AdvancAir®

Brookhaven

Environmental Control Unit (ECU)

99C0134-00

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1.0 Glossary of Terms

AI	Air Innovations
C	(degrees) Celsius
DI/DO	Digital in/Digital Out
EAT	Entering Air Temperature
ECU	Environmental Control Unit
EMO	Emergency Off
F	(degrees) Fahrenheit
HEPA	High Efficiency Particulate Air (filter)
ID	Inside Diameter
I/O	Input/Output
kW	Kilowatt
LAT	Leaving Air Temperature
LOTO	Lockout Tagout
MERV	Minimum Efficiency Reporting Value (pre-filter)
OD	Outside Diameter
PID	Proportional Band (P), Integral Time (I), Derivative Time (D)
P&ID	Process and Instrumentation Diagram
PLC	Programmable Logic Controller
PSI	Pounds per Square Inch
PV	Process Value (PV switching-Yokogawa readout)
RH	Relative Humidity
SCFM	(Standard) Cubic Feet per Minute
SSR	Solid State Relay
TXV	Thermostatic Expansion Valve
V	Volt(s)
VAC/VDC	Volts (AC or DC)

2.0 Equipment Checklist

2.1 Safety Equipment

1. Safety glasses

   NOTE: Always wear safety glasses due to presence of high voltage electricity, high pressure refrigerant and water.

2. Ladder, six-feet high

   NOTE: Make sure person on ladder is spotted by additional personnel.

2.2 Test Equipment

1. Volt-ohmmeter
2. Static pressure meter
3. Temperature/RH% measurement meter
4. Air Flow measurement (flowhead)

2.3 Tools and Equipment for Receiving and Unpacking

1. Forklift with 6,000 lb. lifting capacity and six-foot tongs
2. Screw gun
3. Hammer
4. Crow bar
5. Tin snips

2.4 Tools: Start Up

1. Normal hand tools (e.g., screw drivers, Allen heads)

2.5 Tools: Troubleshooting

1. Test equipment listed above
2. Refrigerant gauges
3. Leak detector

3.0 Receiving, Unpacking and Inspecting

Each unit will be individually shrink-wrapped and skidded on pallets. In addition, each will be protected by an outer shell-type crate consisting of 1" x 6" lumber. The units will be attached to the skid with metal banding. Fork pockets are located on all four sides of the units for access from any side.

CAUTION

Units must be unloaded by use of an appropriately sized powered fork truck with a recommended lifting capacity of 6000 lbs. and six-foot tongs.
Fork pockets on the units are 3"x 4". Make sure that the forks on the truck do not exceed this size.
Lifting from ground level must be done from the side of the units.
Lifting from the truck should be done from underneath the skids only.
Lifting from receiving dock can be done from the back of the unit.

After the units are unloaded, the following steps should be taken to remove the units from the crate.

1. Loosen one side of the crate using a screw gun, hammer and crow bar, as needed.
   By completely removing one side of the crate, the unit can then be lifted off the main skid.
2. Using tin snips, cut the banding loose from the frame.
3. Locate the fork pockets on the side of the unit that will be lifted.
4. Using a powered lift truck, carefully lift the unit off the base pallet and set it on the required surface.

IMPORTANT

- ✓ **Upon arrival, inspect the packing crates or boxes for obvious signs of damage or mishandling.**
- ✓ **Write any discrepancy or visual damage on the bill of lading before signing.**
- ✓ **Inspect all equipment for any sign of damage caused during transit.**
- ✓ **Report all visual or concealed damage to the carrier and file notification of a pending claim immediately.**
- ✓ **Keep copies of all documents including the bill of lading noting the damage.**
- ✓ **If it is necessary to file a freight claim, immediately contact the shipping company to start the process. Request that shipping company provide a claim form or submit claim to shipping company on line, if this option is available.**

Note: If this procedure is not followed, the shipping company may reject the claim and the consignee may suffer the loss.

4.0 Set-up Prior to Operation

1. Locate final placement for ECU
2. Determine the mounting level is
3. Connect the In/Out water lines to condenser

NOTE: Installing contractor may have to shim.

4. Purge air from water lines. (Refer to layout drawings, Process and Instrumentation Diagram (P&ID) drawing, and Mechanical Schedule drawings for location and/or sizing.)
5. Connect condensate drain line. (refer to layout drawing, P&ID drawing, and Mechanical Schedule for location and/or sizing.)
6. Connect all supply, return, and make-up air as per design.

NOTE: Ducting sizing for Supply and Return dictated by customer.

7. Install all sensors in supply air duct locations chosen by customer.
8. Wire sensors per supplied schematics.
9. Run and connect all high voltage main wiring from remote disconnect feed to ECU as per schematics supplied.

5.0 System Overview

The AdvancAir is an air-conditoning control system that monitors and automatically conditions the air for a wide range of cleanroom applications. This specific ECU (environmental control unit) provides control over the temperature and humidity monitoring within the enclosure. The temperature specification is 72°+/-2°F.The humidity control specification is <50% RH.

Design airflow is user selectable in 300-600CFM range. The ESP at duct outlet is 2" to 5" across the airflow range. Duct losses as calculated by BNL is 5.2" @ 600CFM.

5.1 Nameplate

CleanroomSystems

Model Number	99C0134-00
Serial Number	12K20129
Date	11/26/2012
High Test Pressure	300psi
Low Test Pressure	150psi
Unit Weight	880lbs
Refrigerant Charge	8lbs R-134a
Volts/Phase/HZ	208/3/60

Unit Electrical Loads	FLA	MCA	MOP
Amperage	35.0	41.7	50.0

Component Electrical Data

Item	Volts	FLA	HP	LRA
Compressor	208	12.7	4	102
Supply Air Fan Motor	208	6.4	2	55
Electric Heater	208	13.9	-	-
Max. outlet temp	135F			
Max. static pressure	4.4"			
Min spacing to combustible surfaces	0"			

CleanroomSystems Inc.
7600 Performance Dr. Syracuse, N.Y. 13212
800-525-3268 / 315-452-7400

5.2 The Systems Main Sections

The main sections of the AdvancAir system include:

- Compressor section
- Evaporator/Heater section
- Control Box/Fan Section

For detailed information on operating, maintaining, and troubleshooting AdvancAir equipment, please see the sections of this manual that cover those specific topics.

NOTE: Be sure to review the safety precautions noted in Section 7 before performing any type of maintenance on the unit.

6.0 Safety Precautions

CAUTION

DO NOT ATTEMPT TO OPERATE OR SERVICE THE ADVANCAIR ENVIRONMENTAL CONTROL UNIT UNTIL YOU HAVE READ THIS CHAPTER CAREFULLY AND FAMILIARIZED YOURSELF WITH THE EQUIPMENT.

6.1 Electrical Safety Precautions: High Voltage

DANGER

HIGH VOLTAGE
110 VAC TO 575 VAC

NOTE: When servicing or repairing the AdvancAir unit, please follow these procedures:

ALWAYS OBSERVE THE FOLLOWING SAFETY PRECAUTIONS:

1. Whenever possible, disconnect power by shutting off the main power switch before working on the unit. Advise all plant personnel of the shut off, and padlock the main distribution center supply switch if possible.

   NOTE: It may be necessary to disconnect more than one power source before work begins, verify that ALL power to the unit has been disconnected.

2. If power must remain on, work with extreme caution. Avoid any sudden, rapid movements, and plan your work before you begin. If a tool drops, do not make a grab for it. Let it fall. Most contact with high voltage wires results from unplanned movement.
3. Make sure of your footing. If you slip, you may instinctively grab for support-which can be lethal around live electrical wires, control boxes, and connections. Work on a rubber mat or dry wooden platform whenever possible
4. Use well maintained tools with insulated handles. Never hold uninsulated metal tools in your hand if exposed live conductors are within reach.
5. Treat all wires and connections as high voltage until a meter or wiring diagram shows otherwise.
6. Always wear protective eyewear at any point during times when required to open any service or electrical control panel, in case of refrigerant leak or electrical hazard.

6.1.1 Electrical Shock-First Aid

Obtain expert medical attention immediately if a person receives an electrical shock.

WARNING

DO NOT TOUCH THE INJURED PERSON UNTIL YOU ARE SURE THAT ELECTRICAL CONTACT WITH THE PERSON IS DISCONNECTED.

6.2 Electrical Safety Precautions: Low Voltage

DANGER

HIGH VOLTAGE
24 VAC OR 115 VAC

Control circuits used in the refrigeration unit are of low-voltage design (24 VAC). Although this voltage level is not considered dangerous, the potential exists for current that can cause severe burns if shorted to ground.

1. Whenever possible, disconnect the main power source and de-energize the main circuit breaker before beginning work on the unit.

   NOTE: It may be necessary to disconnect more than one power source. Before work begins, verify that ALL power to the unit has been disconnected

2. Do not wear watches, rings, or jewelry. These can short out and cause severe burns to the person wearing them.

6.3 Refrigerant Safety Precautions

DANGER

AVOID BREATING THIS GAS.
ALWAYS PROVIDE ADEQUATE VENTILATION DURING BRAZING AND SOLDERING OPERATIONS.

1. If exposed to an open flame, refrigerant produces phosgene gas that can be toxic or cause irritation to the throat and lungs.

DANGER

AVOID CONTACT WITH SKIN OR EYES.
WEAR EYE PROTECTION TO PREVENT INJURY.

2. In liquid state, refrigerant will boil rapidly when exposed to air. This rapid boiling can cause severe frostbite if it makes contact with skin or eyes. Exercise extreme caution when working with refrigerant. Wear goggles or other eye protection to prevent injury.

DANGER

IT MAY BE NECESSARY TO DISCONNECT MORE THAN ONE POWER SOURCE BEFORE WORK BEGINS. VERIFY THAT ALL POWER TO THE UNIT HAS BEEN DISCONNECTED.

3. This ECU is a closed refrigeration system from the factory, therefore does not require any access by the end user, However if the closed refrigeration system integrity is in question, you must contact a certified refrigeration mechanic who has proper authorization to deal with a pressurized refrigeration system.

4. **Refer to general safety precautions in 7.4.11 if a refrigerant leak is suspected.**

6.3.1 Refrigerant Exposure-First Aid

If frostbite occurs from contact with refrigerant, follow the steps below until medical help is available.

1. Up to 30 minutes after exposure: Soak the exposed area in lukewarm water. Do not use ice water or hot water. Get medical attention immediately.
2. More than 30 minutes after exposure: Coat the exposed area with a bland ointment (such as petroleum jelly) and cover lightly with a bandage. Get medical attention immediately.

6.4 General Safety Precautions

DANGER

SAFETY GLASSES SHOULD ALWAYS BE WORN WHEN WORKING ON ANY OF THE ECUs BECAUSE HIGH VOLTAGE POWER AND HIGH PRESSURIZED AIR AND REFRIGERANT ARE PRESENT.

1. Use extreme caution when drilling into the air conditioning unit. Drilling through electrical wires by mistake can cause severe electrical shock to the operator and damage to system components.
2. Be sure all mounting fasteners are tight. If they are replaced, verify that they are correct length and size for the specific application.
3. Never close (front seat) the compressor discharge service valve while unit is operating.
4. Keep tools and test equipment clean and in good working condition.
5. Plan your work and select the proper tool for each procedure. Accidents are much less likely when the proper tools and equipment are used.
6. Do not allow inexperienced personnel to work unsupervised on any air conditioning equipment or components.
7. Be extremely careful if guards or protective screens are removed from the unit's fan motors while they are operating.
8. Never apply an open flame to a sealed, charged refrigeration system or container.

WARNING

9. In the case a refrigerant leak is suspected by a possible puncture of a refrigerant carrying line, immediately shut down the main power to the unit. The refrigerant under pressure will leak directly upwards from its leak source until the refrigerant is no longer within the system. It will leave a film of refrigerant oil that travels with the refrigerant that will need to be cleaned upon repair by a certified refrigeration technician.

CAUTION

10. If there is ever a requirement to change out the large fan motor in the top cube, a stepping platform needs to be used and raised a minimum of 10 inches from the base of the unit, and two persons should perform the lifting of the fan motor. The stepping platform needs to meet the OSHA requirements.

6.5 Warnings/Hazards

6.5.1 Fan Hazard

1. Make sure the power to the unit is OFF before removing the panel to this cube to eliminate possibility for injury from a moving fan.
2. The fan motor is a heavy object. Take extreme caution if it needs to be removed. Consider using two people or a hoist. (Fig.A)

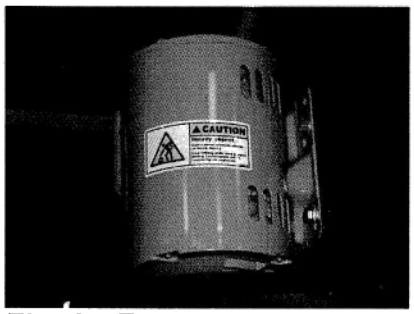


Fig. A Fan motor is a heavy object

6.5.2 Compressor

The compressor is a heavy object. Take extreme caution if it needs to be removed. Consider using two people or a hoist. (Fig.B)

Fig. B Compressor is a heavy object

6.5.3 Hot Surfaces

There are many components that can be very hot to the touch that need to be paid attention to (Compressor, and Electric Heater). All component locations can be seen clearly in their locations in P&ID document included in the 3-ring binder containg this manual. (Fig.C)

Fig. C Hot surface warning

WARNING

BEFORE ACCESSING ANY HOT SURFACES FOR SERVICE, MAKE CERTAIN FOR MAIN POWER DISCONNECT IS OFF.

6.6 Lock Out-Tag Out Procedures

6.6.1 Water

A lockout for water feeding the water-cooled condenser is not included in this system, as one needs to be supplied by the end user as part of the facility water supplying this ECU. Use of hand valves and unions that are as close to this ECU as possible would be recommended. The ECU needs to be turned OFF when shutting down water flow to the condenser. We have documented the related design around the water use required in the Mechanical Schedule found in this binder.

6.6.2 Electrical

The main disconnect provided to this ECU is provided by the end user, and must be compliant to local codes and regulations. It should also be in direct sight and proximity to this unit. This unit does incorporate an Emergency Machine Off (EMO) and a shutdown button that can be used to shut down power sources at the unit, and can both be found on the front panel of control box. For visual support of these locations, refer to the unit layout drawing found in this binder.

6.7 Safeties

Refer to this binder for additional support documents within this manual that outline the locations and types of the various safety interlocks. Some can be seen, and some are integral to the refrigeration system, which are behind the panels during operation.

6.7. 1 High and Low Pressure Switches

Within the closed refrigeration system and must contact a refrigeration service professional when either are activated to cease cooling system operation, which will be seen in conditioning alarms on the controller screen, as the conditions will now go out of spec.

6.7.2 Loss of Air Indicator

This indicator is on the front panel as a lighted alarm when this occurs, which will also have the same effect of shutting down the cooling operation, etc. (see above alarm for resulting visuals). This must also be referred to certified HVAC technician for assistance.

6.7.3 Emergency Machine Off Switch

The EMO switch is located on the front panel of the control box to easily access and immediately shut off power to the ECU directly at the unit, in case of any "emergency" that indicates this requirement. (Fig.D)

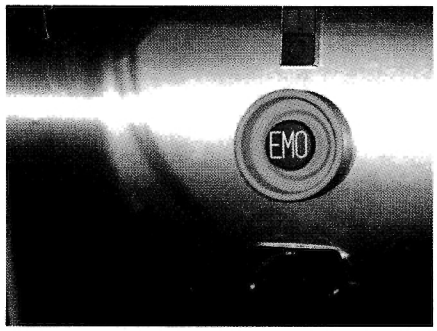


Fig D EMO Switch (from representative ECU)

7.0 Operating Procedures

IMPORTANT

This ECU was initially subject to a factory start-up by Air Innovations authorized personnel. Contact Air Innovations to provide addition training on this ECU as requested.

DANGER

RISK OF PERSONAL INJURY OR DAMAGE TO EQUIPMENT

This section details the procedures needed to operate the AdvancAir unit and to perform the primary system management functions and common adjustments, specifically:

7.1 Start Up:

IMPORTANT

Make certain that the main power disconnect assigned to this ECU conforms with any applicable local electrical codes/regulations.

DANGER

CAUTION: HIGH VOLTAGE MAY BE PRESENT AT THE POWER DISTRIBUTION BLOCK IN THE CONTROL BOX

1. Open the control box door. Switch all circuit breakers and/or fuses to the On position. Close the control box door.
2. Be sure the emergency off switch is in the run position (pulled out).
3. Switch the remote disconnect to the ON position. The temperature and humidity controllers will energize. The red, loss of airflow indication light will come on.

   NOTE: The humidity sensor receives its DC power from the enclosure control box. Be sure it is energized before powering up ECU.

3. Push the start switch. This will energize a relay which will energize the 3-pole main power contactor. The fan will ramp up to the speed based on the frequency preprogrammed into the frequency drive. The compressor, heater and humidifier will also start. The green, airflow indication light will come on. The red, loss of airflow indication light will go out.

   NOTE: The system will begin to control temperature (humidity controller monitors only) based on the process values and the setpoint setting of the controller.

7.2 Operation

The control requirements for this ECU are listed below. Review for proper understanding of unit operation before start up. Additional documentation that should be reviewed before start up may be found at their respective tabs elsewhere in this binder, namely:

- Wiring schematic
- P&ID (Process and Instrumentation Diagram)
- Unit layout drawing
- Mechanical Schedule

7.3 Performance Specs

7.3.1 Temperature control:

+/- .5F sensor accuracy as measured in supply air duct downstream of HEPA filter.

7.3.2 Temperature set point:

Adjustable from 70 - 74°F (72F design set point)

7.3.3 Humidity control (non settable):

+/- 2.5% sensor accuracy (<50%RH design)

7.3.4 Air flow:

Adjustable from 300-600 SCFM design range.

7.3.5 Air flow sensors:

+/- 15% sensor accuracy. Required to display flow of controlled air going to chamber in SCFM. Mounted in supply air duct downstream of HEPA filter.

7.3.6 Water-cooled condenser:

- Water Temperature: 60-65F
- Water flow rate: 4.6 GPM
- Condenser water pressure: 30 PSI to 60 PSI

7.4 Shut Down

1. Push the STOP switch. This will de-energize the high voltage contactor. The fan, compressor, and heater will also shut off. The red, loss of airflow indication light will come on.

2. Shut off the remote disconnect. The controller's displays and all lights will go off.

NOTE: If the airflow switch detects no airflow, the compressor, and heater will not energize. This is a safety feature to prevent coil icing, heater over temperature.

DANGER

HIGH VOLTAGE WILL REMAIN ON THE LINE SIDE FEEDER OF THE MAIN DISCONNECT UNTIL THE BUILDING DISCONNECT SWUPPLYING THE UNIT HAS BEEN SHUT OFF. BEFORE PERFORMING SERVICE ON EELCTRICAL OR MECHANICAL EQUIPMENT, ALWAYS TURN OFF THE ELECTRICAL SUPPLY.

7.5 Setpoint Adjustments

The temperature controller setpoints are changed by using the UP or DOWN arrow keys. Once a change is made press the SET/ENTER key for the controller to register the change.

8.0 Troubleshooting

This section provides a quick-reference check for possible causes of malfunctions and recommended corrective actions. The section is structured as follows:

8.1 Room Conditions: Troubleshooting Chart

8.1.1 Room Temperature Too Low

Symptom	*Possible Cause*	*Recommended Action*
1.Room temperature remains below setpoint	Temperature sensor is defective or needs calibration	**1**.Replace or recalibrate sensor.
2.Same	Temperature controller is defective	**1**.Replace controller.
3.Same	Defective reheat coil (if equipped)	**1**.Raise setpoint **2**.Check reheat coil amp draw.
4.Same	Defective reheat coil control system	**1**.Check control voltage to reheat SSR, **2**.Check that heater overload has not tripped.
5.Low air flow in evaporator section	Defective fan motor, or wiring	**1**.Investigate and repair. See wiring schematic.
6.Same	Dirty evaporator coil	**1**.Clean coil.

8.1.2 Room Temperature Too High

Symptom	*Possible Cause*	*Recommended Action*
1.Room temperature remains above setpoint	Temperature sensor is defective or needs calibration	**1**.Replace or recalibrate sensor.
2.Same	Temperature controller is defective	**1**.Replace controller.
3.Same	Defective reheat coil (if equipped)	**1**.Raise setpoint, check reheat coil amp draw.
4.Low air flow in evaporator section	Defective fan motor, or wiring	**1**.Investigate and repair. See wiring schematic.
5.Same	Dirty evaporator coil	**1**.Clean coil.
6.Same	Dirty prefilters	**1**.Replace filters.
7.No air conditioning	Compressor not running	**1**.Check controls, switches, and wiring using schematics
8.Insufficient cooling delivered to area	System short of capacity	**1**.See section 10.2.4
9.Same	Extra load on system beyond the design load	**1**.Check for additional equipment in room. **2**. Check for sources of air leaking in or out.
10.Low suction pressure, coil icing, low evaporator discharge air temperature	Misadjusted or defective hot gas bypass valve	**1**.Adjust valve to obtain proper discharge air temperature . **2**.Repair or replace valve.

8.1.3 Room Humidity Too High

Symptom	*Possible Cause*	*Recommended Action*
1.Humidity remains above specification	Entering air conditions to evaporator coil are above specified temperature and/or RH%.	1.Make certain delived air conditions in spec.
2.Same	Humidity controller (read only) is defective	**1**.Replace controller.
3.Evaporator discharge air too warm	Evaporator coil is removing too little moisture	**1**.See section 10.2.4
4.Low system capacity	Evaporator coil is removing too little moisture	**1**.See section 10.2.4
5.Poor evaporator air flow	Evaporator coil is removing too little moisture	**1**.Check operation of fan system, and confirm airflow delivered is in 300-600CFM spec..

8.2 Air Conditioning; Troubleshooting Chart

8.2.1 Compressor Fails To Start

Symptom	*Possible Cause*	*Recommended Action*
1.Electric circuit test	Power failure	**1**.Check for blown line fuse or broken lead. **2**.Check main circuit breaker.
2.Same	Disconnect switch is open	**1**.Determine why switch was opened. If system is in working order, close the switch.
3.Electric circuit test shows power on line side but not on motor side of fuse.	Fuse is blown	**1**.Replace fuse. **2**.Check load on motor.
4.Full voltage at motor terminals but motor will not run	Burned out motor	**1**.Replace compressor.
5.Test for burned-out holding coil or broken contacts	Inoperative motor starter/contactor	**1**.Repair or replace.
6.Motor starter holding coil is not energized	Open control circuit for: • Dual pressure control • Motor protection module • Open circuit to run relay • Contactor coil • Delay on restart	**1**.Locate open control and determine its cause. See individual control instructions.
7.Compressor will not operate. Locked motor amperage.	Frozen compressor due to mechanical damage or lockup.	**1**.Replace compressor.
8.Open contacts on low-pressure switch. Suction pressure below cut-in setting.	Suction pressure below cut-in setting of low pressure cut-out switch.	**1**.Check for loss of refrigerant. **2**.Repair leak and recharge. **3**. Replace hot gas bypass valve.
9.Open contacts on high-pressure switch. **10**.Discharge pressure above cut-in setting.	Discharge pressure above cut-in setting of high - pressure cut-out switch	**1**.See item 10.2.5. Check water flow. Check air-cooled condenser.
11.Starter will not pull in	Overload contacts are open. (Motor starter operation only.)	**1**.Reset overload and determine cause.

8.2.2 Unit Short Cycles

Symptom	*Possible Cause*	*Recommended Action*
1.Excessively high discharge pressure	Faulty condensing	**1.**Check for water failure or condenser.
2.High discharge pressure	Overcharge of refrigerant or non-condensable gas	**1.**Remove excess refrigerant or purge non-condensable gas.
3.Normal operation except too frequent stopping and starting on low-pressure switch. Bubble in sight glass.	Lack of refrigerant	**1.**Isolate refrigerant leak, repair, then recharge system.
4.Low suction pressure. Low evaporator discharge air temperature.	Misadjusted or defective hot gas bypass valve	**1.**Adjust valve to proper discharge air temperature. **2.**Check hot gas shut-off valve. **3.**Determine cause and correct.
5.High discharge pressure	Condenser water piping is restricted or supply water pressure is too low	**1.**Determine cause and correct.
6.Compressor cuts off and on from high-pressure cut-out	Faulty or fouled condenser. • Water cooled: Lack of water or insufficient water. • Air cooled: Faulty fan motors; need pressure control	**1.**Review condenser operation. • Fill with water, check piping system and cooling tower. Clean. • Make any necessary repairs.
7.Trips on breaker	Device too small or misadjusted	**1.**Replace motor breaker with proper rating, or adjust setpoint.

8.2.3 Compressor is Noisy

Symptom	*Possible Cause*	*Recommended Action*
1.Compressor knocks	Internal parts of compressor are broken	**1.**Replace compressor
2.Abnormal cold suction line. Compressor knocks	Liquid "flood back"	**1.**Check and adjust superheat. Valve may be too large or remote bulb loose on suction. ***Normal running superheat: 20°F (-6°C)at compressor.***
3.Same	Expansion valve stuck in open position	**1.**Repair or replace valve
4.Same	Check evaporator coil for ice.	**1.**De-ice coil.

8.2.4 System Short of Capacity

Symptom	*Possible Cause*	*Recommended Action*
1.Expansion valve hisses. Bubbles in sight glass	Lack of refrigerant	**1.**Add refrigerant.
2.Temperature change in refrigerant line through dryer	Clogged dryer	**1.**Clean or replace.
3.Short cycling	Expansion valve stuck or obstructed	**1.**Repair or replace valve.
4.Superheat too high	Improper superheat adjustment	**1.**Adjust TXV. ***Maintain minimum 10°F (-12°C) superheat at compressor.***
5.Reduced water flow. High discharge pressure	Obstructed water lines or water regulator is out of adjustment	**1.**Remove obstruction. **2.**Adjust valve to proper discharge pressure.
6.Evaporator discharge air temperature too high. High suction pressure.	Hot gas bypass valve is out of adjustment	**1.**Adjust valve to obtain proper discharge temperature.
7.Low suction pressure	Suction service valve not fully open	**1.**Back seat valve stem.
8.Same	Clogged suction strainer	**1.**Clean or replace.

8.2.5 Discharge Pressure Too High

Symptom	*Possible Cause*	*Recommended Action*
1.Excessively warm water leaving condenser	Too little or too warm condenser water, restricted water flow	**1.**Clean water strainers and check cooling tower operation. **2.**Adjust water regulating valve for 225 lb. discharge.
2.Excessively cool water leaving condenser, small temperature rise through condenser	Fouled tubes in shell-and-tube condenser	**1.**Clean tubes.
3.High-temperature water entering condenser	Improper operation of cooling tower	**1.**Check tower fan motor, starter, and thermostat.
4.Exceptionally hot condenser and excessive discharge pressure	Air or non-condensable gas in system	**1.**Purge non-condensable.
5.Same	Overcharge of refrigerant	**1.**Remove excess refrigerant gradually-normal subcooling is 5-10°F (-15°C to -12°C)
6.Excessively hot liquid returning from condenser	Defective head pressure controls, if applicable	**1.**Review operation. **2.**Investigate and repair.
7.Same	Defective condenser fan motor or controls	**1.**Repair or replace defective parts. See wiring schematic.
8.Noisy discharge	Discharge service valve is partially closed	**1.**Back seat valve stem.

8.2.6 Discharge Pressure Too Low

Symptom	*Possible Cause*	*Recommended Action*
1.Small temperature rise of water through condenser	Excessive water flow through condenser	**1.**Reset flow to design discharge pressure.
2.Bubbles in sight glass	Lack of refrigerant	**1.**Repair leak and charge.
3.Entering condenser water temperature is too low	Cooling tower fan thermostat out of adjustment	**1.**Readjust fan thermostat.
4.Low-capacity noisy operation	Broken or leaky compressor discharge valves	**1.**Replace compressor.
5.Excessively cold liquid returning from condenser	Faulty air-cooled ambient controls (if applicable)	**1.**Repair or adjust controls.
6.Excessively sub-cooled liquid	Malfunctioning head pressure control (s), if applicable	**1.**Review operation. **2.**Investigate and repair.

8.2.7 Suction Pressure Too High

Symptom	*Possible Cause*	*Recommended Action*
1.Abnormally cold suction line. Liquid flooding back to compressor.	Overfeeding of expansion valve	**1.**Regulate superheat setting of expansion valve. **2.**Check to see that remote bulb is properly attached to suction line.
2.Same	Expansion valve stuck in open position	**1.**Repair or replace valve.
3.Noisy compressor	Broken suction valves in compressor	**1.**Replace compressor.
4.Noise at suction valve	Service valve not fully open	**1.**Back seat valve stem.
5.FLA exceeds design. Unit tripping.	System load greater than design	**1.**Reduce system load.

8.2.8 Suction Pressure Too Low

Symptom	*Possible Cause*	*Recommended Action*
1.Bubbles in sight glass	Lack of refrigerant	**1.**Repair leak and charge.
2.Evaporator discharge air is too low	Malfunctioning hot gas bypass valve	**1.**Adjust or repair valve.
3.Temperature change in refrigerant line through dryer	Clogged liquid dryer	**1.**Replace dryer or line core.
4.No flow of refrigerant through valve. Unit short cycles.	Expansion valve power assembly has lost charge	**1.**Replace expansion valve assembly.
5.Loss of capacity	Obstructed expansion valve	**1.**Clean valve or replace if necessary.
6.Noisy suction at valve	Service valve not fully open	**1.**Back seat valve stem.

9.0 Maintenance

Performing the preventative maintenance procedures covered in this section will greatly increase the performance and reliability of the AdvancAir equipment and components.

Through preventative maintenance, future repairs can be spotted and scheduled for periods of time when production is idle. In this way, emergency shutdowns due to system or component failures can be virtually eliminated. So can the financial loss resulting from production downtime and ruined products.

This section of the Operation and Maintenance Manual provides recommended maintenance procedures and schedules. This section is structured as follows:

9.1 Preventative Maintenance: Items and Timing

NOTE: A standard size straight blade screwdriver is required to open any of the service panels for access to the interior components for repair or maintenance.

9.1.1 Compressor

(To be performed only by a certified HVAC technician)

Component/Action	*Timing*
Test suction low-pressure safety switch	Yearly
Test discharge high-pressure safety switch	Yearly
Investigate any unusual noises or vibrations	Ongoing
Check oil sight glass for 1/2 to 1/3 level while operating	Twice a year
Verify crankcase heater operation (if applicable)	Twice a year
Verify suction superheat (set for approximately 15°F (-9°C)	Twice a year

9.1.2 Condenser

(To be performed only by a certified HVAC technician)

Component/Action	*Timing*
Water-cooled units: Acid clean waterside, adjust the water regulating valve for 225 lbs. discharge	Yearly or as required

9.1.3 Evaporator

(To be performed only by a certified HVAC technician)

Component/Action	*Timing*
Clean coil airside as necessary	Yearly
Check TXV superheat (set for approximately 10-15 F° (-12°C to -9°C)	Twice a year
Check discharge air temperature. Adjust discharge bypass valve as needed.	Twice a year

9.1.4 Reheat System

Component/Action	*Timing*
Clean coil as necessary	Yearly
Vary temperature setpoint. Verify proper response by measuring room temperature change	Twice a year

9.1.5 Air Conditioner: General

(To be performed only by a certified HVAC technician)

Component/Action	*Timing*
Verify system dryness by sight glass color. (Green=OK/yellow=wet)	Monthly
Check for refrigerant shortage, indicated by bubbles in sight glass	Monthly
Leak check entire system as necessary	Yearly
Check for loose component fasteners	Twice a year

9.1.6 Unit Fan

(To be performed only by a certified HVAC technician)

Component/Action	*Timing*
Check blower integrity (bearings, bearing mounts, blades, (if applicable)	Twice a year
Check blower wheel set-screw tightness (direct drive system only)	Twice a year

9.1.7 Control Box

NOTE: Some of these tasks below will require the personnel performing the task to be able to properly utilize a Volt and/or Amp meter.

Component/Action	*Timing*
Turn off power-then tighten ALL electrical connections	Yearly
Inspect all switching devices for signs of excessive arcing or overheating	Twice a year
Visually inspect fuses (if applicable) for signs of over heating	Twice a year
Check output voltages of power supply and control transformers	Yearly
Test condition of indicator lights *Note: Turn off ALL power-turn on to illuminate lights*	Twice a year
Check amp draw of all components - compare with wiring information sheet in section 1.0 for FLA (full load amps)	Twice a year
Check calibration of temperature and humidity sensor	Yearly
Check operation of smoke detectors - if applicable	Twice a year
EMO switch-Check operation at regular intervals	Monthly

9.1.8 Room Conditions

Component/Action	*Timing*
Verify static pressure to maintain room pressure	Ongoing
Check HEPA filters for leaks	Yearly
Check room particle counts	Monthly

9.2 Changing the Filters

9.2.1. To remove the filters:

Pre-filter: Located in section uder the dcontrol box cube. Carefully remove the filter from the holding frame by backing out thumbscrews located on right side of frame.
HEPA filter: Located in supply air duct. Carefully remove the multiple hex head screws to gain access to the HEPA filter mounting, to remove.

9.2.2. To insert filters:

Pre-filter: Reverse the above procedure.
HEPA filter: Reverse the above procedure.

9.3 Temperature and Humidity Sensor

9.3.1 Temperature/Humidity Sensor

The temperature/humidity sensor is an ACI A/RH2-TT100 (0-100)-D-4 model.

Calibration:
The accuracy is recommended to be checked at least once a year. Calibration must be performed by ACI.

9.4 Temperature, Humidity Controllers

The controllers are Yokogawa Corp. model UT-152.

9.5 Evaporator Control

The maximum amount of moisture in the cleanroom environment is regulated by the evaporator coil, specifically by its surface temperature. Colder surface temperatures will condense out more of the available moisture from the air that passes by it. Therefore, control of the coil temperature provides control of the room's air moisture content.

The discharge gas bypass valve regulates the coil temperature by metering a portion of the discharge gas into the evaporator coil. It is adjusted with a potentiometer located in the control box.

Calibration of this valve is not necessary.

9.6 Pressure Test Points

Pressure test points are located in the compressor section.

9.7 Water Valve Adjustment

The water valve may require adjustment periodically to maintain proper condensing temperature.

9.8 PID Control Functions

The three basic types of control functions are discussed below.

9.8.1 Proportional Band (P)

The proportional band parameter regulates the effect of the proportional action. This setting causes the output to change continuously in proportion to the input deviation magnitude. A small proportional band value will (with a small deviation in input) cause a large change in output, and vice versa. Note:

1. A small proportional band setting will cause control fluctuations or oscillations.
2. A large proportional band setting will cause a control offset. The smaller the value, the small the offset.
3. If the proportional band value is set to zero, ON/OFF control will result.

When manually setting the proportional band, keep the following in mind.

1. As a rule, adjust for larger numeric values to smaller ones.
2. If cycling or oscillating occurs, the value is too small. Oscillations will likely go above and below setpoint.
3. The longer the derivative time, the stronger the corrective action, and the more likely it is that oscillations will occur.
4. The derivative is OFF when set to zero. For control of fast-response input such as flow and pressure, or of input that fluctuates rapidly, set the derivative to zero.

When manually setting the derivative time, keep the following in mind:

1. As a rule, adjust from smaller numeric values to larger ones.
2. If the derivative is too large, very short-period oscillations will result. These oscillations will be much smaller than those caused by the proportional band or integral time and are unlikely to cross the setpoint, but will instead fluctuate above or below it.
3. Normal offset cannot be corrected by a proportional band change.

9.8.2 Integral Time (I)

Integral time (I) can be defined as the time required to develop an output change due to integral action that is equal to the change due to proportional action. The integral time (I) will automatically diminish the offset or normal deviation (offset) that cannot be prevented by adjusting the proportional band. The integral time will continuously increase or decrease the output in proportion to the time integral of the deviation from setpoint. Note:

1. The smaller or shorter the integral time, the faster the output changes, and vice versa.
2. Shortening the integral time, like lowering the proportional band setting, will cause output to oscillate. However, such oscillations will have a longer period than those caused by a small proportional band.

When manually setting the integral time, keep the following in mind:

1. As a rule, adjust from larger numeric values to smaller ones.
2. If the integral time is too small, long-period oscillations will result. These oscillations are likely to go above and below setpoint with a long period.

9.8.3 Derivative Time (D)

The derivative action is the action that changes the output in proportion to the deviation derivative or rate of change. Just as the proportional and integral action cause the controlled object to approach the setpoint, the derivative time (D) slows this approach to prevent over-shoot.

10.0 Decommissioning

1. Refrigeration components must be dealt with by a certified refrigeration technician for proper reclaiming and discarding of components used in the refrigeration circuit. Copper and steel will be able to be recycled.
2. Electrical components of RoHs compliance can be recycled.
3. Sheet Metal/steel components can be recycled.
4. Motors, such as compressor and fan motor, can be recycled.

11.0 Warranty

GENERAL

Air Innovations (inclusive of its divisions; **Floratech** and **CleanroomSystems**) warrants, to the original buyer, its goods and all parts thereof to be free from defects in material and workmanship for one year from the date of invoicing assuming **NORMAL USE AND SERVICE.**

LIABILITY

Air Innovations liability shall be limited to the repair or replacement (at its option) of any part, which, at our sole discretion, is determined to be defective. The purchaser shall pay all transportation costs. Additionally, if a malfunction occurs within 90 days from the date of invoice, **Air Innovations** will reimburse the reasonable cost of labor required for the repair or replacement provided authorization is obtained from one of our authorized representatives prior to incurring any labor charges.

LIMITATIONS OF LIABILITY

THESE WARRANTIES ARE MADE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND IN LIEU OF ANY OTHER OBLIGATION OR LIABILITY, INCLUDING LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES. Air Innovations will not be responsible for any costs or liabilities whatsoever resulting from improper installation or service of its equipment. In the event that **Air Innovations** or its distributors are found liable for damage based on any defect or nonconformity in the products, their total liability for each defective product shall not exceed the purchase price of such defective product. Additionally, neither the repair nor the replacement of any part shall serve to renew or extend the original warranty period. No person or representative is authorized to change these warranties or assume any other obligations or liabilities for **Air Innovations** in connection with the sale of its systems.

INDEMNIFICATION

Purchaser agrees to indemnify, hold harmless and defend seller and its officers, directors, agents and employees from and against any and all claims, liabilities, costs and expenses arising out of or related to Purchaser's use of the goods, or in any way involving injury to person or property or accident occasioned by the goods sold by **Air Innovations** to Purchaser.

FOREIGN GOVERNMENT AND INDIAN NATIONS

If Purchaser is a foreign government or an Indian nation, Purchaser hereby expressly waives its defense of sovereign immunity in the event of a dispute between Purchaser and **Air Innovations** regarding this invoice and Purchaser expressly acquiesces to the jurisdiction of the federal and state courts of the United States.

SEVERABILITY

If one or more of the provisions contained in this contract shall for any reason be held to be invalid, illegal or unenforceable in any respect, such invalidity, illegality or unenforceability shall not affect any other provision of this contract, but this contract shall be construed as if such invalid, illegal or unenforceable provision had never been contained.

ADDITIONAL REQUIREMENTS

If a defect covered by the Warranty occurs, contact **Air Innovations** for authorization to proceed with corrective action. Do not return any parts or incur any charges for which you expect to be reimbursed under this Warranty without receiving this authorization. If parts are replaced under this Warranty, the defective parts must be returned prepaid within 30 days. This Warranty shall be null and void in its entirety if the Serial Number on the air conditioner or compressor is altered, removed or defaced.

January 04 revision

12.0 Contact for More Information

Air Innovations, Inc.
7000 Performance Drive
North Syracuse, NY 13212

Toll free: (800) 825-3268

Service Department: press 3

Direct: (315) 452-7420

Service Department: ext. 7434

Normal business hours are 8 a.m. to 5 p.m. Eastern, Monday-Friday.

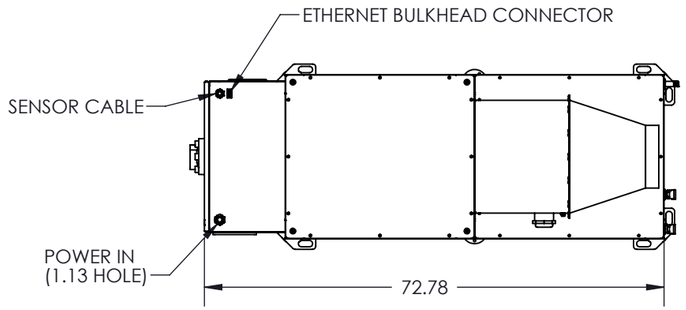
After hours, contact: (315) 391-8747

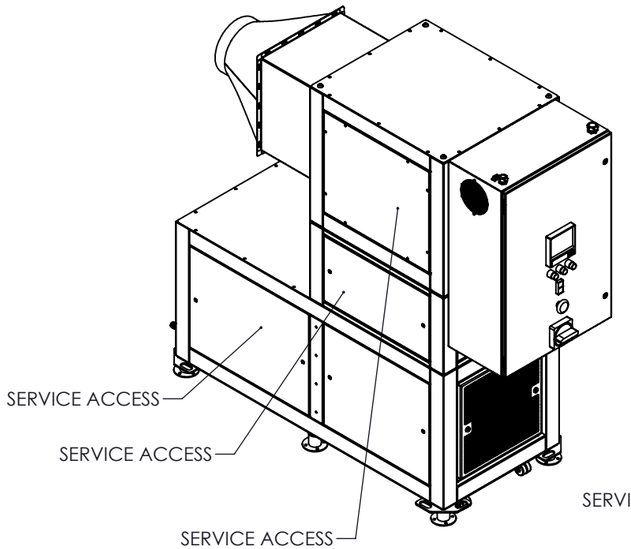
Web site: www.airinnovations.com

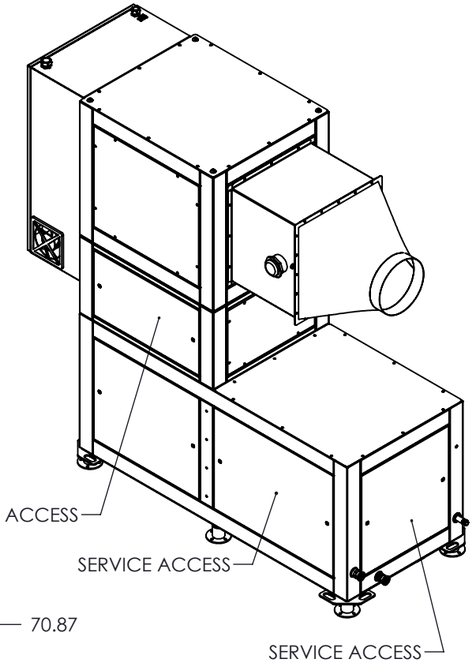
Email: info@airinnovations.com

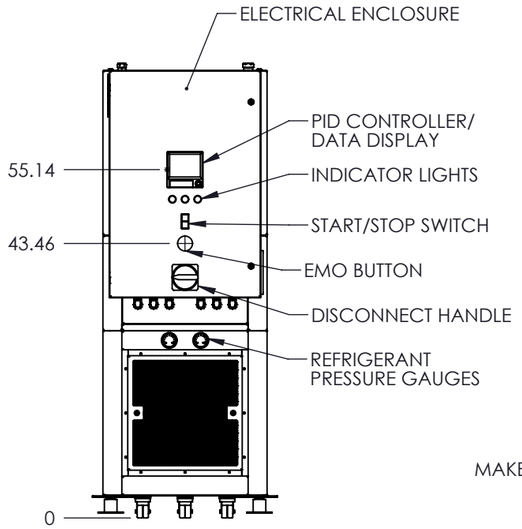
NOTES:

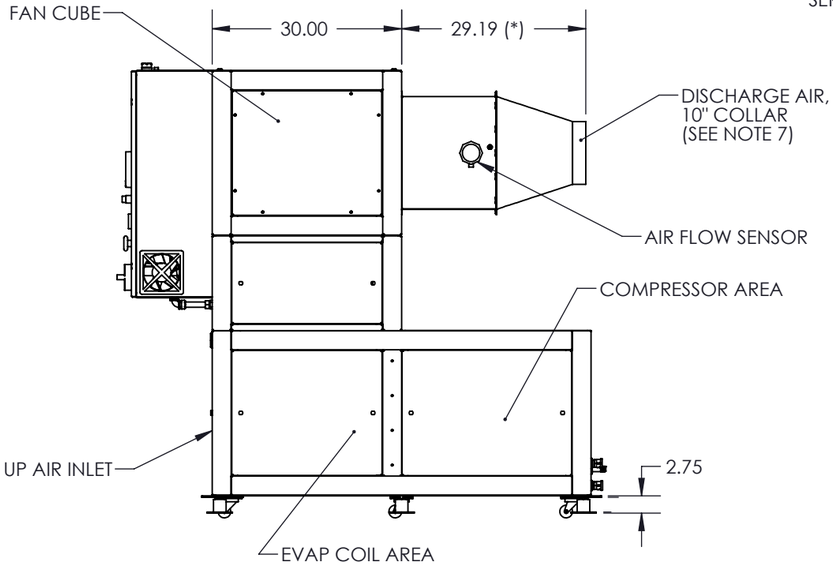
1. ALL DIMENSIONS SHOWN ARE FOR REFERENCE ONLY, SOME MAY CHANGE SLIGHTLY DURING MANUFACTURE.
2. FLUID CONNECTION LOCATIONS MAY CHANGE PENDING INTERNAL COMPONENT PLACEMENT.
3. DUCT CONNECTION LENGTHS (*) SUBJECT TO CHANGE PER FABRICATOR METHODS.
4. CASTERS: (5) SWIVEL, 250 LBS CAPACITY EACH, OVERALL HEIGHT: 3.25"

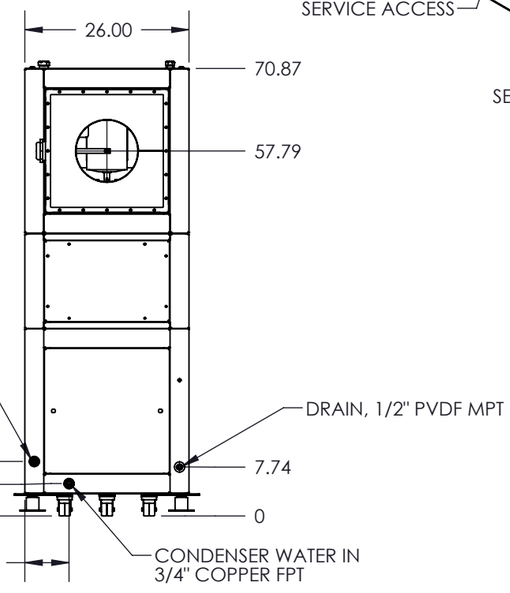


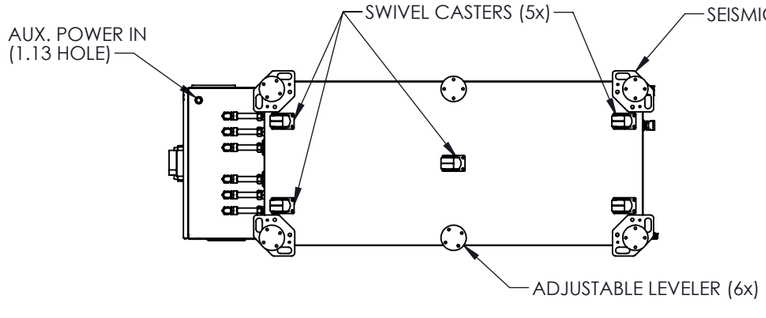












		NAME	DATE
UNLESS OTHERWISE SPECIFIED:			
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± 2 BEND ± 2 TWO PLACE DECIMAL ± .03 THREE PLACE DECIMAL ± .015	DRAWN	BCM	5/29/12
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	MATERIAL		
COMMENTS:	FINISH		
DO NOT SCALE DRAWING			

AiR INNOVATIONS

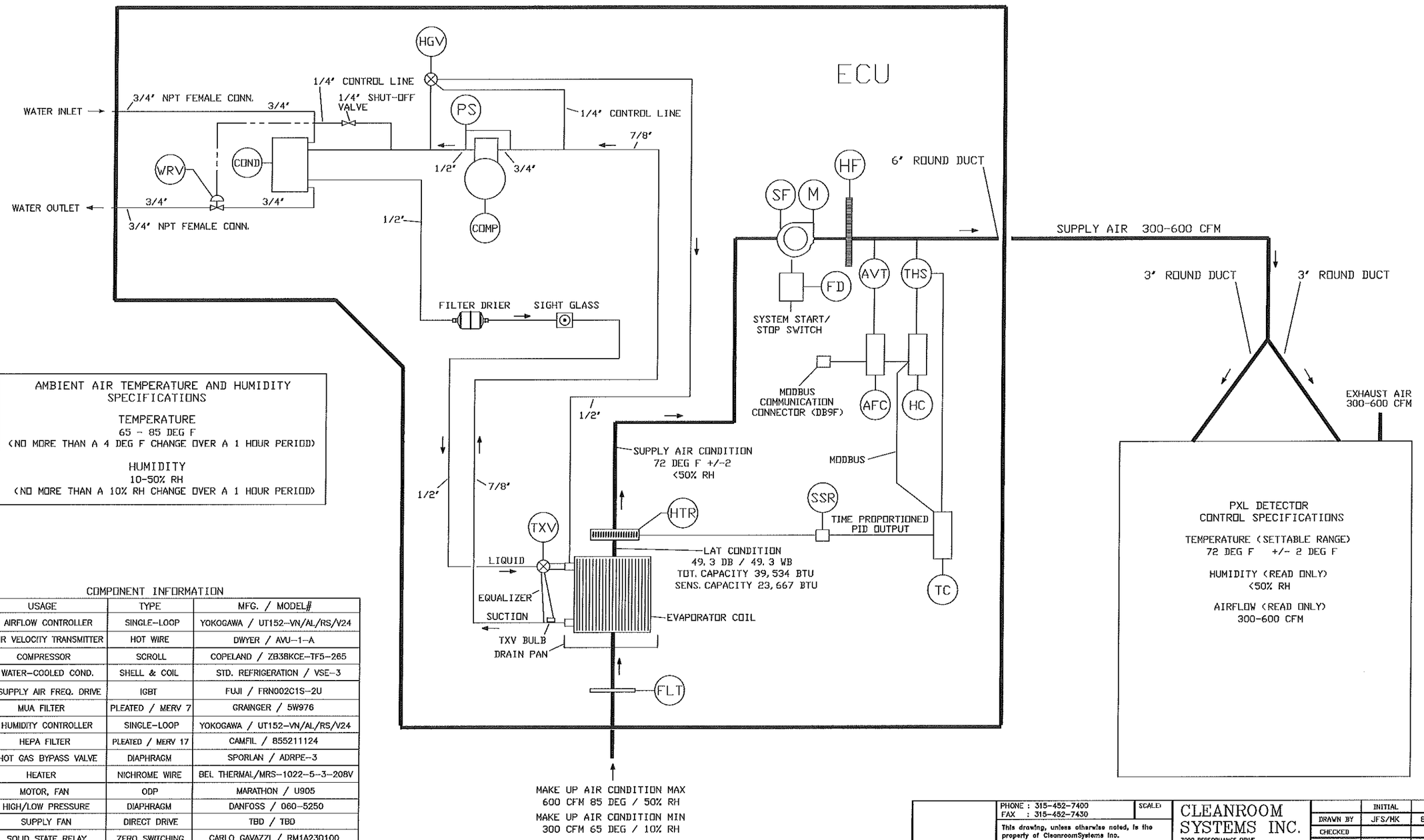
Cleanroom Systems / Floratech
7000 PERFORMANCE DRIVE, SYRACUSE, NY, 13212, 452-7400

TITLE: Brookhaven National Labs proposal

SIZE	DWG. NO.	REV
B	BNL proposal	

SHEET 1 OF 1

BROOKHAVEN NATIONAL LABS ECU A18599 - PROCESS AND INSTRUMENTATION DIAGRAM



AMBIENT AIR TEMPERATURE AND HUMIDITY SPECIFICATIONS

TEMPERATURE
65 - 85 DEG F
(NO MORE THAN A 4 DEG F CHANGE OVER A 1 HOUR PERIOD)

HUMIDITY
10-50% RH
(NO MORE THAN A 10% RH CHANGE OVER A 1 HOUR PERIOD)

PXL DETECTOR CONTROL SPECIFICATIONS

TEMPERATURE (SETTABLE RANGE)
72 DEG F +/- 2 DEG F

HUMIDITY (READ ONLY)
<50% RH

AIRFLOW (READ ONLY)
300-600 CFM

COMPONENT INFORMATION

REF.	USAGE	TYPE	MFG. / MODEL#
AFC	AIRFLOW CONTROLLER	SINGLE-LOOP	YOKOGAWA / UT152-VN/AL/RS/V24
AVT	AIR VELOCITY TRANSMITTER	HOT WIRE	DWYER / AVU-1-A
COMP	COMPRESSOR	SCROLL	COPELAND / ZB38KCE-TF5-265
COND	WATER-COOLED COND.	SHELL & COIL	STD. REFRIGERATION / VSE-3
FD	SUPPLY AIR FREQ. DRIVE	IGBT	FUJI / FRN002C1S-2U
FLT	MUA FILTER	PLEATED / MERV 7	GRAINGER / 5W976
HC	HUMIDITY CONTROLLER	SINGLE-LOOP	YOKOGAWA / UT152-VN/AL/RS/V24
HF	HEPA FILTER	PLEATED / MERV 17	CAMFIL / 855211124
HGV	HOT GAS BYPASS VALVE	DIAPHRAGM	SPORLAN / ADRPE-3
HTR	HEATER	NICHROME WIRE	BEL THERMAL/MRS-1022-5-3-208V
M	MOTOR, FAN	ODP	MARATHON / U905
PS	HIGH/LOW PRESSURE	DIAPHRAGM	DANFOSS / 060-5250
SF	SUPPLY FAN	DIRECT DRIVE	TBD / TBD
SSR	SOLID STATE RELAY	ZERO SWITCHING	CARLO GAVAZZI / RM1A23D100
TC	TEMPERATURE CONTROLLER	SINGLE-LOOP	YOKOGAWA / UT152-VN/AL/RS/V24
THS	TEMP & HUMIDITY SENSOR	COMBINATION	ACI / A/RH-2-TT100-D-4
TXV	EXPANSION VALVE	DIAPHRAGM	SPORLAN / EBFJE-C-CP60
WRV	WATER REGULATING VALVE	DIAPHRAGM	JOHNSON-PENN / V46AA-1 (3/8")

REV.	INITIAL	DATE	DESCRIPTION
A	MK	8/30/12	ADDED AIR CONDITIONS BEFORE & AFTER COIL

WHERE USED

PHONE : 315-452-7400
FAX : 315-452-7430

SCALE:

UNLESS OTHERWISE NOTED
TOLERANCE:
.XX ±.05
.XXX ±.015
ANGLE ±1°

CLEANROOM SYSTEMS INC.
7000 PERFORMANCE DRIVE
N. SYRACUSE N.Y. 13212-3448

	INITIAL	DATE
DRAWN BY	JFS/MK	8/22/12
CHECKED		
APPROVED		

TITLE
BROOKHAVEN NAT'L LABS ECU P&ID

MATERIAL

DWG. BRKHVN ECU P&ID A18599

REV. A

1 OF 1

Brookhaven National Labs

Temperature (F) .vs. Water Content of Air

7000 grains per pound (definition)
Relative Humidity - Green arcs

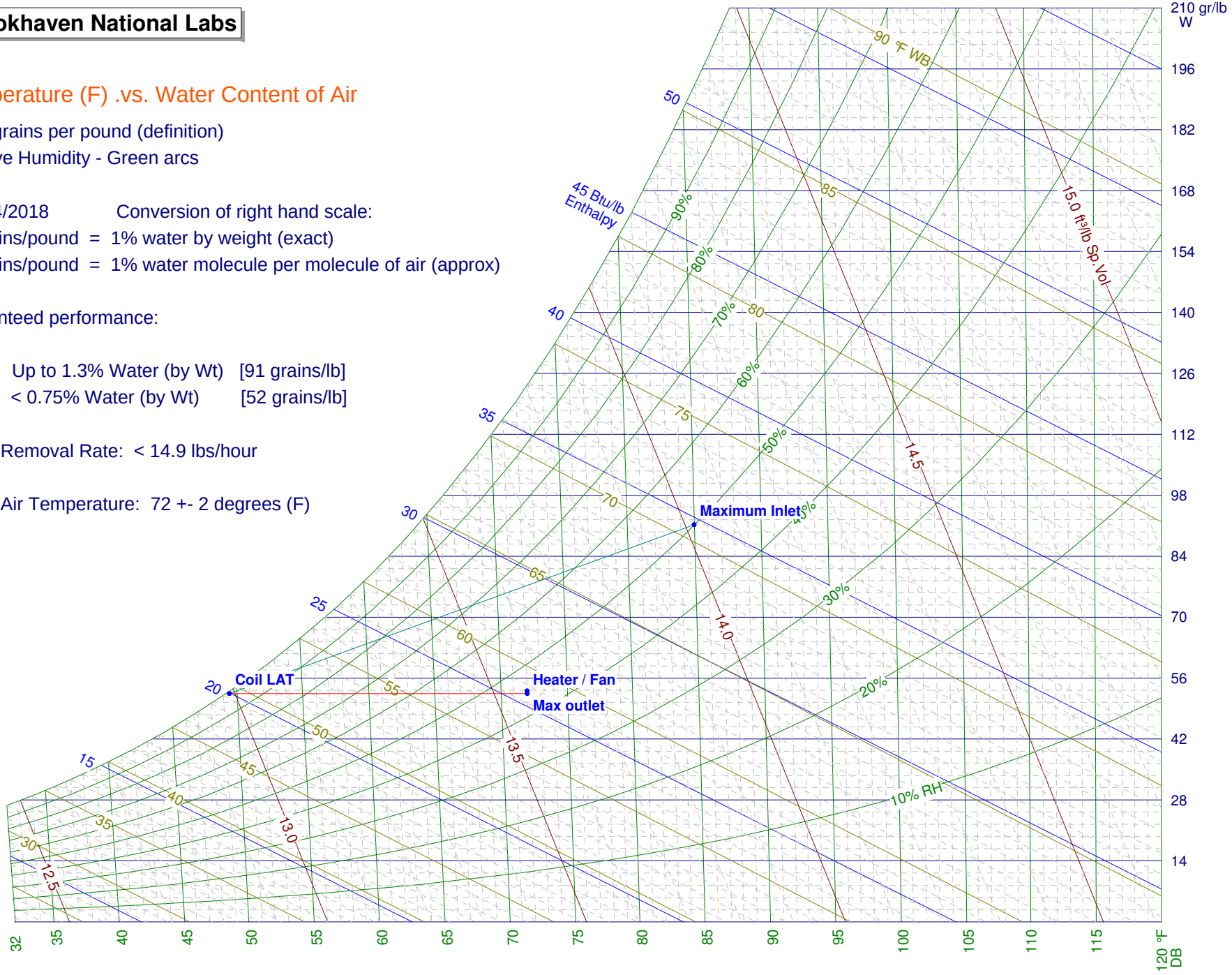
JT: 6/4/2018 Conversion of right hand scale:
70 grains/pound = 1% water by weight (exact)
45 grains/pound = 1% water molecule per molecule of air (approx)

Guaranteed performance:

Inlet: Up to 1.3% Water (by Wt) [91 grains/lb]
Outlet: < 0.75% Water (by Wt) [52 grains/lb]

Water Removal Rate: < 14.9 lbs/hour

Outlet Air Temperature: 72 +- 2 degrees (F)



State Point Report

Point Name	Dry Bulb Temp. °F	Wet Bulb Temp. °F	Relative Humidity %	Enthalpy of Moist Air Btu/lb	Humidity Ratio gr/lb	Specific Volume ft³/lb	Dew Point Temp. °F
Max outlet	72.00	58.67	45.00	25.56	53.0579	13.565	49.53
Maximum Inlet	85.00	70.74	50.00	34.72	91.2459	14.018	64.30
Coil LAT	49.50	49.35	99.00	19.99	52.4503	12.990	49.23
Heater / Fan	72.00	58.53	44.49	25.47	52.4503	13.564	49.23

Process Energy Report

Process Type	From Point	To Point	Flow Std. ft³/min	Sensible Heat kBtu/hr	Sensible Cool kBtu/hr	Latent Heat kBtu/hr	Latent Cool kBtu/hr	Water Added lb/hr	Total Load kBtu/hr
Heat	Coil LAT	Heater / Fan	600	14.760+	0.0	0.0	0.0	0.0	14.760
Cool	Maximum Inlet	Coil LAT	600	0.0	23.524+	0.0	16.182+	-14.9	-39.706
Totals:				14.760	23.524	0.000	16.182	0.0	

Note: Only loads for processes which normally use purchased energy are included in the totals. These items are marked with a trailing plus sign ("+").

Process Input/Output Report

Process	Flow Std. ft³/min	Type Or % Flow	Dry Bulb Temp. °F	Enthalpy (Moist Air) Btu/lb	Humidity Ratio gr/lb	Relative Humidity %	Wet Bulb Temp. °F	Specific Volume ft³/lb
Coil LAT / Heater / Fan	600	Heat	72.0	25.5	52.4503	44.5	58.5	13.564
Maximum Inlet / Coil LAT	600	Cool	49.5	20.0	52.4503	99.0	49.4	12.990

Jim Thomas

Subject: New Specs for PXL cooling System

From: Sharma, Rahul [mailto:rsharma@bnl.gov]
Sent: Tuesday, May 22, 2012 4:02 PM
To: Michael Wetzel
Subject: New Specs for PXL cooling System

Hey Mike,
Please see the updated specs:

Airflow Range (outlet)	300 CFM to 600 CFM (Adjustable)
Pressure Range (outlet)	5.0" to 2.0" WC (Range)
Ambient Temperature	65F to 85F
Ambient Relative Humidity	10%RH – 50%RH (Ref Document)
Output Temperature	72F+/- 2.0F (Measured in the detector area)
Output Relative Humidity	<50%RH
Physical Dimensions	Less than 78 inches in height and footprint must not exceed 26"x60"
Filtration	30/30 grade pre-filter and HEPA H13 filtration with 99.95% retention (total)
Drain	Gravity Flow
Ductwork	40 feet of 6 inch diameter flexible ductwork (non-conductive)will require four 90 degree bends and then will transition into two 3-inch ducts that run 8-feet
Power	208V or 480V/3P/60Hz
Noise	< 75dB (Measured at a distance of 1m from all 4 sides
Monitoring	Air Flow, Pressure and Temperature monitoring to be done remotely from the control room.

Regards,
RAHUL SHARMA
Mechanical Engineer,
Electronic Detectors Group,
510 Physics Building,
Brookhaven National Laboratory,
Upton, NY-11973

Cleanroom**Systems**

An Air Innovations Company

Monday, July 23, 2012

Rahul Sharma
Brookhaven National Lab
Electronic Detectors Group
510 Physics building
Upton, NY 11973

QUOTATION #120330-01rev3

Enclosed is a revision to our original proposal dated March 30, 2012 and subsequent revision dated July 18, 2012. This revision updates the payment terms and adds travel expenses to the base price.

Please let me know if there are any further changes or clarifications you need within.

Thank you for considering Cleanroom**Systems**.

Best Regards,

Michael Wetzel P.E.
President

cc: file
Encl.: heatload, quote, proposal drawing, duct loss calculations, warranty, terms,

Scope of Work

CleanroomSystems proposes to engineer, manufacture and test your AdvancAir Environmental Control Unit to the parameters as described herein. The unit is configured to provide once-thru steady state air to your RHIC collider. Inlet air will be from an existing controlled environment.

Our scope is limited to the supply and performance of individual components as identified in this proposal only. Installation and system performance beyond our supplied components is the responsibility of others.

Non-recurring Engineering (NRE)

CleanroomSystems will complete engineering and provide BNL with key documents for your review and approval prior to commencing ECU procurement activities. These key documents will include; Mechanical schedule, Electrical schematic, P&ID drawing and overall ECU drawing.

ECU Design Parameters

System:	Configured as once through
Physical dimensions:	Nominal 26" X 72" footprint - 72" high See attached drawing for preliminary configuration Mounted on swivel casters and adjustable feet
Construction:	Epoxy painted steel cabinet - black
Design Output Conditions:	72F +/- 2.0F <50%RH
Specified Ambient Condition:	65F - 85F 10%RH - 50%RH
Acceptable ambient change rate:	No more than 4F over any 1 hour period No more than 10%RH over any 1 hour period
Design Airflow:	300 - 600 CFM (user selectable) External static pressure range at duct outlet 2" to 5" across airflow range (does not mean we will deliver 5" across the range but as the airflow changes the fan static capacity must stay in the static pressure range) Duct losses calculated per BNL specs equal 5.2" at 600 (see attached report)
Assumed Process load:	Not applicable, unit is specified to maintain a specific outlet condition

Controls:	1 PID loop controller for Temperature - Auto tuning 1 Read only Humidity indicator 1 Read only airflow indicator 1 Variable frequency drives for the recirculating fan Emergency Off Switch (EMO) Indicator lights for fan and compressor operation ModBus communication with Temp, RH and Airflow controllers and alarms, single point of connection.
Sensors:	Duct mounted combination humidity/temperature sensors Sensor accuracy +/- 2.5%RH and 0.5F Airflow sensor in outlet, accuracy typically +/-15%
Refrigeration:	Nominal 3.5 Ton R-134a Scroll compressor Water cooled condenser Approximate usage 2.5GPM @ 60F water supply (TBD) Hot gas bypass refrigeration control
Humidifier:	None
Fans:	Motorized impeller
Reheater:	5KW electric reheater
Filtration:	Standard pre-filtration 30/30 typical HEPA filter at outlet (99.97% 0.3µ)
Standards:	ECU will be listed by a NRTL to UL specifications

Items not included in proposal, to be provided, installed and connected by others;

Rigging:	AdvancAir to be located in final position
Power:	208/3P/60Hz Main power disconnect
Water:	Condenser water for heat of rejection
Drain:	Gravity flow
Ductwork:	Supply as needed
Controls:	Field mounting and wiring of all control wire and sensors
Certification:	Compliance testing of system by others as necessary

Pricing / Delivery

The price to manufacture and test the described AdvancAir ECU is...	$ 78,000.00
A non-recurring engineering (NRE) charge will apply to the first unit only...	$ 25,000.00
A non-recurring NRTL testing charge will apply to the first unit only…	$16,000.00
PROJECT TOTAL	**$119,000.00**

Payment Terms:

$12,500 upon submittal of documents – estimated 30 days ARO
$12,500 upon approval of documents – 40 days ARO
$23,400 materials, billed at approval of documents – 40 days ARO
$16,000 upon NRTL approval – 13 weeks ARO
$46,800 upon shipment of ECU – 14 weeks ARO
$ 7,800 site acceptance – 16 weeks ARO or 30 days from shipment whichever is first

* All payment terms NET 30 days from invoicing.

Shipment: FOB North Syracuse, NY 13212

Validity: Quote valid for 60 days

Price includes a two-day startup, on-site (Upton, NY), by one of our technicians. Travel expenses are included. Please provide a two week lead time when scheduling the technician. Additional technician time, if required, will be billed at a rate of $850/day + travel expenses, whole day increments only - travel or site time.

All pricing is per our standard terms and conditions attached, except where noted otherwise in this proposal. Taxes, duties and freight have not been included.

AiR INNOVATIONS

7000 Performance Drive
North Syracuse, NY 13212
Phone 315-452-7400

REVISION HISTORY

Revision	Description	Date	Author
1.0	Original Release	5/24/12	MLW

Supply ductwork static pressure losses
Brookhaven National Lab

MLW	5/24/2012		
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Static loss calculations

An air friction chart for flexible ductwork was used to determine losses per section of duct. See scanned image at the end of this document.

1. BNL specifies 600 CFM in 6” duct for 40’ w/ 4 - 90 degree bends.

    1.1. Losses in the straight duct are 4.5”/100’ duct

        1.1.1. At 40’ this equates to **1.8”** total loss

    1.2. Losses in each elbow are the equivalent of 10’ of straight duct

        1.2.1. At 4 elbows this equates to .045X10X4 = **1.8”** total

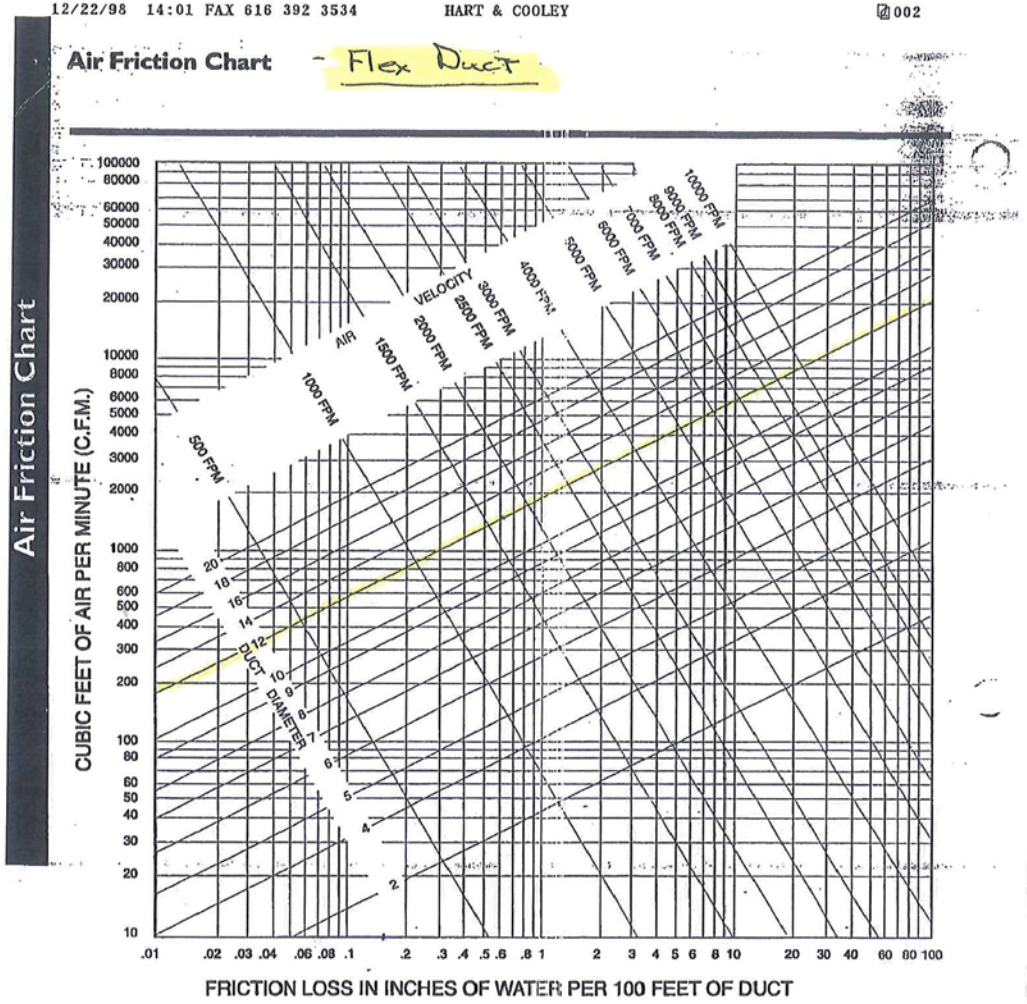
2. SBNL specifies there will also be 2 X 3” duct for 8’, each leg handling 300CFM

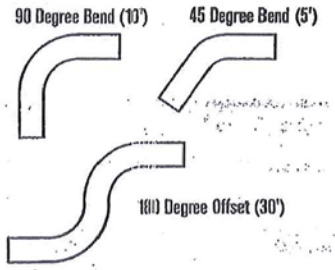
    2.1. Assumes legs are parallel and therefore not additive for pressure loss calculations

        2.1.1. Losses in 3” straight duct are 20.0”/100’ = **1.6”** total for 8’

Total duct losses at 600 CFM in the described system are therefore 5.2”

Air Friction Chart - Flex Duct





Approximate Dynamic Loss Coefficients
Numerals indicate Equivalent Feet of Straight Duct.

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