	12.0	1.00	5.0	5.0		17.00	21.3	200.0	532.0		1.01	49.56																
	204	DPD SCHEDULER	251	544		0.8		Office Spaces	5	1.26	0.06	15.1	1.26	5.0	6.3		21.36	26.7	251.0	544.0		1.00	62.27																
	205	ASSISTANT SCIENTIST	125	245		0.8		Office Spaces	5	0.63	0.06	7.5	0.63	5.0	3.2		10.65	13.3	125.0	245.0		1.00	31.05																
	206	SCIENTIST	121	243		0.8		Office Spaces	5	0.61	0.06	7.3	0.61	5.0	3.1		10.31	12.9	121.0	243.0		1.00	30.06																
	208	ADMIN ASSISTANT	104	126		0.8		Office Spaces	5	0.52	0.06	6.2	0.52	5.0	2.6		8.84	11.1	104.0	126.0		0.96	25.77																
	209	ASSIST ASTRONOMER	124	242		0.8		Office Spaces	5	0.62	0.06	7.4	0.62	5.0	3.1		10.54	13.2	124.0	242.0		1.00	30.73																
	210	FELLOWS	230	445		0.8		Office Spaces	5	1.15	0.06	13.8	1.15	5.0	5.8		19.55	24.4	230.0	445.0		1.00	56.99																
	211	ASSISTANT ASTRONOMER	120	244		0.8		Office Spaces	5	0.6	0.06	7.2	0.60	5.0	3.0		10.20	12.8	120.0	244.0		1.00	29.73																
	212	CONFERENCE	201	512		0.8		Conference Rooms	50	10.05	0.06	12.1	10.05	5.0	50.3		62.31	77.9	201.0	512.0		0.90	181.64																
	214	AREA OF RESCUER ASSISTANC	96	210		0.8		Office Spaces	5	0.48	0.06	5.8	0.48	5.0	2.4		8.16	10.2	96.0	210.0		1.00	23.79																
	215	FELLOWS	259	488		0.8		Office Spaces	5	1.3	0.06	15.5	1.30	5.0	6.5		22.04	27.6	259.0	488.0		1.00	64.25																
	216	FELLOWS	259	629		0.8		Office Spaces	5	1.3	0.06	15.5	1.30	5.0	6.5		22.04	27.6	259.0	629.0		1.01	64.25																
	217	NGO VISITOR	122	243		0.8		Office Spaces	5	0.61	0.06	7.3	0.61	5.0	3.1		10.37	13.0	122.0	243.0		1.00	30.23																
	218	ASSISTANT ASTRONOMER	110	130		0.8		Office Spaces	5	0.55	0.06	6.6	0.55	5.0	2.8		9.35	11.7	110.0	130.0		0.96	27.26																
	220	ASTRONOMER	163	345		0.8		Office Spaces	5	0.82	0.06	9.8	0.82	5.0	4.1		13.88	17.4	163.0	345.0		1.00	40.46																
	221	DIRECTOR SCI. OPS.	156	364		0.8		Office Spaces	5	0.78	0.06	9.4	0.78	5.0	3.9		13.26	16.6	156.0	364.0		1.01	38.66																
	222	DEPT. DIRECTOR	171	370		0.8		Office Spaces	5	0.86	0.06	10.3	0.86	5.0	4.3		14.56	18.2	171.0	370.0		1.00	42.44																
	223	DIRECTOR	293	667		0.8		Office Spaces	5	1.47	0.06	17.6	1.47	5.0	7.4		24.93	31.2	293.0	667.0		1.01	72.67																
	224	ASSOC. DIRECTOR DEVELOPM	167	368		0.8		Office Spaces	5	0.84	0.06	10.0	0.84	5.0	4.2		14.22	17.8	167.0	368.0		1.00	41.45																
	225	SUPPORT SCIENTIST	137	284		0.8		Office Spaces	5	0.69	0.06	8.2	0.69	5.0	3.5		11.67	14.6	137.0	284.0		1.00	34.02																
	226	RESTROOM UNISEX	51	10	1	0.8		Toilet Rooms - Public (Per Wc)										51.0	10.0		70	70	1.05																
	227	RESTROOM UNISEX	51	9	1	0.8		Toilet Rooms - Public (Per Wc)										51.0	9.0		70	70	1.05																
	228	JANITOR	44	11		0.8		Janitor Closets, Trash Rooms, Recycling										44.0	11.0		44	44	1.05																
	229	ELECTRICAL	75	40		0.8		Electrical Equipment Rooms			0.06	4.5					4.50	5.6	75.0	40.0		0.91	13.12																
	229A	EQUIPMENT	39	618		0.8		Electrical Equipment Rooms			0.06	2.3					2.34	2.9	39.0	618.0		1.05	6.82																
	230	VISITOR	193	211		0.8		Office Spaces	5	0.97	0.06	11.6	0.97	5.0	4.9		16.43	20.5	193.0	211.0		0.95	47.90																
	231	DATA ANALYSIS	189	429		0.8		Office Spaces	5	0.95	0.06	11.3	0.95	5.0	4.8		16.09	20.1	189.0	429.0		1.01	46.90																
	234	CORRIDOR	2,105	987		0.8		Corridors			0.06	126.3					126.30	157.9	2,105.0	987.0		0.89	368.18																
	236	SUPPLIES	57	35		0.8		Storage Rooms			0.12	6.8					6.84	8.6	57.0	35.0		0.81	19.94																
	242	STORAGE	52	11		0.8		Storage Rooms			0.12	6.2					6.24	7.8	52.0	11.0		0.34	18.19																
<b>Totals</b>			6,881	10,624								29.42					553.78	10,624	6,881	10,624	250	250	0.34																

<-Y to Include ASHRAE + 30% airflow

P Total Zone Occupants (to determine occupant Diversity)

Outdoor air per person 55.4 cfm/person

Minimum O.A. for Un-Occupied bldg -->cfm **406.6**

Occupant Diversity = P / SumPz = 100%

Outdoor air as % of design primary supply air 15%

O.A per unit floor area 0.24 cfm/ft2

<V<sub>oc</sub>>

<V<sub>ps</sub>>

O.A.(Vot)	1,614.36	eq 6-8
	1614.36 cfm min required	
SCHED	1,631	cfm

## Appendix C – HAP Design Load Reports

## Air System Sizing Summary for AHU 1 - Lower Level (In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Air System Information

Air System Name ..... <b>AHU 1 - Lower Level</b>	Number of zones ..... <b>1</b>
Equipment Class ..... <b>SPLT AHU</b>	Floor Area ..... <b>6232.1</b> sqft
Air System Type ..... <b>SZCAV</b>	Location ..... <b>Hilo Intl, HI, USA</b>

### Sizing Calculation Information

Calculation Months ..... <b>Jan to Dec</b>	Zone CFM Sizing ..... <b>Sum of space airflow rates</b>
Sizing Data ..... <b>Calculated</b>	Space CFM Sizing ..... <b>Individual peak space loads</b>

### Central Cooling Coil Sizing Data

Total coil load ..... <b>19.9</b> Tons	Peak coil load occurs at ..... <b>August 17:00</b>
Total coil load ..... <b>239.2</b> MBH	OA DB / WB ..... <b>83.9 / 73.5</b> F
Sensible coil load ..... <b>191.8</b> MBH	Entering DB / WB ..... <b>75.8 / 66.0</b> F
Coil CFM at peak load ..... <b>10390</b> CFM	Leaving DB / WB ..... <b>59.0 / 58.8</b> F
Sum of peak zone CFM ..... <b>10390</b> CFM	Resulting RH ..... <b>60</b> %
Sensible heat ratio ..... <b>0.802</b>	Design supply temp. .... <b>58.0</b> F
CFM/Ton ..... <b>521.3</b>	Zone T-stat Check ..... <b>1 of 1</b> OK
sqft/Ton ..... <b>312.7</b>	Max zone temperature deviation ..... <b>0.0</b> F
BTU/(hr sqft) ..... <b>38.4</b>	
Water flow @ 10.0 F rise ..... <b>N/A</b>	

### Central Heating Coil Sizing Data

Max coil load ..... <b>17.9</b> MBH	Load occurs at ..... <b>Design Heating</b>
Coil CFM at Design Heating ..... <b>10390</b> CFM	BTU/(hr sqft) ..... <b>2.9</b>
Max coil CFM ..... <b>10390</b> CFM	Ent. DB / Lvg DB ..... <b>69.3 / 70.8</b> F
Water flow @ 20.0 F drop ..... <b>N/A</b>	

### Supply Fan Sizing Data

Design CFM ..... <b>10390</b> CFM	Fan motor BHP ..... <b>8.54</b> BHP
Design CFM/sqft ..... <b>1.67</b> CFM/sqft	Fan motor kW ..... <b>6.77</b> kW
	Fan total static ..... <b>3.00</b> in wg

### Outdoor Ventilation Air Data

Design airflow CFM ..... <b>910</b> CFM	CFM/person ..... <b>12.13</b> CFM/person
CFM/sqft ..... <b>0.15</b> CFM/sqft	

## Zone Sizing Summary for AHU 1 - Lower Level

(In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Air System Information

Air System Name ..... <b>AHU 1 - Lower Level</b>	Number of zones ..... <b>1</b>
Equipment Class ..... <b>SPLT AHU</b>	Floor Area ..... <b>6232.1</b> sqft
Air System Type ..... <b>SZCAV</b>	Location ..... <b>Hilo Intl, HI, USA</b>

### Sizing Calculation Information

Calculation Months ..... <b>Jan to Dec</b>	Zone CFM Sizing ..... <b>Sum of space airflow rates</b>
Sizing Data ..... <b>Calculated</b>	Space CFM Sizing ..... <b>Individual peak space loads</b>

### Zone Terminal Sizing Data

Zone Name	Design Supply Airflow (CFM)	Minimum Supply Airflow (CFM)	Zone CFM/sqft	Reheat Coil Capacity (MBH)	Reheat Coil Water gpm @ 20.0 F	Zone Htg Unit Coil Capacity (MBH)	Zone Htg Unit Water gpm @ 20.0 F	Mixing Box Fan Airflow (CFM)
AHU 1 - Lower Level	10390	10390	1.67	0.0	-	0.0	-	0

### Zone Peak Sensible Loads

Zone Name	Zone Cooling Sensible (MBH)	Time of Peak Sensible Cooling Load	Zone Heating Load (MBH)	Zone Floor Area (sqft)
AHU 1 - Lower Level	163.6	August 17:00	28.8	6232.1

## Zone Sizing Summary for AHU 1 - Lower Level

(In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Space Loads and Airflows

Zone Name / Space Name	Cooling Sensible (MBH)	Time of Peak Sensible Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (sqft)	Space CFM/sqft
<i>AHU 1 - Lower Level</i>						
101 ENGINEER	7.2	December 14:00	393	1.5	133.8	2.94
102 STORAGE	6.5	December 14:00	352	0.7	116.4	3.02
104 ELEVATOR	0.3	November 10:00	17	0.1	57.7	0.29
106 INTERNS	12.5	December 16:00	683	1.8	202.5	3.37
107 INTERNS	14.4	August 17:00	786	1.5	254.3	3.09
108 INTERNS	14.2	September 17:00	776	1.4	249.7	3.11
112 ADMIN. ASSISTANT	4.9	September 17:00	270	0.7	101.7	2.65
113 INTERNS	6.4	September 17:00	347	0.7	124.7	2.78
114 ENGINEER	5.1	September 17:00	276	0.7	103.2	2.67
115 ENGINEER	5.0	September 17:00	270	0.6	110.6	2.44
116 ENGINEER	5.1	September 17:00	281	0.7	122.6	2.29
117 ENGINEER	5.1	September 17:00	280	0.7	121.9	2.30
118 SMALL CONFERENCE	10.9	June 17:00	594	1.7	199.8	2.97
121 CONFERENCE	25.4	June 16:00	1388	5.0	961.7	1.44
124 SENIOR ASSISTANT MANAGER	3.3	June 12:00	177	0.7	116.0	1.53
125 SENIOR ASSISTANT MANAGER	4.1	June 7:00	225	0.5	114.3	1.97
126 SENIOR ASSISTANT MANAGER	4.1	June 7:00	224	0.6	114.5	1.96
127 ASSPCOATE DORECTPR EMGOMEER	4.3	June 7:00	237	0.7	145.8	1.62
128 SENIOR ASSISTANT MANAGER	3.1	August 9:00	169	0.5	114.5	1.48
129 SENIOR ASSISTANT MANAGER	3.6	June 9:00	197	0.5	120.8	1.63
130 RESTROOM UNISEX	0.1	July 19:00	5	0.0	50.3	0.10
131 RESTROOM UNISEX	0.1	August 20:00	4	0.0	51.9	0.08
132 SHOWER	0.1	August 19:00	4	0.0	44.8	0.09
133 ELEC.	0.5	August 18:00	28	0.0	76.0	0.37
133A EQIP.	11.4	July 16:00	622	0.1	39.6	15.73
134 VISITOR	3.6	July 15:00	198	0.6	193.6	1.02
135 VISITOR	10.2	July 10:00	558	2.0	189.4	2.95
137 STAIRS	4.3	December 15:00	236	1.0	102.8	2.29
140 CORRIDOR	10.5	August 16:00	573	2.5	1750.2	0.33
141 STAIRS	4.1	June 18:00	222	1.4	146.9	1.51

## Air System Heat Balance Summary for AHU 1 - Lower Level

(In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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**Table 1. System Loads**

COMPONENT LOADS	DESIGN COOLING - AUGUST 17:00			DESIGN HEATING		
	OA DB / WB 83.9 F / 73.5 F			OA DB / WB 61.6 F / 51.5 F		
	Details	Sensible [BTU/hr]	Latent [BTU/hr]	Details	Sensible [BTU/hr]	Latent [BTU/hr]
Zone Conditioning	-	159701	26676	-	32691	0
Plenum Load	-	0	0	-	0	0
Return Fan Load	9480 CFM	0	-	9480 CFM	0	-
Ventilation Load	910 CFM	8605	18778	910 CFM	8244	0
Supply Fan Load	10390 CFM	23103	-	10390 CFM	-23103	-
Zone Fan Coil Fans Load	-	0	-	-	0	-
>> Total System Loads	-	191409	45453	-	17832	0
Central Cooling Coil	-	191827	47334	-	0	0
Central Heating Coil	-	0	-	-	17940	-
>> Total Conditioning	-	191827	47334	-	17940	0
<b>Key:</b>	<b>Positive values are cooling loads Negative values are heating loads</b>			<b>Positive values are heating loads Negative values are cooling loads</b>		

**Table 2. Zone Heat Balance Loads**

Zone Heat Balance Component	DESIGN COOLING - AUGUST 17:00			DESIGN HEATING		
	OA DB / WB 83.9 F / 73.5 F			OA DB / WB 61.6 F / 51.5 F		
	Details	Sensible [BTU/hr]	Latent [BTU/hr]	Details	Sensible [BTU/hr]	Latent [BTU/hr]
Exterior Wall Convection	3626 sqft	35256	-	3626 sqft	6616	-
Roof Convection	0 sqft	0	-	0 sqft	0	-
Window Convection	545 sqft	4465	-	545 sqft	1834	-
Skylight Convection	0 sqft	0	-	0 sqft	0	-
Door Convection	146 sqft	813	-	146 sqft	324	-
Floor Convection	6232 sqft	18717	-	6232 sqft	4656	-
Interior Wall Convection	12167 sqft	27835	-	12167 sqft	3332	-
Ceiling Convection	6232 sqft	19910	-	6232 sqft	2896	-
Overhead Lighting Convection	1997 W	1736	-	0 W	0	-
Task Lighting Convection	0 W	0	-	0 W	0	-
Electric Equipment Convection	11760 W	30095	-	0 W	0	-
People Convection	75	5513	15375	0	0	0
Infiltration	474 CFM	4382	9623	474 CFM	4367	0
Miscellaneous Equipment	-	0	0	-	0	0
Air Internal Energy Change	-	0	-	-	0	0
Safety Factor	10% / 10%	14872	2500	20%	4805	0
>> Total Zone Loads	-	163593	27498	-	28831	0
<b>Key:</b>	<b>Positive values are cooling loads Negative values are heating loads</b>			<b>Positive values are heating loads Negative values are cooling loads</b>		

**Note 1:** Surface convection line items show the combined effects of conductive heat gain to the surface and radiative heat gains absorbed at the surface which are then convected to room air.

**Note 2:** Lighting, equipment, and people line items include only the direct convective heat gain from the heat source to the room air. The radiative portion of the heat gain is first absorbed by surfaces in the room and then later convected from the surface to the air. Therefore the effect of the radiative portion of the heat gain is found in the surface convection line items.

**Note 3:** Solar heat gain is absorbed by surfaces in the room, re-radiated to other surfaces, and finally convected from the surfaces to room air. Therefore, the effect of solar heat gain is found in the surface convection line items.

## Air System Sizing Summary for AHU 2 - Upper Level (In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Air System Information

Air System Name	<b>AHU 2 - Upper Level</b>	Number of zones	<b>1</b>
Equipment Class	<b>SPLT AHU</b>	Floor Area	<b>6891.9</b> sqft
Air System Type	<b>SZCAV</b>	Location	<b>Hilo Intl, HI, USA</b>

### Sizing Calculation Information

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

### Central Cooling Coil Sizing Data

Total coil load	<b>19.4</b> Tons	Peak coil load occurs at	<b>August 15:00</b>
Total coil load	<b>233.2</b> MBH	OA DB / WB	<b>85.7 / 74.0</b> F
Sensible coil load	<b>180.7</b> MBH	Entering DB / WB	<b>76.6 / 67.5</b> F
Coil CFM at peak load	<b>10624</b> CFM	Leaving DB / WB	<b>61.2 / 60.9</b> F
Sum of peak zone CFM	<b>10624</b> CFM	Resulting RH	<b>63</b> %
Sensible heat ratio	<b>0.775</b>	Design supply temp.	<b>58.0</b> F
CFM/Ton	<b>546.7</b>	Zone T-stat Check	<b>1 of 1</b> OK
sqft/Ton	<b>354.7</b>	Max zone temperature deviation	<b>0.0</b> F
BTU/(hr sqft)	<b>33.8</b>		
Water flow @ 10.0 F rise	<b>N/A</b>		

### Central Heating Coil Sizing Data

Max coil load	<b>14.5</b> MBH	Load occurs at	<b>Design Heating</b>
Coil CFM at Design Heating	<b>10624</b> CFM	BTU/(hr sqft)	<b>2.1</b>
Max coil CFM	<b>10624</b> CFM	Ent. DB / Lvg DB	<b>68.7 / 70.0</b> F
Water flow @ 20.0 F drop	<b>N/A</b>		

### Supply Fan Sizing Data

Design CFM	<b>10624</b> CFM	Fan motor BHP	<b>8.73</b> BHP
Design CFM/sqft	<b>1.54</b> CFM/sqft	Fan motor kW	<b>6.92</b> kW
		Fan total static	<b>3.00</b> in wg

### Outdoor Ventilation Air Data

Design airflow CFM	<b>1631</b> CFM	CFM/person	<b>32.62</b> CFM/person
CFM/sqft	<b>0.24</b> CFM/sqft		

## Zone Sizing Summary for AHU 2 - Upper Level (In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Air System Information

Air System Name ..... **AHU 2 - Upper Level**  
 Equipment Class ..... **SPLT AHU**  
 Air System Type ..... **SZCAV**

Number of zones ..... **1**  
 Floor Area ..... **6891.9** sqft  
 Location ..... **Hilo Intl, HI, USA**

### Sizing Calculation Information

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

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

### Zone Terminal Sizing Data

Zone Name	Design Supply Airflow (CFM)	Minimum Supply Airflow (CFM)	Zone CFM/sqft	Reheat Coil Capacity (MBH)	Reheat Coil Water gpm @ 20.0 F	Zone Htg Unit Coil Capacity (MBH)	Zone Htg Unit Water gpm @ 20.0 F	Mixing Box Fan Airflow (CFM)
AHU 2 - Upper Level	10624	10624	1.54	0.0	-	0.0	-	0

### Zone Peak Sensible Loads

Zone Name	Zone Cooling Sensible (MBH)	Time of Peak Sensible Cooling Load	Zone Heating Load (MBH)	Zone Floor Area (sqft)
AHU 2 - Upper Level	141.1	July 16:00	20.5	6891.9

## Zone Sizing Summary for AHU 2 - Upper Level (In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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### Space Loads and Airflows

Zone Name / Space Name	Cooling Sensible (MBH)	Time of Peak Sensible Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (sqft)	Space CFM/sqft
<i>AHU 2 - Upper Level</i>						
104 ELEVATOR	0.3	December 13:00	16	0.1	66.0	0.24
137 STAIR	2.0	December 12:00	111	0.4	103.1	1.07
141 STAIRS	2.8	June 17:00	154	0.8	175.5	0.88
201 DATA REDUCTION	7.8	February 9:00	426	1.0	133.8	3.18
202 ASSIST SCIENTIST	6.0	December 11:00	325	0.5	138.4	2.35
203 FELLOWS	9.8	December 15:00	532	1.1	200.5	2.65
204 DPD SCHEDULER	10.0	September 16:00	544	0.9	251.6	2.16
205 ASSIST SCIENTIST	4.5	September 16:00	245	0.4	125.1	1.96
206 SCIENTIST	4.5	September 16:00	243	0.4	121.4	2.00
208 ADMIN. ASSISTANT	2.3	August 17:00	126	0.3	104.1	1.21
209 ASSIST ASTRONOMER	4.4	September 16:00	242	0.4	123.9	1.96
210 FELLOWS	8.2	December 11:00	445	0.5	229.9	1.94
211 ASSIST ASTRONOMER	4.5	September 16:00	244	0.4	120.6	2.02
212 CONFERENCE	9.4	June 17:00	512	1.0	201.1	2.54
214 AREA OF RESCUE ASSISTANCE ROOM	3.8	June 17:00	210	0.4	96.9	2.17
215 FELLOWS	9.0	July 8:00	488	1.3	259.3	1.88
216 FELLOWS	11.5	December 9:00	629	1.3	259.6	2.42
217 NGO VISITOR	4.5	September 16:00	243	0.4	122.0	1.99
218 ASSOST ASTRPMP,ER	2.4	August 17:00	130	0.3	110.0	1.18
220 ASTRONOMER	6.3	August 9:00	345	0.5	163.4	2.11
221 DIRECTOR SCI. OPS.	6.7	June 8:00	364	0.6	156.8	2.32
222 DEPT. DIRECTOR	6.8	June 8:00	370	0.5	171.9	2.15
223 DIRECTOR	12.2	June 8:00	667	1.0	293.1	2.28
224 ASSOC. DIRECTOR DEVELOPEMENT	6.7	August 8:00	368	0.6	167.5	2.20
225 SUPPORT SCIENTIST	5.2	June 7:00	284	0.5	137.3	2.07
226 RESTROOM UNISEX	0.2	July 17:00	11	0.1	50.2	0.22
227 RESTROOM UNISEX	0.2	July 17:00	10	0.1	51.1	0.20
228 JANITOR	0.2	August 17:00	9	0.1	44.6	0.19
229 ELECTRICAL	0.7	July 16:00	40	0.1	75.4	0.53
229A EQUIP.	11.3	July 16:00	618	0.0	39.5	15.62
230 VISITIOR	3.9	July 14:00	211	0.4	193.4	1.09
231 DATA ANALYSIS	7.9	July 8:00	429	1.1	189.4	2.27
234 CORRIDOR	18.1	August 16:00	987	2.8	2105.6	0.47
236 SUPPLIES	0.6	November 13:00	35	0.1	57.4	0.61
242 STORAGE	0.2	July 17:00	11	0.1	52.3	0.20

## Air System Heat Balance Summary for AHU 2 - Upper Level

(In Alternative: HFB-X Building 2)

Project: 250296 - HFB-X Cooling System Replacement(converted)

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**Table 1. System Loads**

COMPONENT LOADS	DESIGN COOLING - AUGUST 15:00			DESIGN HEATING		
	OA DB / WB 85.7 F / 74.0 F			OA DB / WB 61.6 F / 51.5 F		
	Details	Sensible [BTU/hr]	Latent [BTU/hr]	Details	Sensible [BTU/hr]	Latent [BTU/hr]
Zone Conditioning	-	137747	20314	-	23149	0
Plenum Load	-	0	0	-	0	0
Return Fan Load	8993 CFM	0	-	8993 CFM	0	-
Ventilation Load	1631 CFM	18598	28149	1631 CFM	14776	0
Supply Fan Load	10624 CFM	23623	-	10624 CFM	-23623	-
Zone Fan Coil Fans Load	-	0	-	-	0	-
>> Total System Loads	-	179968	48462	-	14302	0
Central Cooling Coil	-	180726	52445	-	0	0
Central Heating Coil	-	0	-	-	14496	-
>> Total Conditioning	-	180726	52445	-	14496	0
<b>Key:</b>	<b>Positive values are cooling loads Negative values are heating loads</b>			<b>Positive values are heating loads Negative values are cooling loads</b>		

**Table 2. Zone Heat Balance Loads**

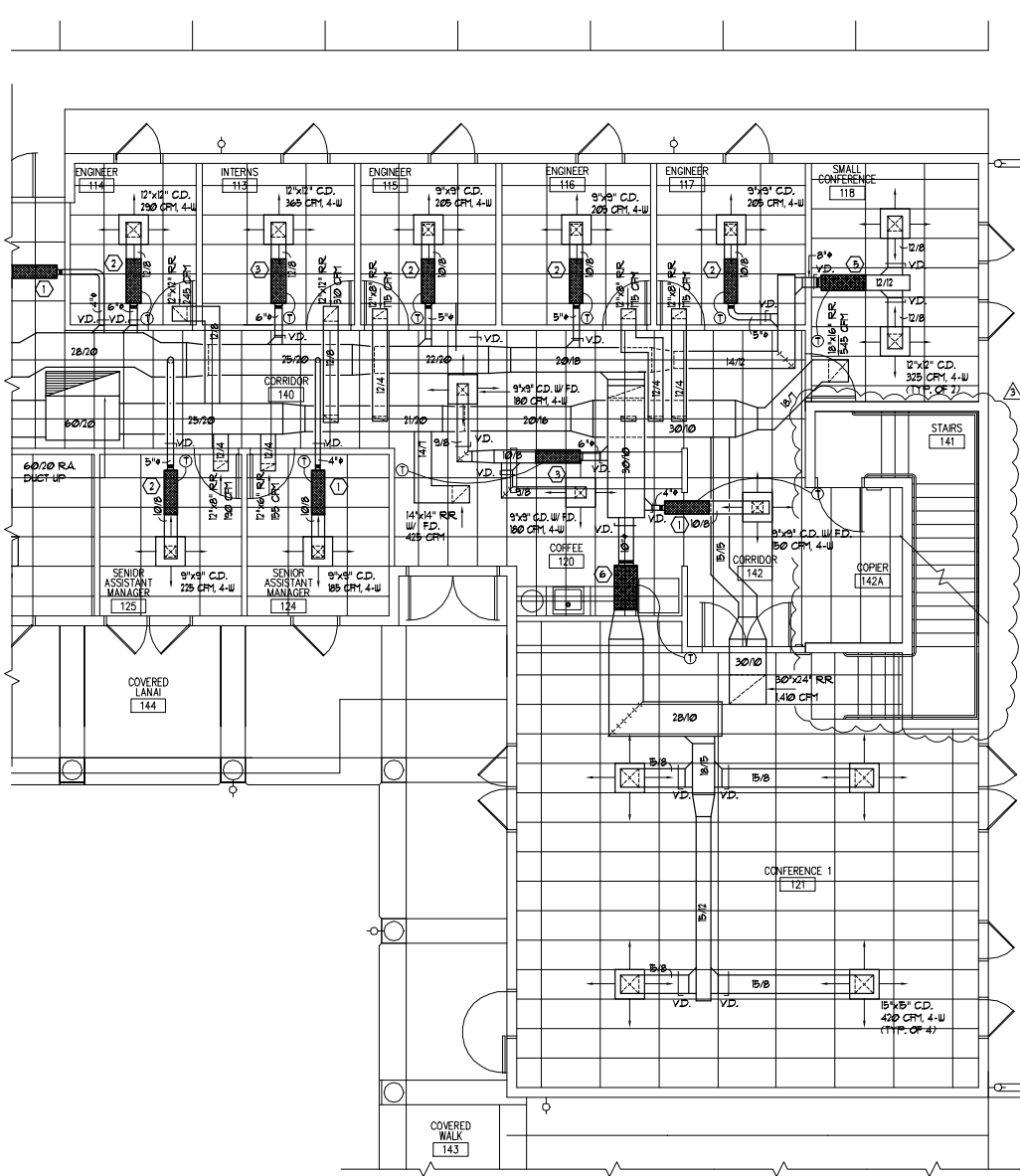
Zone Heat Balance Component	DESIGN COOLING - AUGUST 15:00			DESIGN HEATING		
	OA DB / WB 85.7 F / 74.0 F			OA DB / WB 61.6 F / 51.5 F		
	Details	Sensible [BTU/hr]	Latent [BTU/hr]	Details	Sensible [BTU/hr]	Latent [BTU/hr]
Exterior Wall Convection	3423 sqft	12380	-	3423 sqft	2245	-
Roof Convection	0 sqft	0	-	0 sqft	0	-
Window Convection	678 sqft	4639	-	678 sqft	2157	-
Skylight Convection	0 sqft	0	-	0 sqft	0	-
Door Convection	0 sqft	0	-	0 sqft	0	-
Floor Convection	6892 sqft	20877	-	6892 sqft	1912	-
Interior Wall Convection	14849 sqft	23326	-	14849 sqft	3444	-
Ceiling Convection	6900 sqft	24253	-	6900 sqft	3193	-
Overhead Lighting Convection	1992 W	1563	-	0 W	0	-
Task Lighting Convection	0 W	0	-	0 W	0	-
Electric Equipment Convection	12020 W	30760	-	0 W	0	-
People Convection	50	3675	10250	0	0	0
Infiltration	451 CFM	4983	9204	451 CFM	4169	0
Miscellaneous Equipment	-	0	0	-	0	0
Air Internal Energy Change	-	0	-	-	0	0
Safety Factor	10% / 10%	12646	1945	20%	3424	0
>> Total Zone Loads	-	139103	21399	-	20544	0
<b>Key:</b>	<b>Positive values are cooling loads Negative values are heating loads</b>			<b>Positive values are heating loads Negative values are cooling loads</b>		

**Note 1:** Surface convection line items show the combined effects of conductive heat gain to the surface and radiative heat gains absorbed at the surface which are then convected to room air.

**Note 2:** Lighting, equipment, and people line items include only the direct convective heat gain from the heat source to the room air. The radiative portion of the heat gain is first absorbed by surfaces in the room and then later convected from the surface to the air. Therefore the effect of the radiative portion of the heat gain is found in the surface convection line items.

**Note 3:** Solar heat gain is absorbed by surfaces in the room, re-radiated to other surfaces, and finally convected from the surfaces to room air. Therefore, the effect of solar heat gain is found in the surface convection line items.

## Appendix D – M1.2.2 Drawing



**LOWER LEVEL PARTIAL AIR CONDITIONING PLAN DETAIL**  
 SCALE 1/4" = 1'-0"

**Air System Sizing Summary for Second Floor**  
 Project Name: Gemini Base Facility Expansion  
 Prepared by: M2I International, Inc. 05/12/2006 07:27:24

<b>Air System Information</b>		Second Floor	Number of zones	28
Air System Name		SPLIT AHU	Floor Area	7016.8 sq ft
Equipment Class		VAV		
<b>Sizing Calculation Information</b>		Zone and Space Sizing Method	Zone CFM	Peak zone sensible load
Zone CFM		Space CFM	Calculation Months	Jan to Dec
Sizing Data		Individual peak space loads	Spring Data	Calculated
<b>Central Cooling Coil Sizing Data</b>		Total coil load	74.4 Tons	Load outside at
Total coil load		282.3 MSH	OA DB / WB	36 / 100
Total coil load		282.3 MSH	Chilled coil WB	57.7 / 71.5
Cooling coil load		189.9 CFM	Leaving DB / WB	75.1 / 82.8
Cooling coil load		1029.1 CFM	Leaving DB / WB	53.8 / 52.4
Cooling coil load		1029.1 CFM	Call ACH50	0.12
Cooling coil load		1029.1 CFM	Supply Factor	0.160
Cooling coil load		1029.1 CFM	Return Air	44
Cooling coil load		1029.1 CFM	Change supply temp	35.3
Cooling coil load		1029.1 CFM	Zone T-Stat Control	17 of 28
Cooling coil load		1029.1 CFM	Min supply temperature deviation	11.3
<b>Supply Fan Sizing Data</b>		Actual max CFM at 0.14 inch	1968 CFM	Fan motor BHP
Standard CFM		1968 CFM	Fan motor kW	4.78 kW
Actual max CFM		1.98 CFM/sq ft	Fan static	2.90 in w.g.
<b>Outdoor Ventilation Air Data</b>		Design airflow CFM	822 CFM	CFM/person
Design airflow CFM		6.12 CFM/sq ft	CFM/person	15.80 CFM/person

**Air System Sizing Summary for First Floor**  
 Project Name: Gemini Base Facility Expansion  
 Prepared by: M2I International, Inc. 05/12/2006 07:29:54

<b>Air System Information</b>		First Floor	Number of zones	28
Air System Name		SPLIT AHU	Floor Area	3863.8 sq ft
Equipment Class		VAV		
<b>Sizing Calculation Information</b>		Zone and Space Sizing Method	Zone CFM	Peak zone sensible load
Zone CFM		Space CFM	Calculation Months	Jan to Dec
Sizing Data		Individual peak space loads	Spring Data	Calculated
<b>Central Cooling Coil Sizing Data</b>		Total coil load	28.8 Tons	Load outside at
Total coil load		218.2 MSH	OA DB / WB	36 / 100
Total coil load		218.2 MSH	Chilled coil WB	54.6 / 73.9
Cooling coil load		132.9 CFM	Leaving DB / WB	75.1 / 82.8
Cooling coil load		1029.1 CFM	Leaving DB / WB	53.8 / 52.4
Cooling coil load		1029.1 CFM	Call ACH50	0.12
Cooling coil load		1029.1 CFM	Supply Factor	0.160
Cooling coil load		1029.1 CFM	Return Air	44
Cooling coil load		1029.1 CFM	Change supply temp	35.3
Cooling coil load		1029.1 CFM	Zone T-Stat Control	12 of 28
Cooling coil load		1029.1 CFM	Min supply temperature deviation	6.1
<b>Supply Fan Sizing Data</b>		Actual max CFM at 0.14 inch	1029.1 CFM	Fan motor BHP
Standard CFM		1029.1 CFM	Fan motor kW	3.87 kW
Actual max CFM		1.75 CFM/sq ft	Fan static	2.00 in w.g.
<b>Outdoor Ventilation Air Data</b>		Design airflow CFM	162 CFM	CFM/person
Design airflow CFM		6.9 CFM/sq ft	CFM/person	15.80 CFM/person

VAV DAMPER SCHEDULE					
UNIT NO.	NOMINAL AIR FLOW (CFM)	INLET SIZE (IN.)	DIMENSIONS (IN.)		
			PLENUM HEIGHT	PLENUM WIDTH	DISCHARGE WIDTH x HEIGHT
1	200 CFM	4 ROUND	12 1/2	10 1/2	10 1/2 x 12 1/2
2	350 CFM	5 ROUND	12 1/2	10 1/2	10 1/2 x 12 1/2
3	500 CFM	6 ROUND	12 1/2	10 1/2	10 1/2 x 12 1/2
4	650 CFM	7 ROUND	12 1/2	12 1/2	12 1/2 x 12 1/2
5	800 CFM	8 ROUND	12 1/2	12 1/2	12 1/2 x 12 1/2
6	1300 CFM	10 ROUND	12 1/2	14 1/2	14 1/2 x 12 1/2

- NOTE:**
- PROVIDE LOCKING COVERS ON ALL THERMOSTATS.
  - VOLUME DAMPERS SHALL BE PROVIDED FOR EACH DIFFUSER, RETURN REGISTER AND EXHAUST REGISTER.

ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.  
**GEMINI OBSERVATORY**  
 HILO BASE FACILITY EXPANSION  
 HILLO, HAWAII  
 2005-07-20 10:00 AM



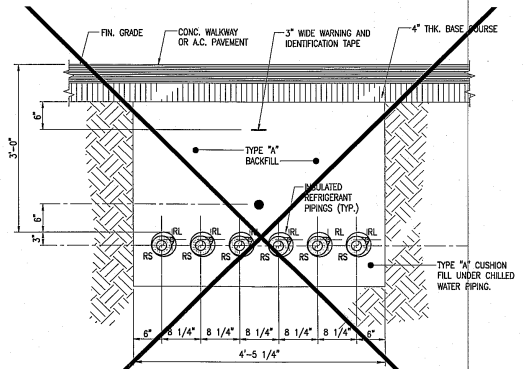
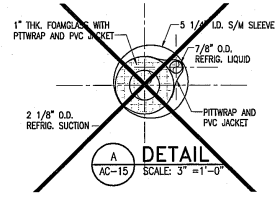
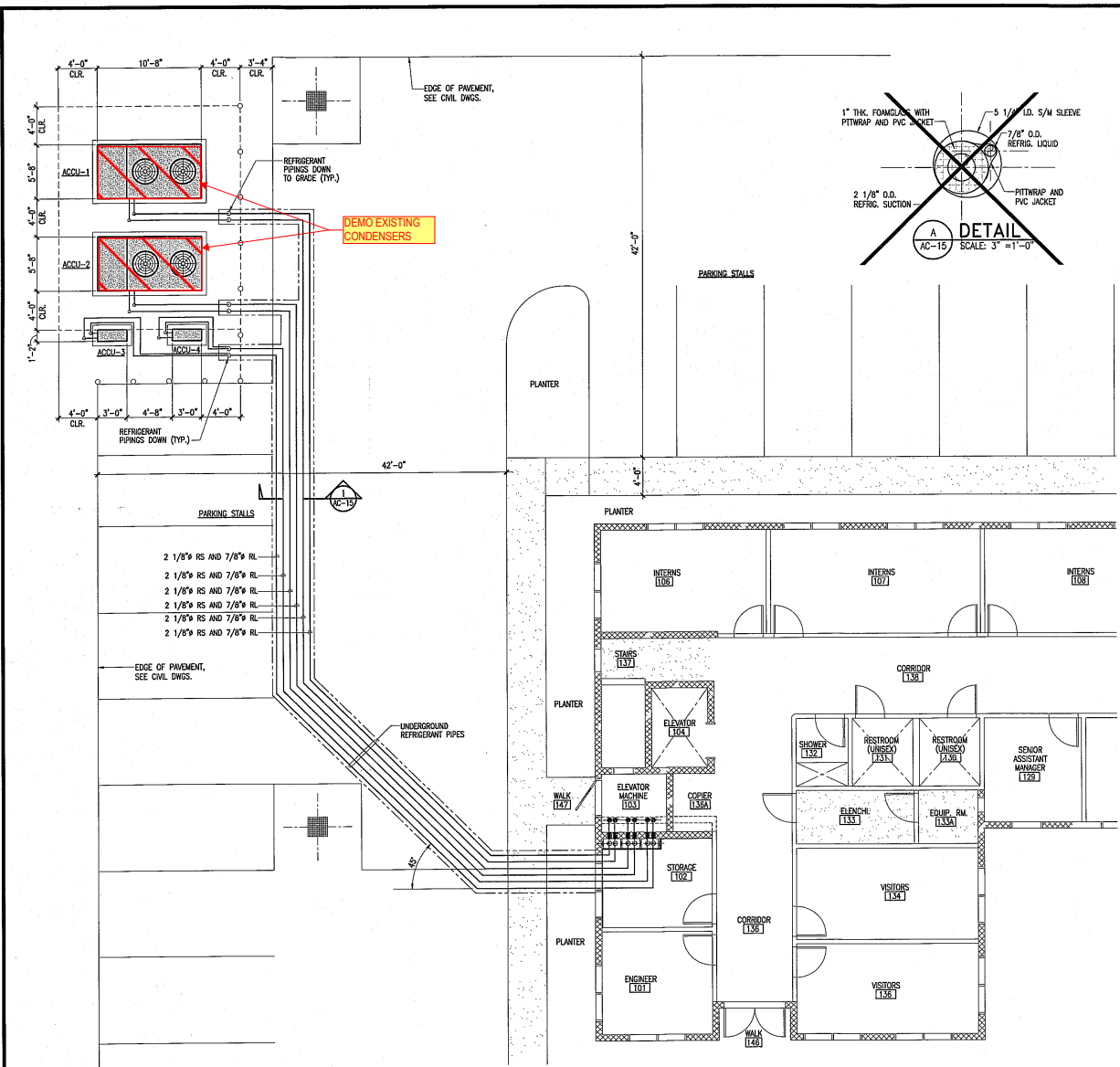
**DURRANT**  
 Media Five

REVISIONS  
 1 REVISED FLOOR PLAN

PROJECT NO.: 050510  
 DATE: 02/2/2005  
 PROJECT DIRECTOR: MC  
 PARTICIPANTS: BLM  
 SHEET CONTENTS:  
 LOWER LEVEL PARTIAL AIR CONDITIONING PLAN DETAIL

## Appendix E – REMOVED

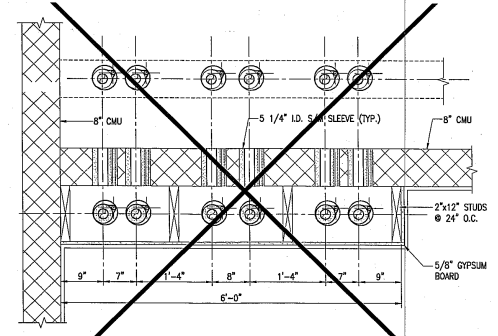
## **Appendix F – Replace the Existing Condensers and AHUs with Multiple Fan Coils**



**TRENCHING NOTE:**

1. TYPE "A" BACKFILL: EARTH AND GRAVEL MIXTURE MUST PASS A ONE HALF INCH (1/2") MESH SCREEN AND CONTAIN NOT MORE THAN 2% PERCENT BY VOLUME OF ROCK PARTICLES, 85 PERCENT COMPACTION IF MATERIAL AT BOTTOM OF TRENCH IS NOT TYPE "A" AN ADDITIONAL 3" SHALL BE EXCAVATED AND TYPE "A" BACKFILL PROVIDED.

**1 REFRIGERANT PIPING AT TRENCH**  
 AC-15 SCALE: 1" = 1'-0"



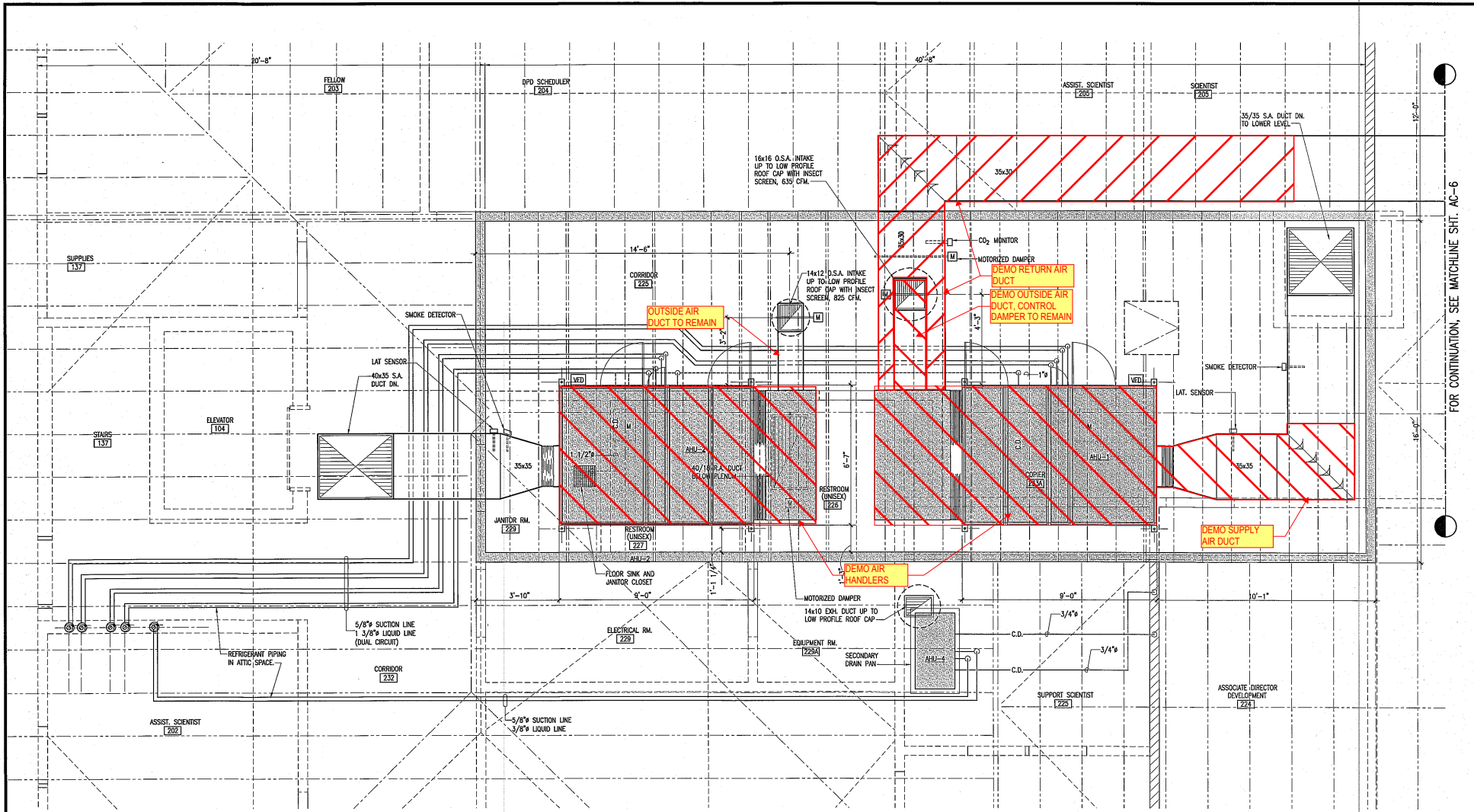
**2 REFRIGERANT PIPING CHASE DETAIL**  
 AC-15 SCALE: 1" = 1'-0"

**AIR CONDITIONING UNIT PLAN**  
 SCALE: 3/16" = 1'-0"

**AS BUILT**  
 OCTOBER 23, 2008

**DEMO**

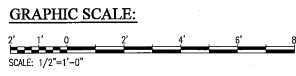
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.	
<b>GEMINI OBSERVATORY</b>	
HILO BASE FACILITY EXPANSION HILO, HAWAII	
TAX MAP KEY : 2-4-01:07 (PORTION)	
DRAWING TITLE:	LOWER LEVEL REFRIGERANT PIPING PLAN
GENERAL CONTRACTOR:	TASEI CONSTRUCTION CORP.
DESIGNER:	OAHU PLUMBING & SHEET METAL, LTD. OAHU AIR CONDITIONING, CO. 938 KOHOU STREET HONOLULU, HAWAII
DATE:	10-23-08
DESIGNER:	D.A.D.
SCALE:	AC-15 OF SHEET 15



FOR CONTINUATION, SEE MATCHLINE SHIT. AC-6

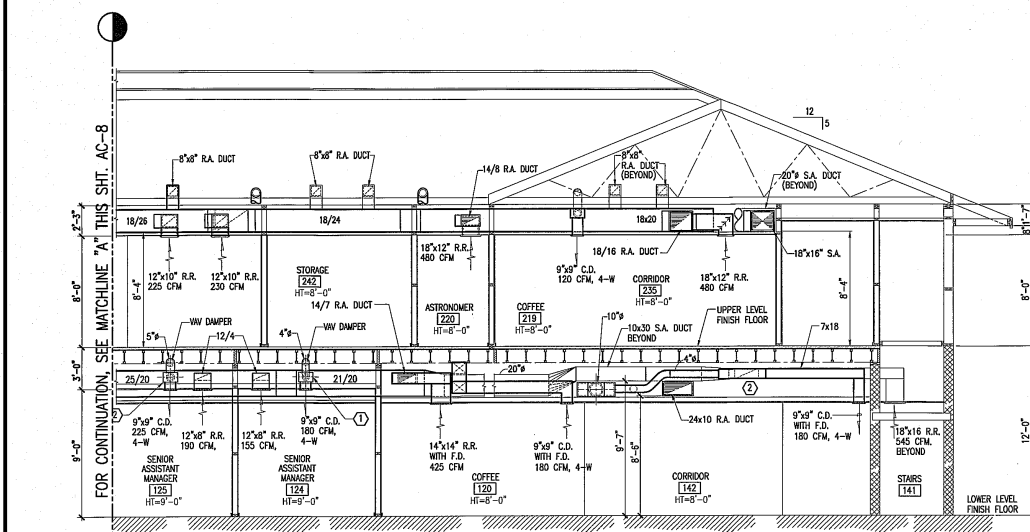
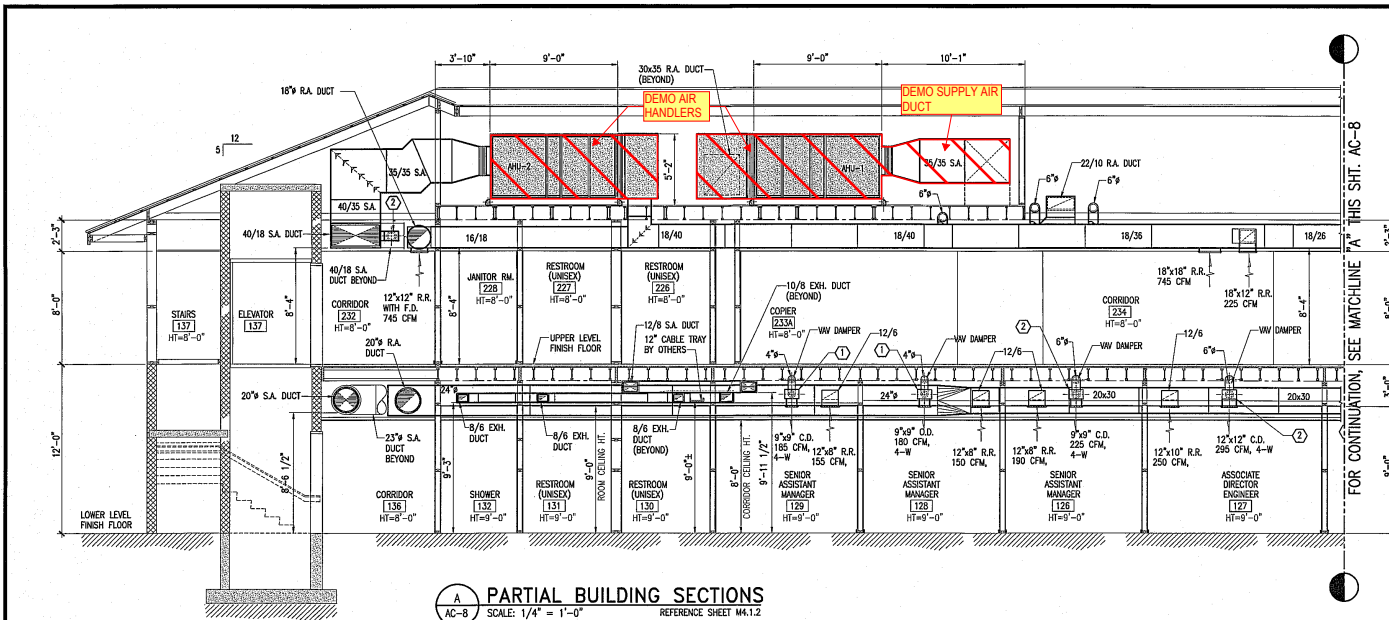
**UPPER LEVEL PARTIAL AIR CONDITIONING PLAN DETAIL**  
 SCALE: 1/2" = 1'-0" REFERENCE SHEET M3.1.1

**AS BUILT**  
 OCTOBER 23, 2008

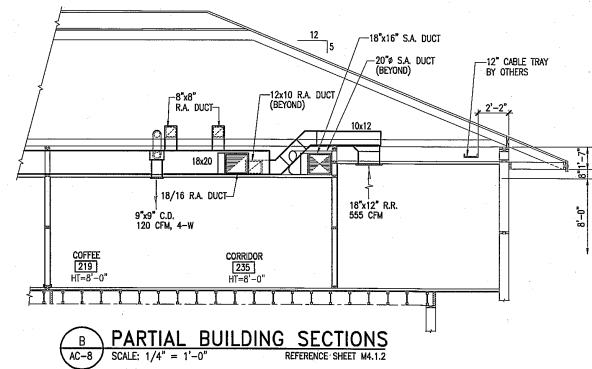


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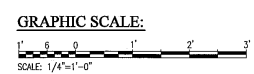
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC. <b>GEMINI OBSERVATORY</b> HILO BASE FACILITY EXPANSION HILO, HAWAII TAX MAP KEY : 2-4-01:07 (PORTION)			
		DRAWING TITLE: <b>UPPER LEVEL PARTIAL AIR CONDITIONING PLAN DETAIL</b>	
GENERAL CONTRACTOR: <b>TAISEI CONSTRUCTION CORP.</b>			
SUBMITTED BY: <b>OAHU PLUMBING &amp; SHEET METAL, LTD.</b> <b>OAHU AIR CONDITIONING, CO.</b> 938 KOHOU STREET HONOLULU, HAWAII			
DATE: <b>17301500</b>	DATE: <b>10-23-08</b>	DRAWN BY: <b>D.A.D.</b>	SHEET NO. / OF SHEETS: <b>AC-6 / 15</b>



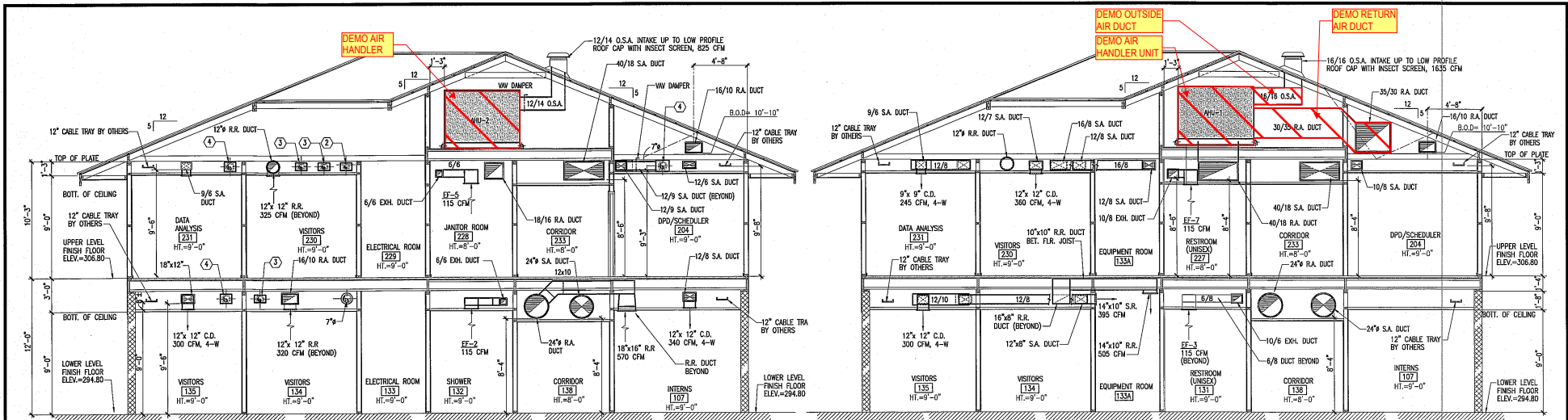
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**AS BUILT**  
OCTOBER 23, 2008

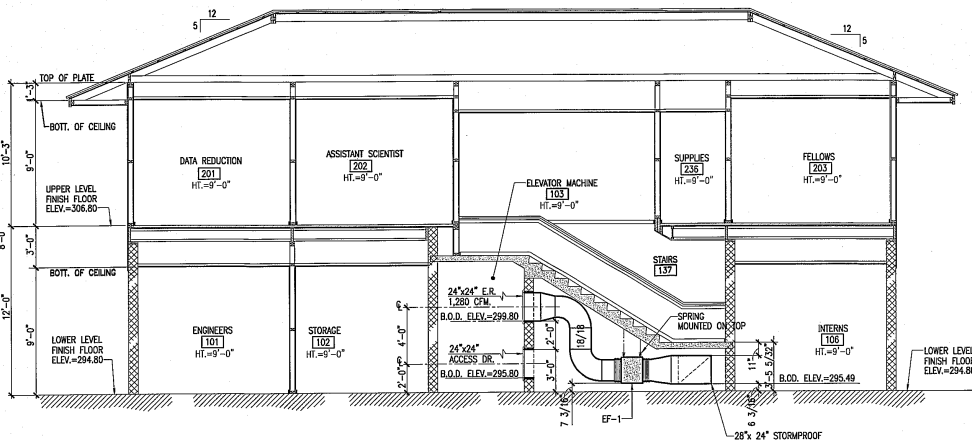


ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.		
<b>GEMINI OBSERVATORY</b>		
HILO BASE FACILITY EXPANSION HILO, HAWAII TAX MAP KEY - 2-4-91-07 (PORTION)		
DRAWN BY: PARTIAL BUILDING SECTIONS		
GENERAL CONTRACTOR: <b>TASEI CONSTRUCTION CORP.</b>		
SUBMITTED BY: <b>OAHU PLUMBING &amp; SHEET METAL, LTD.</b> <b>OAHU AIR CONDITIONING, CO.</b> 938 KOHOU STREET HONOLULU, HAWAII		
DATE: 10-23-08	DESIGNED BY: D.A.D.	SHEET NO. AC-8 OF SHEET: 15



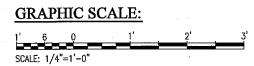
**A PARTIAL AIR CONDITIONING SECTIONS**  
 AC-9 SCALE: 1/4" = 1'-0" REFERENCE SHEET M4.1.1

**B PARTIAL AIR CONDITIONING SECTIONS**  
 AC-9 SCALE: 1/4" = 1'-0"



**C PARTIAL AIR CONDITIONING SECTIONS**  
 AC-9 SCALE: 1/4" = 1'-0" REFERENCE SHEET M4.1.1

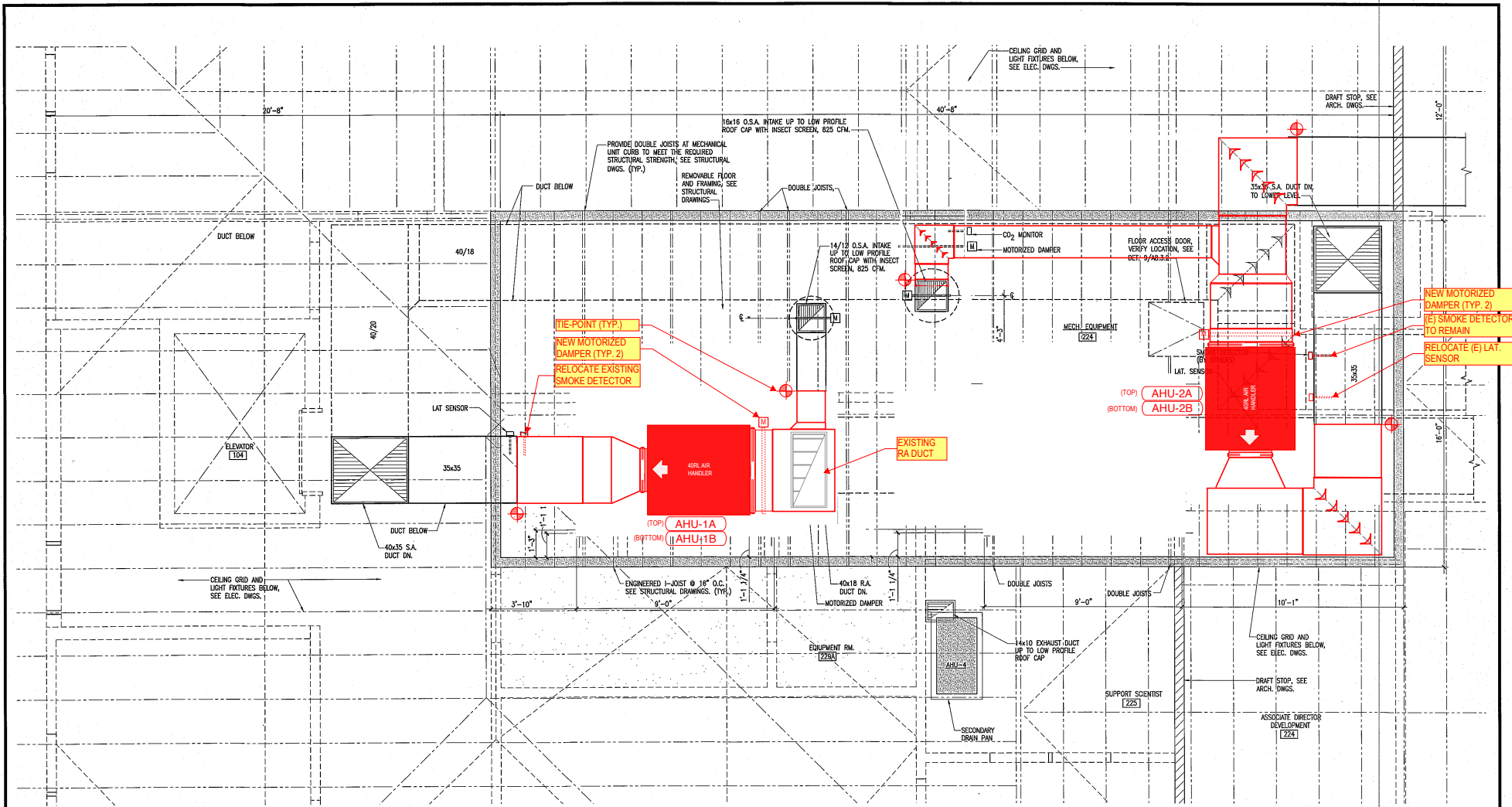
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 OCTOBER 22, 2008



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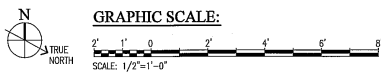
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.		
<b>GEMINI OBSERVATORY</b>		
HILO BASE FACILITY EXPANSION HILO, HAWAII TAX MAP KEY - 2-4-01-07 (PORTION)		
OWNER: PARTIAL BUILDING SECTIONS		
GENERAL CONTRACTOR: <b>TASEI CONSTRUCTION CORP.</b>		
SUBMITTED BY: <b>OAHU PLUMBING &amp; SHEET METAL, LTD.</b>		
<b>OAHU AIR CONDITIONING, CO.</b>		
938 KOHOU STREET HONOLULU, HAWAII		
DATE: 10-23-08	DRAWN BY: D.A.D.	SHEET NO.: AC-9 OF SHEET 15





**ATTIC LEVEL PARTIAL AIR CONDITIONING PLAN**  
 SCALE: 1/2" = 1'-0" REFERENCE SHEET M3.1.1

**AS BUILT**  
 OCTOBER 23, 2008



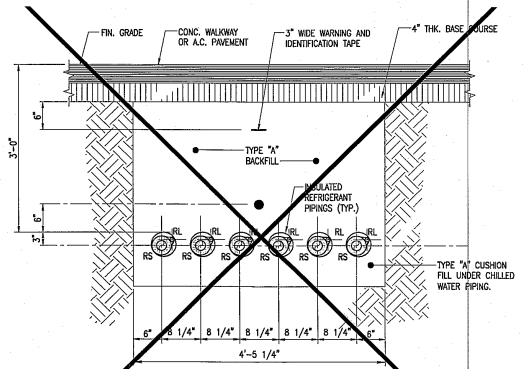
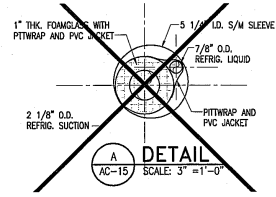
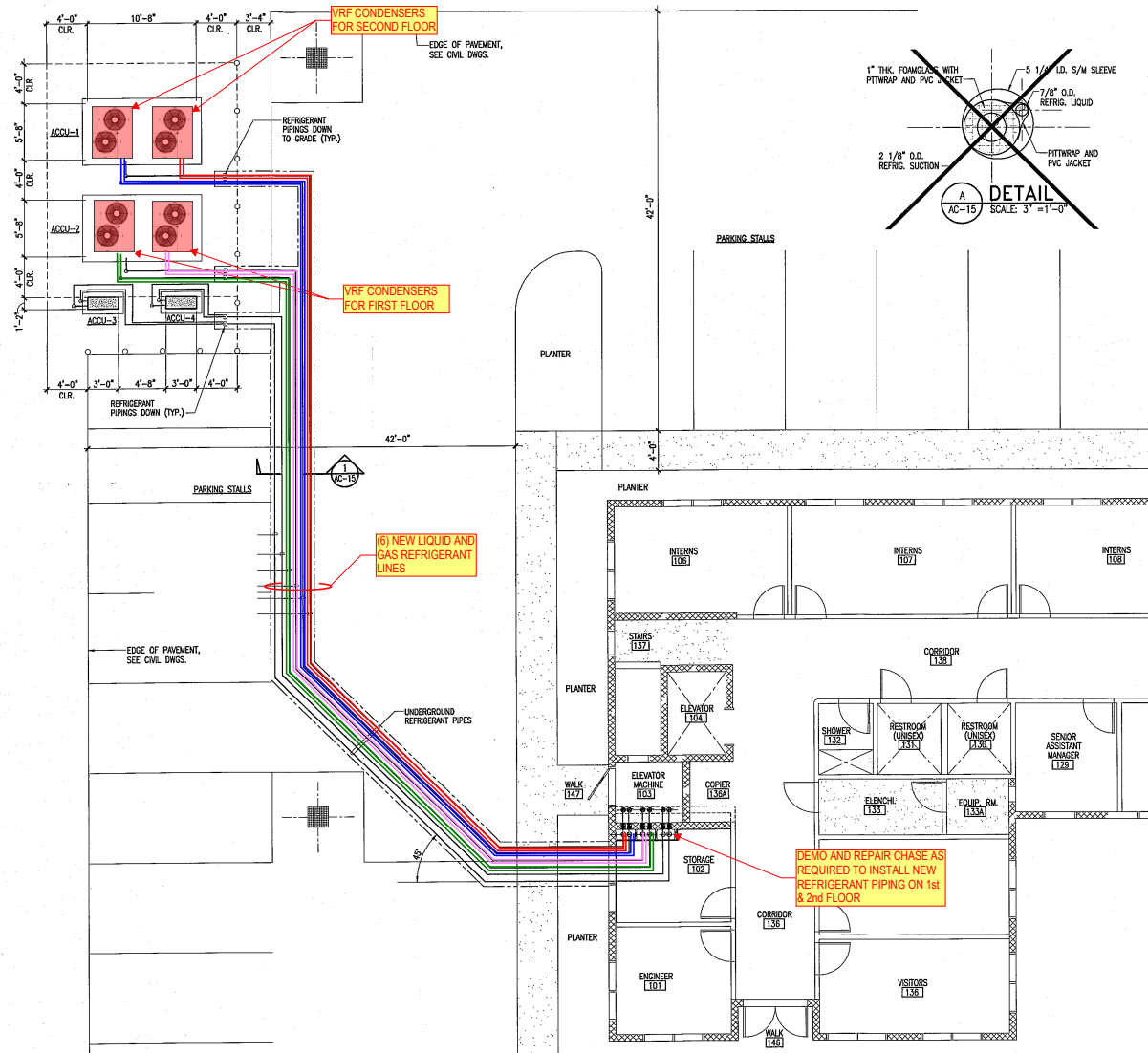
**NEW**

ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.		
<b>GEMINI OBSERVATORY</b>		
HILO BASE FACILITY EXPANSION HILO, HAWAII TAX MAP KEY - 2-4-01-07 (PORTION)		
DRAWING TITLE: <b>ATTIC LEVEL PARTIAL FLOOR PLAN</b>		
GENERAL CONTRACTOR: <b>TAISEI CONSTRUCTION CORP.</b>		
SUBMITTER: <b>OAHU PLUMBING &amp; SHEET METAL, LTD.</b>		
<b>OAHU AIR CONDITIONING, CO.</b>		
938 KOHOU STREET HONOLULU, HAWAII		
JOB: 17301500	DATE: 10-23-08	DRAWN BY: D.A.D. SHEET NO.: AC-7 OF SHEET: 15

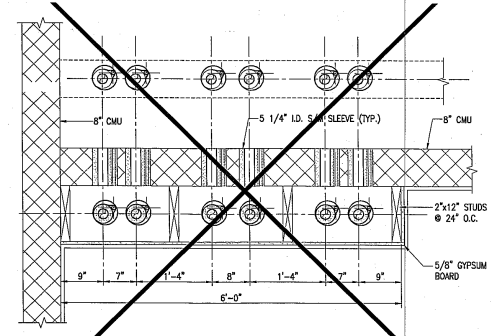


## Appendix G – REMOVED

## **Appendix H – Additional Scope: Replace Underground Refrigerant Lines**



**1 REFRIGERANT PIPING AT TRENCH**  
AC-15 SCALE: 1" = 1'-0"



**2 REFRIGERANT PIPING CHASE DETAIL**  
AC-15 SCALE: 1" = 1'-0"

**ADDITIONAL SCOPE - REPLACE UNDERGROUND REFRIGERANT PIPING**

ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC. <b>GEMINI OBSERVATORY</b> HILO BASE FACILITY EXPANSION HILO, HAWAII TAX MAP KEY : 2-4-01:07 (PORTION)	
DRAWING TITLE: LOWER LEVEL REFRIGERANT PIPING PLAN	GENERAL CONTRACTOR: <b>TAISEI CONSTRUCTION CORP.</b>
DESIGNER: <b>OAHU PLUMBING &amp; SHEET METAL, LTD.</b> OAHU AIR CONDITIONING, CO. 938 KOHOU STREET HONOLULU, HAWAII	DRAWN BY: D.A.D. CHECKED BY: AC-15
JOB NO: 17391590 DATE: 10-23-08	SHEET NO: 15 OF SHEET 15