FUNCTIONAL SPECIFICATION:

LICK APF COOLING KIT

ICESTORM SERIES II STYLE ENCLOSURE

CI: FS-07757-01

EOS SPACE SYSTEMS PTY LIMITED
111 CANBERRA AVENUE GRIFFITH ACT 2603
A.B.N. 25 100 248 253
TELEPHONE 61 2 6222 7900
FACSIMILIE 61 2 6299 7687

CONTROLLED
COPY No. 2

DOCUMENT CONTROL

Prepared	Signed Jason Chapman	Date 03 June 2005
Checked	Signed Mark Elphick	Date 03 June 2005
Approved	Signed Adam Seedsman	Date 03 June 2005

01	03 June 2005	Original Issue	MJE	AJS
Issue	Date	Description	Checked	Approved

ECO # Index	

CONTENTS

ANNEX 3-AIR AND CONTROLS SCHEMATIC 18

1 SCOPE

1.1 APPLICATION

This document describes the Lick APF cooling system including equipment specifications, plumbing specifications, system control strategy.

1.2 OBJECTIVES

The primary purpose of the cooling system is to maintain a constant, even, temperature in the enclosure observing space to within 2 °C of a pre determined set point, while ensuring condensing conditions do not occur.

A secondary objective is to maintain temperature in the enclosure Level 1 equipment space that will not exceed 15°C

Other considerations taken into account are;

- Prevention of Fan Coil Unit Icing.
- De-Icing of Fan Coil Units when required.
- Mixing air to maintain a consistent temperature through out the enclosure observing space.
- Equipment serviceability access.
- Transportation of cooling glycol from fixed enclosure space to the rotating enclosure space.

There may be other considerations that arise during testing of the installed cooling system.

1.3 VENDOR AND CLIENT RESPONSIBILITIES.

Responsibilities for the Vendor and Client are outlined in;

UCO/Lick Planet Finder Telescope Enclosure : Appendix D

Cooling Kit Specification

1.4 RELEVANT DOCUMENTATION

CI Number	Title
EDW-07757	IceStorm II Series Observatory Cooling System Design – Preliminary Sketch Plan
AD-07757	Lick APF Cooling Kit Assembly drawing

2 COOLING SYSTEM EQUIPMENT DESCRIPTION

2.1 SYSTEM CHILLER UNIT

An air cooled chiller was suggested as being suitable for the UCO-Lick APF enclosure and instrument cooling requirements. This suggestion was tabled by a cooling consultant engaged by EOS to design the UCO-Lick APF cooling system philosophy.

The Chiller unit chosen and installed by UCO-Lick for the purpose of providing chilled glycol mix to the enclosure cooling system, will be installed at least 30m horizontally (based on 3 enclosure diameters), from the enclosure footings. This is to reduce the effect of chiller heat exchange exhaust on observatory seeing.

Leaving or supply glycol required will be 24°F (-4.5°C). Estimated typical entering or return glycol will be 33°F (0.5°C). The rest of the chiller specifications are the responsibility of UCO-Lick.

Chilled Glycol will be transported to the enclosure in insulated pipes, as specified by UCO-Lick as being suitable to their requirements.

2.2 SYSTEM FAN COIL UNITS

The system FCU's are supplied by "Corsair Products Pty Ltd" Australia and are a combination of custom built unit and standard product units. All coil pipe diameters will be 1" with 1" male BSP connections, to enable a standardisation of fittings throughout the enclosure.

FCU cooling capacity will be regulated by adjusting glycol flow through the coil with a 3-way proportional valve before the FCU. Air flow through the coil can be adjusted manually at the variable speed fan control, as seasons demand, Unit fans are rated for 220V 60Hz.

Fan Coil Units have designations of FCU-1 (level 1 cooling), FCU-2 (telescope base, observing space cooling) and FCU-3 (observing space cooling) as a means of identification.

2.2.1 FCU-1

The fan coil unit designated FCU-1 is dedicated to cooling the Level 1 equipment space. FCU-1 will be mounted directly under the enclosure service balcony, utilising the service balcony as its' main support.

As a consequence of external mounting, FCU-1 has associated ducting for out and return air into and from the Enclosure level 1 space. The ducting will pass through the ring wall external and internal cladding with all pass throughs requiring weather proof flashing.

The separation between the outlet diffuser and return air grille inside the enclosure ring wall will be greater than 2m to prevent short cycling of air in the level 1 space.

FCU-1 does not have an inline pipe heater for de-icing as fan forced Level 1 air will be used. Pipe heaters can be retro-fitted at a later date if required.

EOS are required to install the FCU-1 arm of the cooling system from the proportional valve. The valve body will be 1" diameter – fittings to be announced, it will be brass thread style. The valve will be situated in a weather proof box or inside the enclosure.

Contract plumbers will be required to plumb cooling and return pipes to the proportional valve, via balancing valves.

FCU1;

- 220V 60Hz single phase fan
- All fittings 1" male BSP
- 10.3kW Total, 8.7kW Sensible
- Water flow 0.50 l/sec
- Chilled water Pressure 23kPa
- Coil resistance 15pa

2.2.2 FCU-2

The fan coil unit designated FCU-2 is dedicated to cooling the Enclosure observation space. FCU-2 will be assembled directly inside the telescope base, utilising sliding rails fitted inside the telescope base with vibration isolation mounts.

As a consequence of the FCU-2 assembly located in the base, dry break pipe fittings and plug in electrical connections are required, allowing the removal of the FCU-2 from the base for telescope maintenance.

Ducting is required to draw return air through the open hole in the telescope yoke into the FCU, then outlet air is ducted back to the enclosure observing space through the eastern side telescope base door way. Ducting is required to prevent short cycling of air inside the telescope base.

Glycol coolant, cooling and return, will be delivered to the cooling coil via 1"dia piping to through an offset void in the pier as designed by UCO-Lick, with consultation to EOS.

FCU-2 has an inline pipe heater on the inlet cooling pipe for de-icing. If ice is detected the pipe heater is switched on, heating the chilled glycol and melting the ice by warming the cooling coil. The pipe heater will be situated inside the pier cavity as per the glycol piping

FCU-2 proportional valve is located at the entrance to the pier void below the azimuth cable wrap. The Azimuth cable wrap manifolds should have capacity to include branches for connection to the proportional valve, via balancing valves.

FCU2;

- 220V 60Hz single phase fan
- All fittings 1" male BSP

- 6.4kW Total, 4.7kW Sensible
- Water flow 0.62 l/sec
- Chilled water Pressure 33kPa
- Coil resistance 15pa

2.2.3 FCU-3

The fan coil unit designated FCU-3 is dedicated to cooling the Enclosure observation space. FCU-3 will be assembled high in the enclosure on the opposite side to the instrument.

Brackets with isolation mounts are required for FCU-3. The brackets will be substantial and attached to the enclosure upper cladding frame. FCU-3 must not interfere with the slit open aperture width or the telescope structure. No ducting is required, a diffuser is built into the FCU for cooled air out flow.

Glycol coolant, cooling and return, will be delivered to the cooling coil via 1"dia piping to through an offset void in the pier as designed by UCO-Lick, with consultation to EOS.

FCU-3 has an inline pipe heater on the inlet cooling pipe for de-icing. If ice is detected the pipe heater is switched on, heating the chilled glycol and melting the ice by warming the cooling coil. The pipe heater will be mounted against the side support beam after the proportional valve.

FCU-3 proportional valve is located before the pipe heater also mounted against the side support beam.

Dry break pipe connections will be installed for maintenance purposes. Spray guards are required around connection points to prevent any accidental coolant leakage finding its' way onto sensitive equipment and optics.

FCU3;

- 220V 60Hz single phase fan
- All fittings 1" male BSP
- 2.6kW Total, 1.9kW Sensible
- Water flow 0.28 l/sec
- Chilled water Pressure 24kPa
- Coil resistance 15pa

2.3 AIR CIRCULATION FANS

Two 400mm axial "Fantech" single speed air circulation fans are mounted high in the enclosure observing space. The primary purpose of these fans is to mix the air in the enclosure ensuring no hot or cold pockets of air in the enclosure observing space.

The fans will be mounted to the enclosure internal upper frame on the instrument side of the enclosure. Any mounts will have to be adjustable and vibration isolated. Air mixing is hard to model and experience has been used to make an educated judgement on the best position. Adjustable mounting will allow the air circulation to be adjusted until a best position is found.

The fans are rated as follows;

- 220V 60Hz AC single phase
- 0.25kW FL 0.83A
- 700 l/sec
- Fantech p/no AP0404AP5/21

The two fans will be hard wire into the enclosure "dirty" power system and will be switched via a single phase contactor with on/off conditions only.

2.4 PIPE HEATERS

FCU-2 and FCU-3 lines each have a pipe heater as emergency de-icing as described previously. The pipe heaters have been placed after the 3-way proportioning valves allowing other equipment in the system to receive correct temperature coolant if one of the FCU's is in de-ice mode.

The pipe heaters are inline and are assembled into the inlet side coolant piping to the FCU's. They are stainless construction 50mm in diameter with 1" male BSP inlet and outlet fittings. EOS are responsible for matching fittings to the pipe heaters.

When in de-ice mode it is recommended that full flow available is maintained through the pipe heaters to prevent element damage. The 3-way proportional valve must divert all flow through the pipe heater. The pipe heater will be switch via a contactor with on/off conditions only.

Pipe heater FCU2;

- 220V 60Hz
- 4kW
- OD 50mm
- 1.5m Long
- Pipe connections 1" male BSP

Pipe heater FCU3;

- 220V 60Hz
- 2kW
- OD50mm
- 0.65m long
- Pipe connections 1" male BSP

2.5 PROPORTIONAL VALVES

The 3 –way proportional valves are "Siemens" VMP 45 series valves with SSB61 series actuators.

The valves are designed for flow rates of 0.25m^3/h to 6m^3/h. The flow rates for all of the FCU's fall into this category.

In case of Actuator failure the valve bodies are supplied with manual close/open handles. These are installed after the faulty actuator is removed, a quick operation. Another option is to use a 3mm Allen key in the top of the actuator to manually close the valve, then remove the actuator for replacement or repair.

Valves must be situated out of the weather and be within 4.5m of the control box, determined by control lead length. Valve bodies should also be lagged to prevent condensation forming on the valve.

Actuator specifications;

- Operating voltage 24V ac
- Running time @ 50Hz 75s
- Control signal DC 0-10V
- Cable length 1.5m

2.6 BALANCING VALVES

Balancing valves are required for the inlet and return sides of all branch offs from main lines to the to proportional valves. These are the responsibility of UCO-Lick.

The valves are required to prevent short cycling/circuiting of glycol coolant if a proportional valve fully opens, such as in de-icing mode. The balancing valves should limit the maximum flow rate through a fan coil unit to the maximum required calculated flow for each respective coil.

The balancing valves are manually set and should not be changed unless the cooling system is modified in the future, or during system tuning.

Valve bodies should also be lagged to prevent condensation forming on the valve.

2.7 CONDENSATION PUMPS

Condensation will be disposed of utilising gravity for FCU-1 and FCU-3. FCU-2 may require a condensate pump to assist condensate removal from the pier unit drip tray to the enclosure exterior. The drain connections will be 19 mm (3/4") OD plain copper stub connections. Flexible PVC tubing can be pressed onto these stubs and routed to either a sump or to a suitable location away from the enclosure.

The recommended pump is low voltage with a sump and float switch for pump on/off conditions. These style of pump are common and can be purchased by UCO-lick if the need arises.

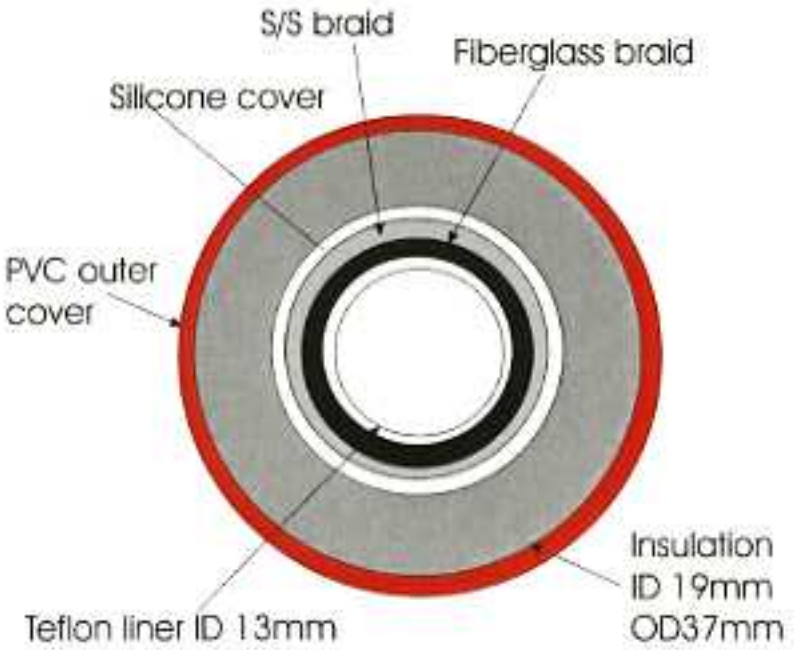
2.8 COOLANT PIPES AND MANIFOLDS

UCO-Lick are responsible for any manifolds and coolant piping required for the enclosure cooling system. EOS will provide assistance for all pipes and manifolds specification or design if required.

All pipes and manifolds require lagging to prevent condensate formation. Soldered joins are recommended were removal of equipment or piping is not seen to be required. This prevents leaking at fittings caused by cold liquid shrinking parts.

As the FCU-3 is mounted high in the observing area, which rotates in relation to FCU-1 and FCU-2, coolant delivery has to be through the Azimuth cable wrap. The main coolant delivery line is split via a manifold into 3 of inlet and 3 of return lines through each side of the wrap, then merged into the two respective pipes again. The azimuth coolant hose consists of a ½" corrugated flexible Teflon pipe covered protective stainless steel braid. A Fire retardant flexible insulation sock 10mm thick is installed around the braid with the whole hose wrapped in a PVC cover. The total external diameter of this assembly is 42mm (Figure 1). Hose end connections are AF2 ½" BSP stainless steel couplings.

EOS Coolant HOSE



PVC outer cover 2mm thick=4mm
Hose outside diameter =19mm
Insulation ID 19mm OD 37mm

Maximum OD of entire bundle is 42mm

Figure 1-Profile of Lick Coolant Hose

Pipe feed and return from and to the chiller system is specified as a 50mm bore. UCO-lick are responsible for specifying pipe material and insulation requirements.

Manifolds/reducers are required for the branch off to FCU-1, FCU-2, FCU-3 and HE-1 (Instrument cooling). Branch pipe bore diameters are;

- FCU-1, 32mm
- FCU-2, 32mm
- FCU-3, (Via azimuth wrap) 25mm
- HE-1, (Via azimuth wrap) 15mm

3 COOLING SYSTEM CONTROL STRATEGY

Regulating the enclosure observing space temperature to a pre-determined set point in an equipment safe manner (no dew in the enclosure) is the primary objective.

3.1 ENCLOSURE CONDITIONS MONITORING

Enclosure observing space conditions will be monitored with off the shelf sensors, measuring temperature plus humidity in 4 locations;

- FCU-3 side of the enclosure slit at zenith
- Air circulating fan side of the enclosure slit at zenith
- Adjacent to the underside of the M1 mirror support frame
- On the level 2 basket wall opposite the diffuser for FCU-2

The data collected from these sensors can be monitored individually as well as averaged for FCU proportional valve control calculations, hence flow change and coil air temperature change.

Dew point calculations will be made for each of these locations estimating when condensation is likely to appear in the enclosure. This information is used to help determine proportional valve settings.

Coil ice conditions are monitored with differential pressure sensors, measuring pressure drop across the coil. Ice build-up will be measured as an increase in the pressure differential across the coil.

Level 1 will have 1 sensor of the same type as the observing space near return air duct inlet.

The goal is to maintain a temperature in the equipment level at 15°C.

3.2 COIL DE-ICING

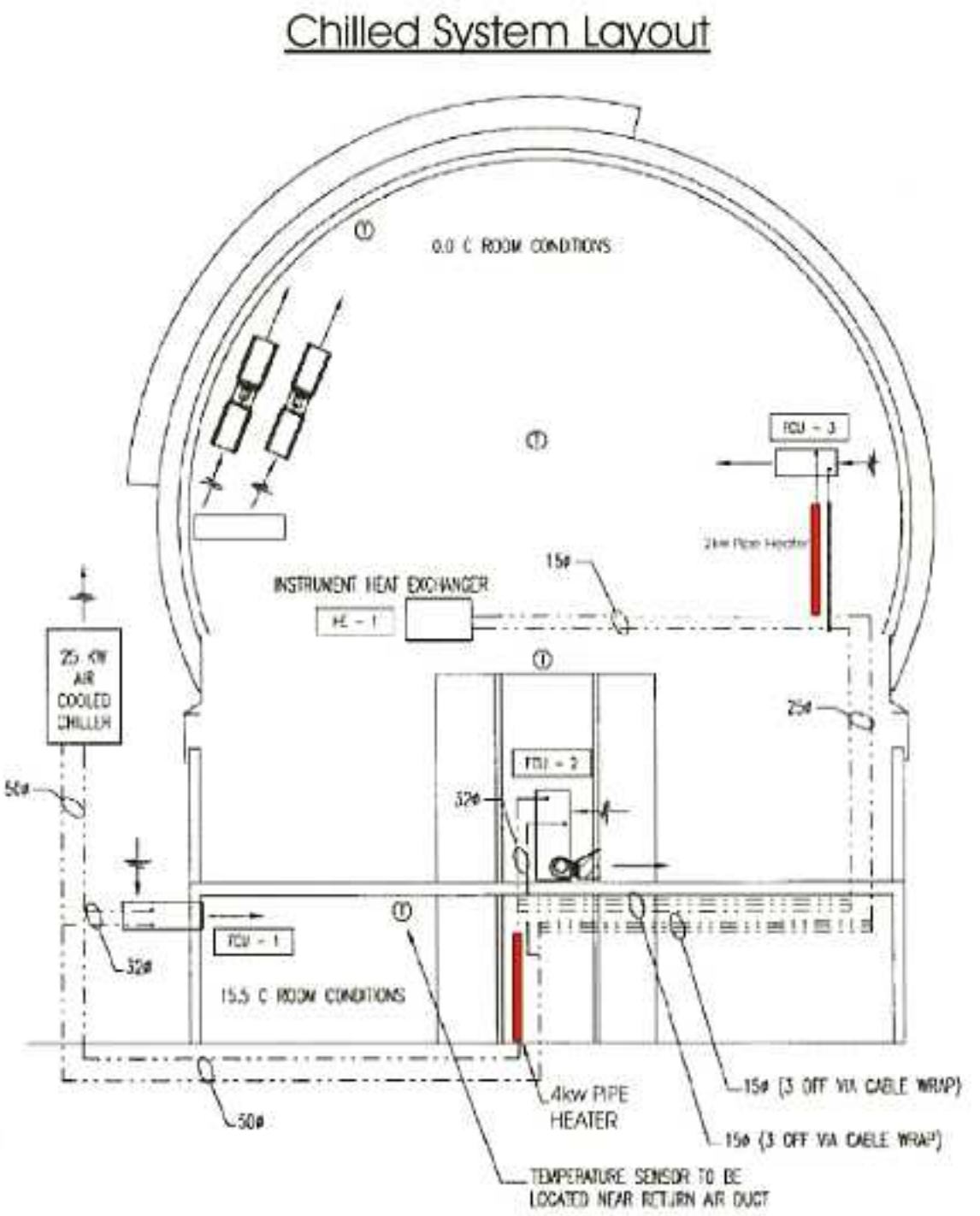
For FCU2 & FCU3, the three way proportional valve is adjusted to allow full flow to the coil. As the glycol flows from the valve to the coil inlet, it passes through a pipe heater. The pipe heater heats the glycol above 0°C, heating the coil copper and melting the ice. This is a time efficient method of ice removal. This system also means that individual FCU's can be de-iced without affecting inlet flow glycol temperature to instruments or other FCU's.

Fan Coil Unit 1 will be de-iced using air from the level 1 equipment area. There is provision for another pipe heater in the FCU1 line if required in the future.

3.3 PROPORTIONAL VALVE CONTROL

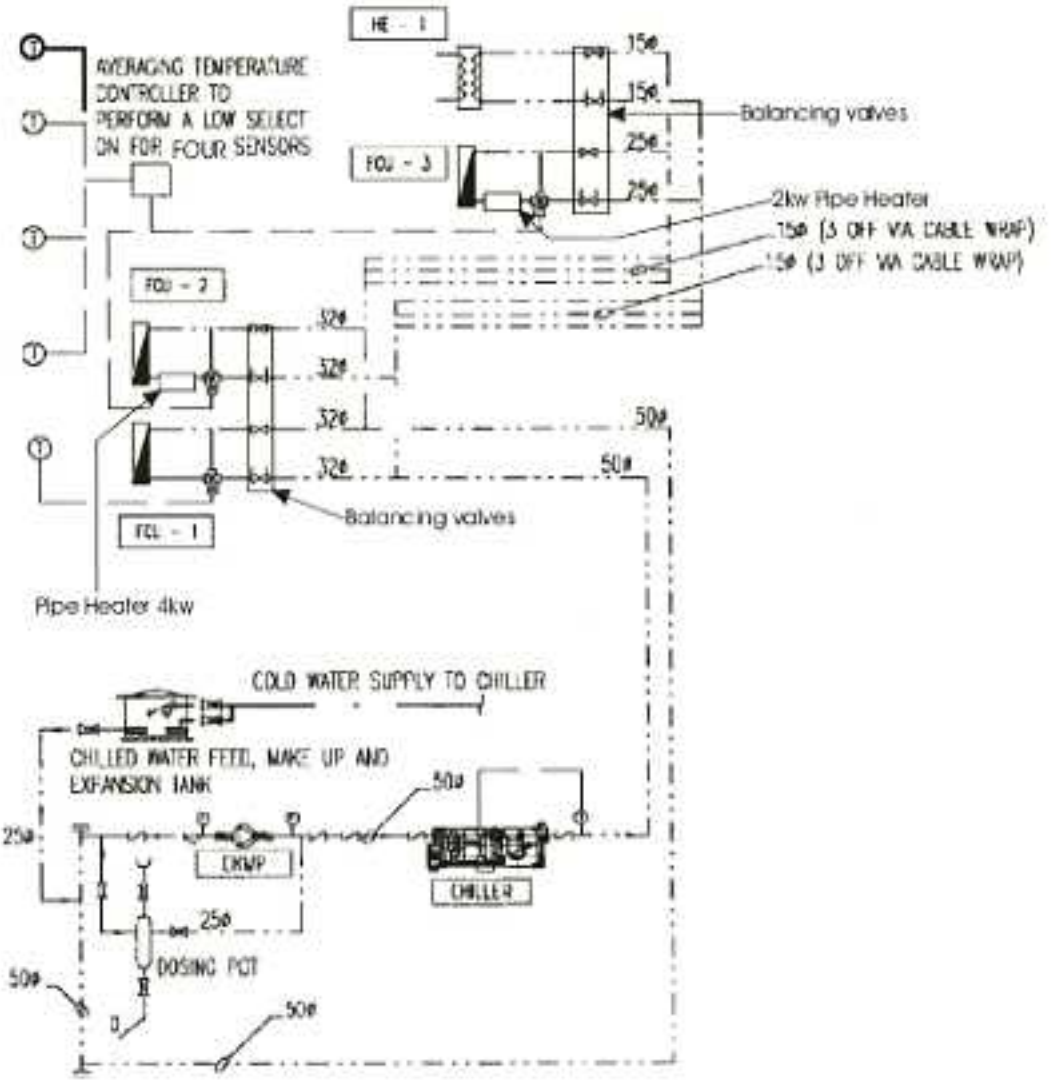
The proportional valve actuators are energised by 24VAC and will be powered by EOS supplied power packs, with control via EOS supplied temperature controllers. Anti condensation and ice-control algorithms are implemented by the temperature controllers. The controllers also monitor for ice build-up and perform de-icing cycles as required. All leads from the valve actuators to the control boxes will be EOS supplied.

ANNEX 1-CHILLED WATER SYSTEM LAYOUT



ANNEX 2-CHILLED WATER SCHEMATIC

Chilled Water Schematic

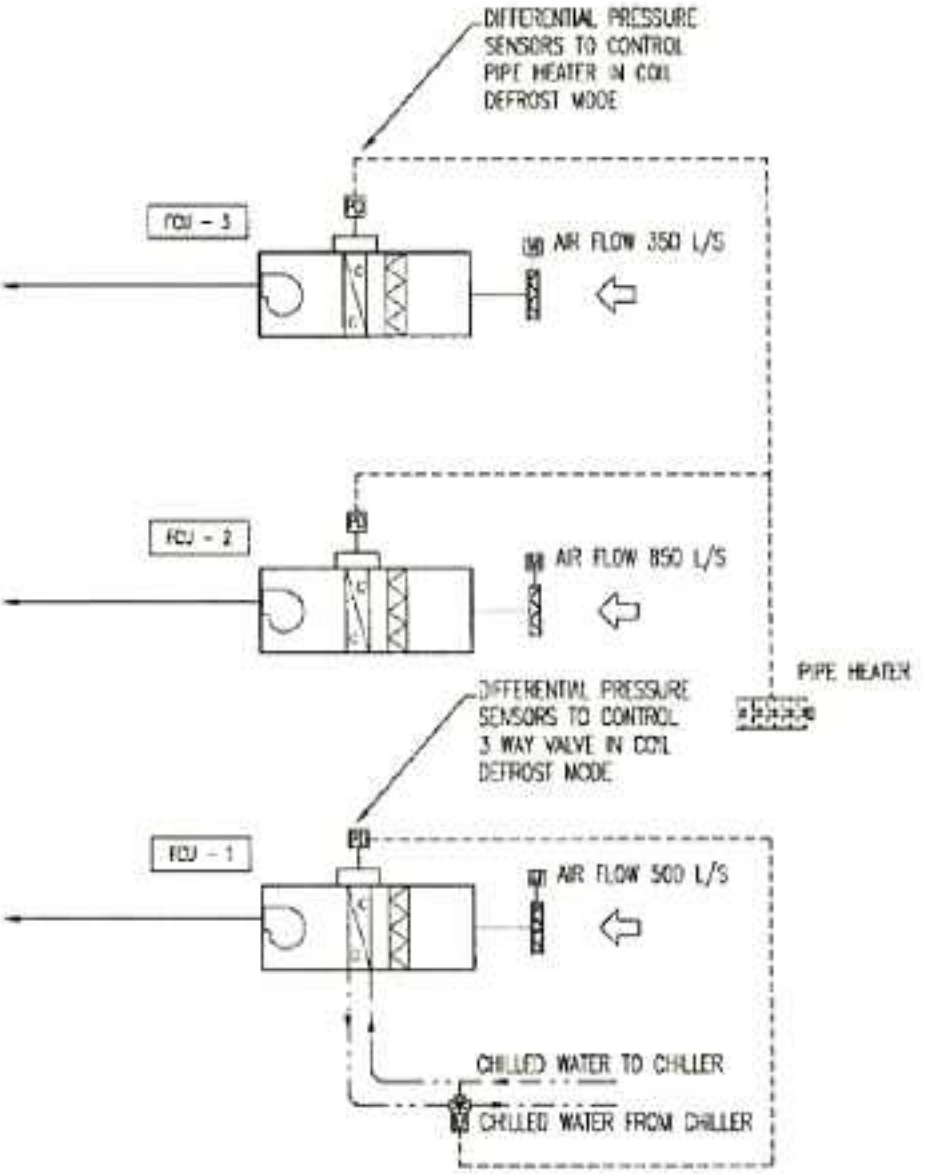


NOTES

ROOM TEMPERATURE SET POINTS ARE VARIABLE AND SHALL BE SET BY THE BUILDING USERS.

ANNEX 3-AIR AND CONTROLS SCHEMATIC

Air and Controls Schematic



NOTES

ROOM TEMPERATURE SET POINTS ARE VARIABLE AND SHALL BE SET BY THE BUILDING USERS.