

LOGO		DGI Png.	2021110
CUSTOMER	LARGE BINOCULAR TELESCOPE CORP. ARIZONA	DATE	01/13/23
SHEET TITLE	PARTIAL FLOOR PLAN - LEVEL 3L OVERALL SPACE USE PLAN	CHECKED	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS	DRAWN	PVDM
SCALE	AS INDICATED	DESIGNED	PVDM
		ORIGINAL SIZE	ANSI B

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM

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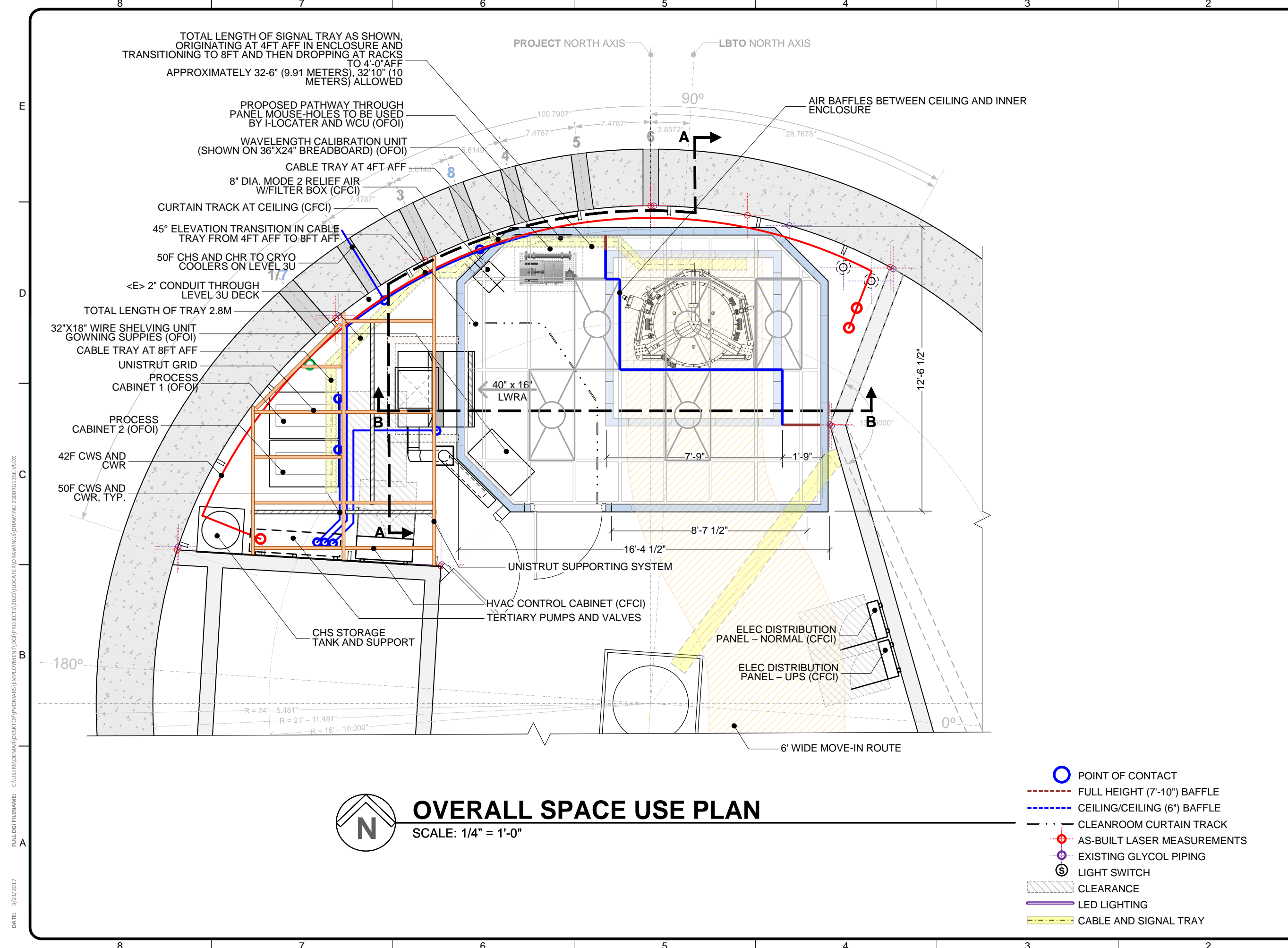
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DATE: 3/21/2017

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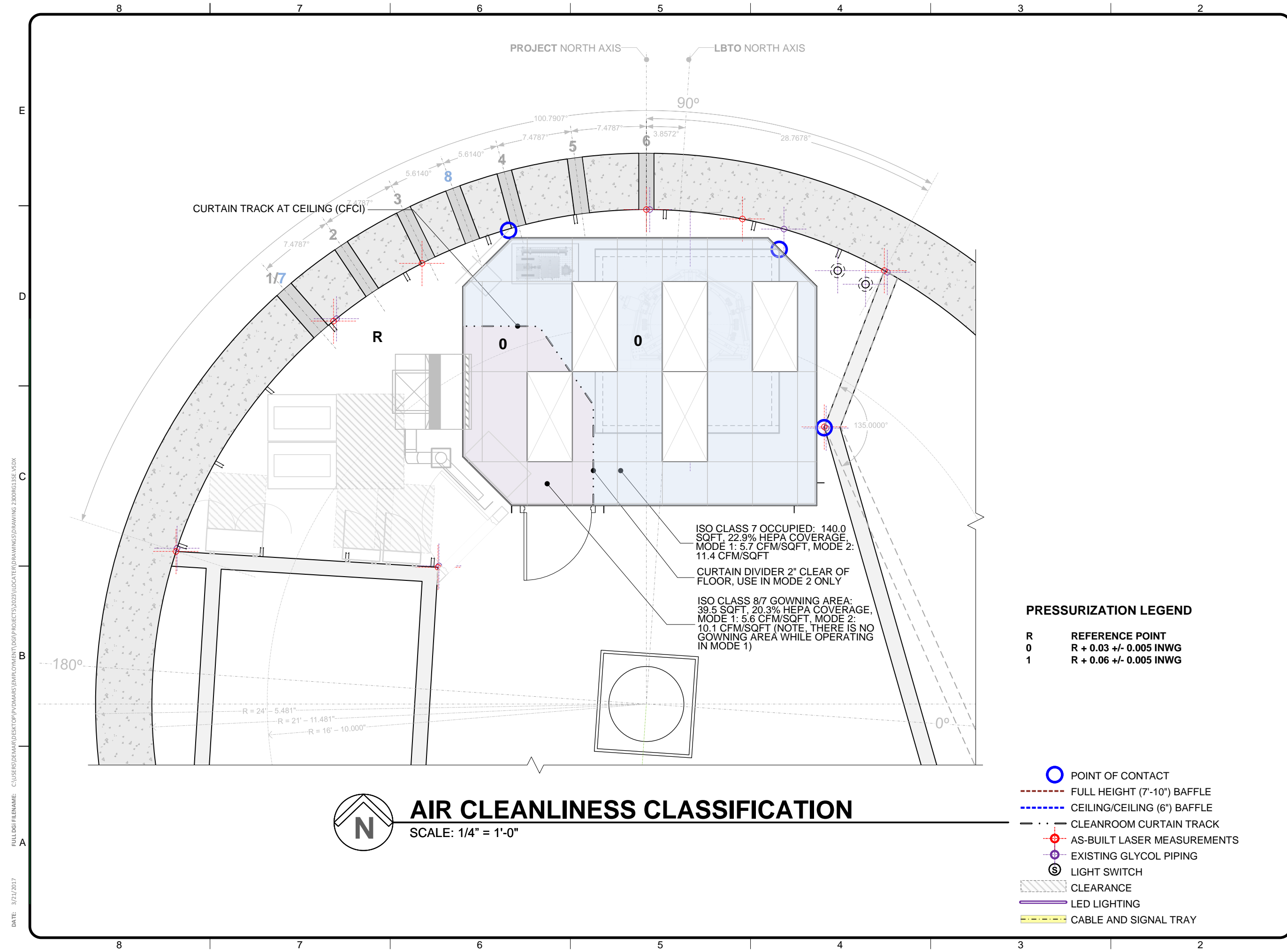
DRAWING No.	REV.
1-0	B



- POINT OF CONTACT
- FULL HEIGHT (7'-10") BAFFLE
- CEILING/CEILING (6") BAFFLE
- CLEANROOM CURTAIN TRACK
- AS-BUILT LASER MEASUREMENTS
- EXISTING GLYCOL PIPING
- LIGHT SWITCH
- CLEARANCE
- LED LIGHTING
- CABLE AND SIGNAL TRAY

DATE: 3/21/2017

FULL DGI FILENAME: C:\USERS\DEMAR\DESKTOP\IPVDMARS\EMPLOYMENT\GIP\PROJECTS\2023\ILOCATER\DRAWINGS\DRAWING 2300RGL3SE.VSDX



AIR CLEANLINESS CLASSIFICATION

SCALE: 1/4" = 1'-0"

ISO CLASS 7 OCCUPIED: 140.0 SQFT, 22.9% HEPA COVERAGE, MODE 1: 5.7 CFM/SQFT, MODE 2: 11.4 CFM/SQFT

CURTAIN DIVIDER 2" CLEAR OF FLOOR, USE IN MODE 2 ONLY

ISO CLASS 8/7 GOWNING AREA: 39.5 SQFT, 20.3% HEPA COVERAGE, MODE 1: 5.6 CFM/SQFT, MODE 2: 10.1 CFM/SQFT (NOTE, THERE IS NO GOWNING AREA WHILE OPERATING IN MODE 1)

PRESSURIZATION LEGEND

- R REFERENCE POINT
- 0 R + 0.03 +/- 0.005 INWG
- 1 R + 0.06 +/- 0.005 INWG

- POINT OF CONTACT
- FULL HEIGHT (7'-10") BAFFLE
- CEILING/CEILING (6") BAFFLE
- CLEANROOM CURTAIN TRACK
- AS-BUILT LASER MEASUREMENTS
- EXISTING GLYCOL PIPING
- LIGHT SWITCH
- CLEARANCE
- LED LIGHTING
- CABLE AND SIGNAL TRAY

LOGO				DGI Png.	2021110
CUSTOMER	LARGE BINOCULAR TELESCOPE CORP. ARIZONA			DATE	01/13/23
SHEET TITLE	PARTIAL FLOOR PLAN - LEVEL 3L AIR CLEANLINESS CLASSIFICATION			CHECKED	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS			DRAWN	PVDM
SCALE	AS INDICATED			DESIGNED	PVDM
ORIGINAL SIZE	ANSI B				

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM

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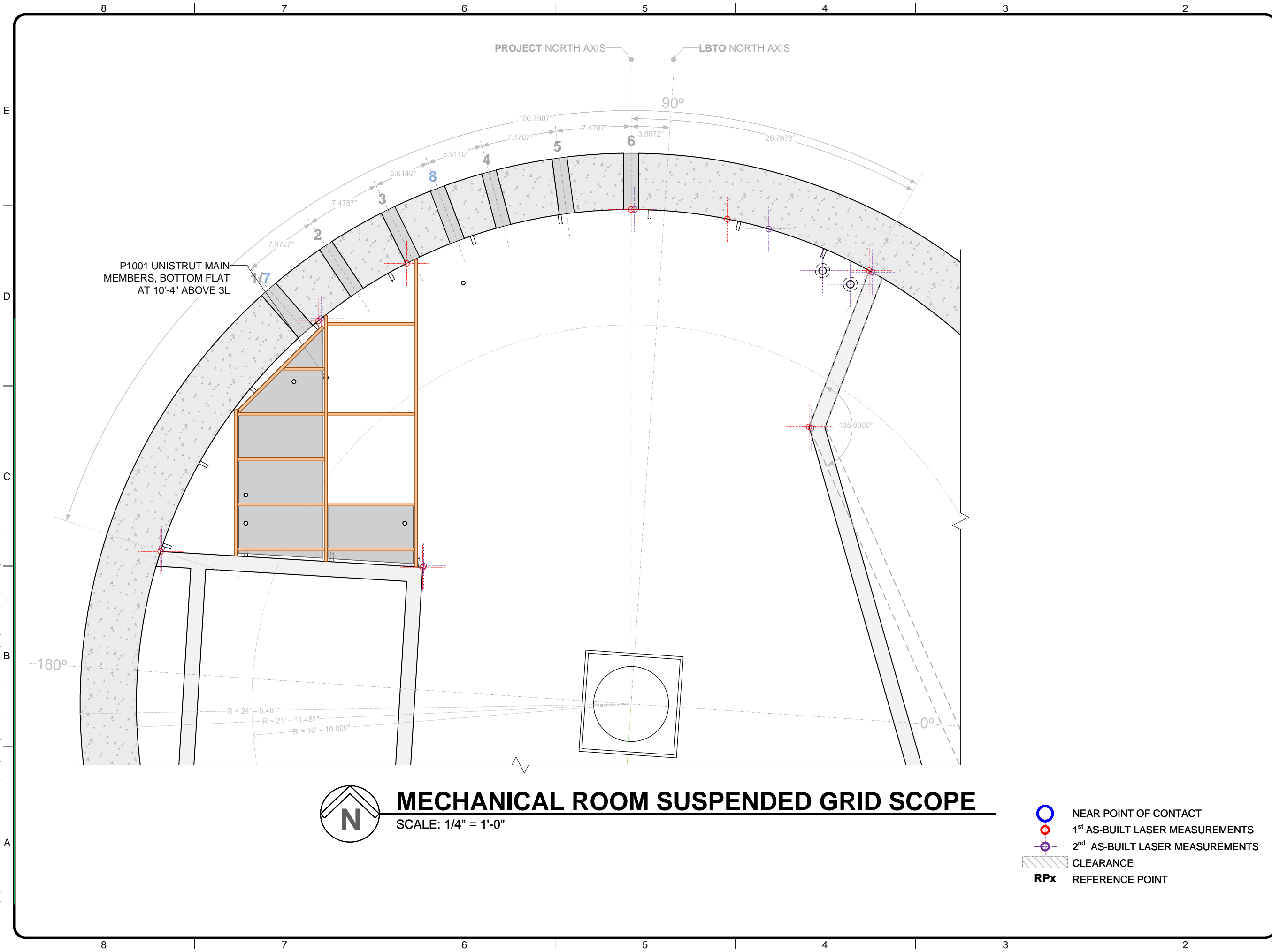
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DGI Png.: 2021110, EXPIRES: 09/30/23

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MECHANICAL ROOM SUSPENDED GRID SCOPE

SCALE: 1/4" = 1'-0"

- NEAR POINT OF CONTACT
- 1st AS-BUILT LASER MEASUREMENTS
- 2nd AS-BUILT LASER MEASUREMENTS
- CLEARANCE
- RPx REFERENCE POINT

LOGO					DGI Png.	2021110
CLIENT	LARGE BINOCULAR TELESCOPE CORP. ARIZONA				CHECKED	PVDM
SHEET TITLE	PARTIAL FLOOR PLAN - LEVEL 3L MECHANICAL ROOM SUSPENDED GRID SCOPE				DRAWN	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS				DESIGNED	PVDM
SCALE	AS INDICATED				ORIGINAL SIZE	ANSI B
DATE	01/13/23				DATE	01/13/23

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM
	C		
	D		
	E		

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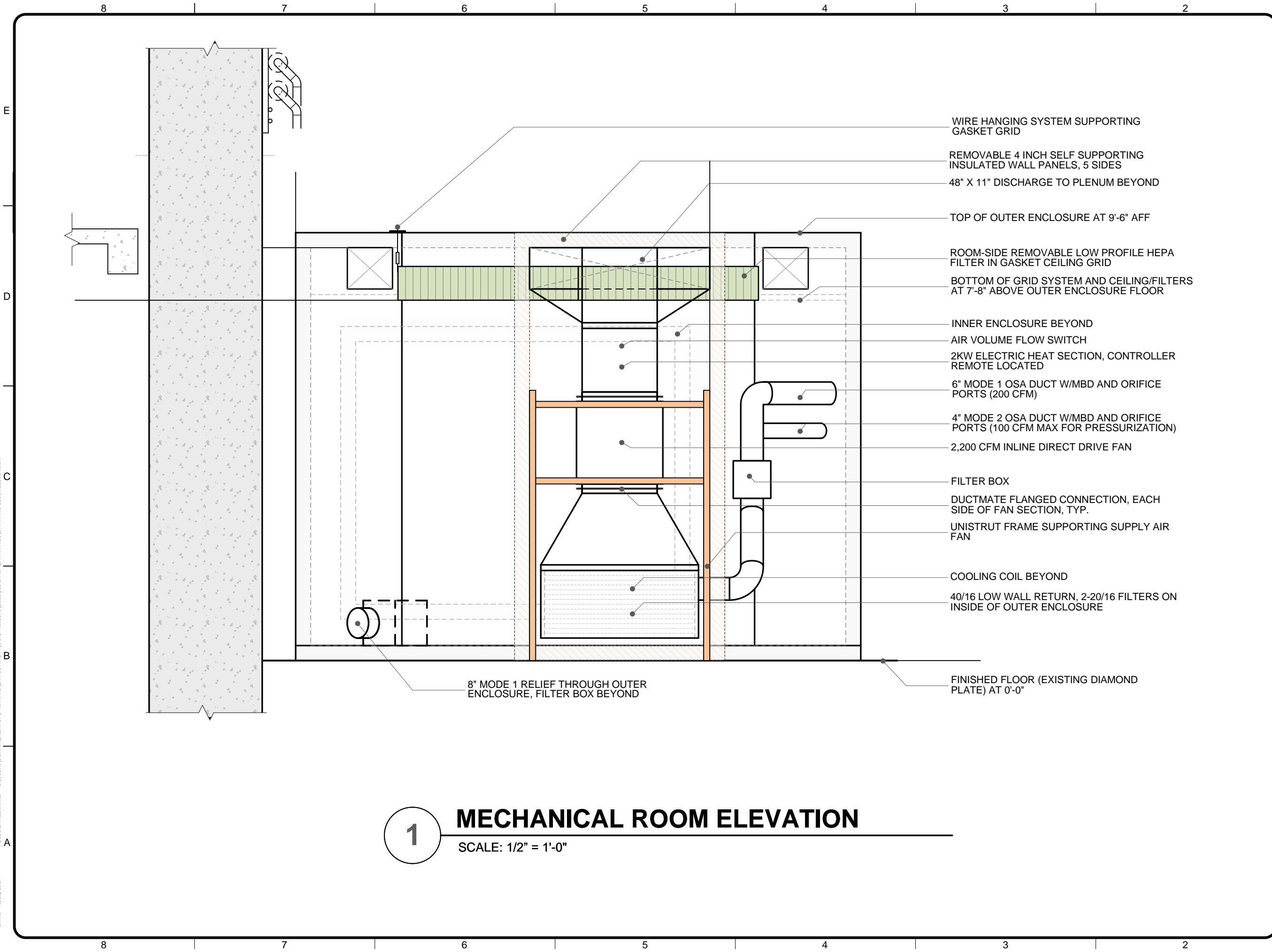
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1

MECHANICAL ROOM ELEVATION

SCALE: 1/2" = 1'-0"

- WIRE HANGING SYSTEM SUPPORTING GASKET GRID
- REMOVABLE 4 INCH SELF SUPPORTING INSULATED WALL PANELS, 5 SIDES
- 48" X 11" DISCHARGE TO PLENUM BEYOND
- TOP OF OUTER ENCLOSURE AT 9'-6" AFF
- ROOM-SIDE REMOVABLE LOW PROFILE HEPA FILTER IN GASKET CEILING GRID
- BOTTOM OF GRID SYSTEM AND CEILING/FILTERS AT 7'-8" ABOVE OUTER ENCLOSURE FLOOR
- INNER ENCLOSURE BEYOND
- AIR VOLUME FLOW SWITCH
- 2KW ELECTRIC HEAT SECTION, CONTROLLER REMOTE LOCATED
- 6" MODE 1 OSA DUCT W/MBD AND ORIFICE PORTS (200 CFM)
- 4" MODE 2 OSA DUCT W/MBD AND ORIFICE PORTS (100 CFM MAX FOR PRESSURIZATION)
- 2,200 CFM INLINE DIRECT DRIVE FAN
- FILTER BOX
- DUCTMATE FLANGED CONNECTION, EACH SIDE OF FAN SECTION, TYP.
- UNISTRUT FRAME SUPPORTING SUPPLY AIR FAN
- COOLING COIL BEYOND
- 40/16 LOW WALL RETURN, 2-20/16 FILTERS ON INSIDE OF OUTER ENCLOSURE
- 8" MODE 1 RELIEF THROUGH OUTER ENCLOSURE, FILTER BOX BEYOND
- FINISHED FLOOR (EXISTING DIAMOND PLATE) AT 0'-0"

LOGO		DGI Png.	2021110
CLIENT	LARGE BINOCULAR TELESCOPE CORP. ARIZONA	DATE	01/13/23
SHEET TITLE	PARTIAL SECTION ON LEVEL 3L MECHANICAL ROOM ELEVATION	CHECKED	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS	DRAWN	PVDM
SCALE	AS INDICATED	DESIGNED	PVDM
		ORIGINAL SIZE	ANSI B

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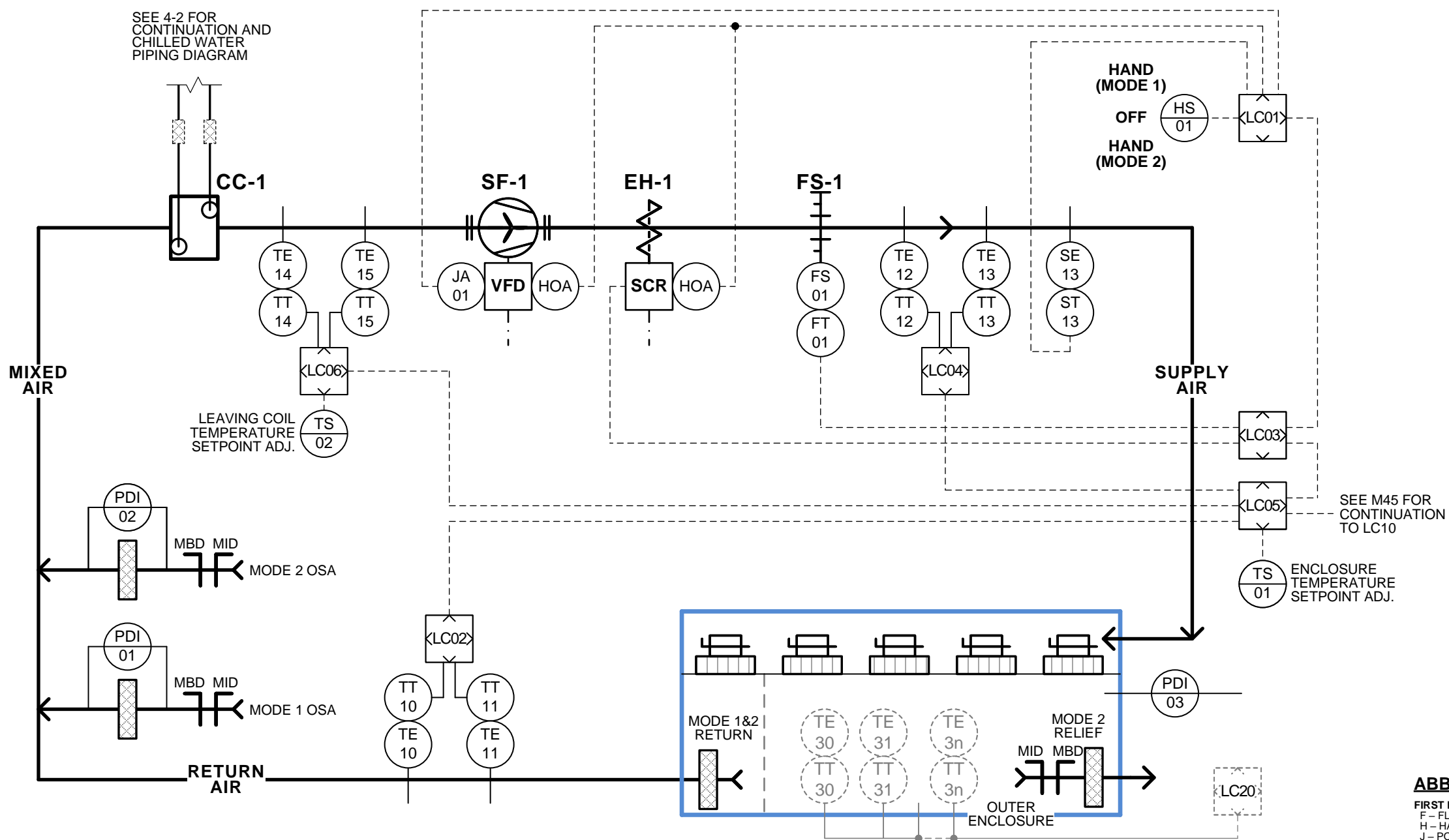
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LOGO					DGI Png.	2021110
CUSTOMER	LARGE BINOCULAR TELESCOPE CORP. ARIZONA				DATE	01/13/23
SHEET TITLE	AIR-SIDE CONTROL AND PROCESS FLOW DIAGRAM DUCTED DESIGN				CHECKED	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS				DRAWN	PVDM
SCALE	AS INDICATED				DESIGNED	PVDM
ORIGINAL SIZE	ANSI B					



ABBREVIATIONS

- FIRST LETTER:**
 F - FLOW
 H - HAND
 J - POWER
 L - LOGIC
 P - PRESSURE
 S - SMOKE
 T - TEMPERATURE
 Z - POSTION
- SECOND AND/OR THIRD LETTER:**
 A - ALARM
 C - CONTROLLER
 D - DIFFERENTIAL
 E - ELEMENT
 I - INDICATOR
 S - SWITCH
 T - TRANSMITTER
- HOA - HAND-OFF-AUTO SWITCH
 OSA - OUTSIDE AIR
 VFD - VARIABLE FREQUENCY DRIVE
 MBD - MANUAL BALANCE DAMPER

1 AIR-SIDE CONTROL P&ID (PLENUM)
SCALE: NONE

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM

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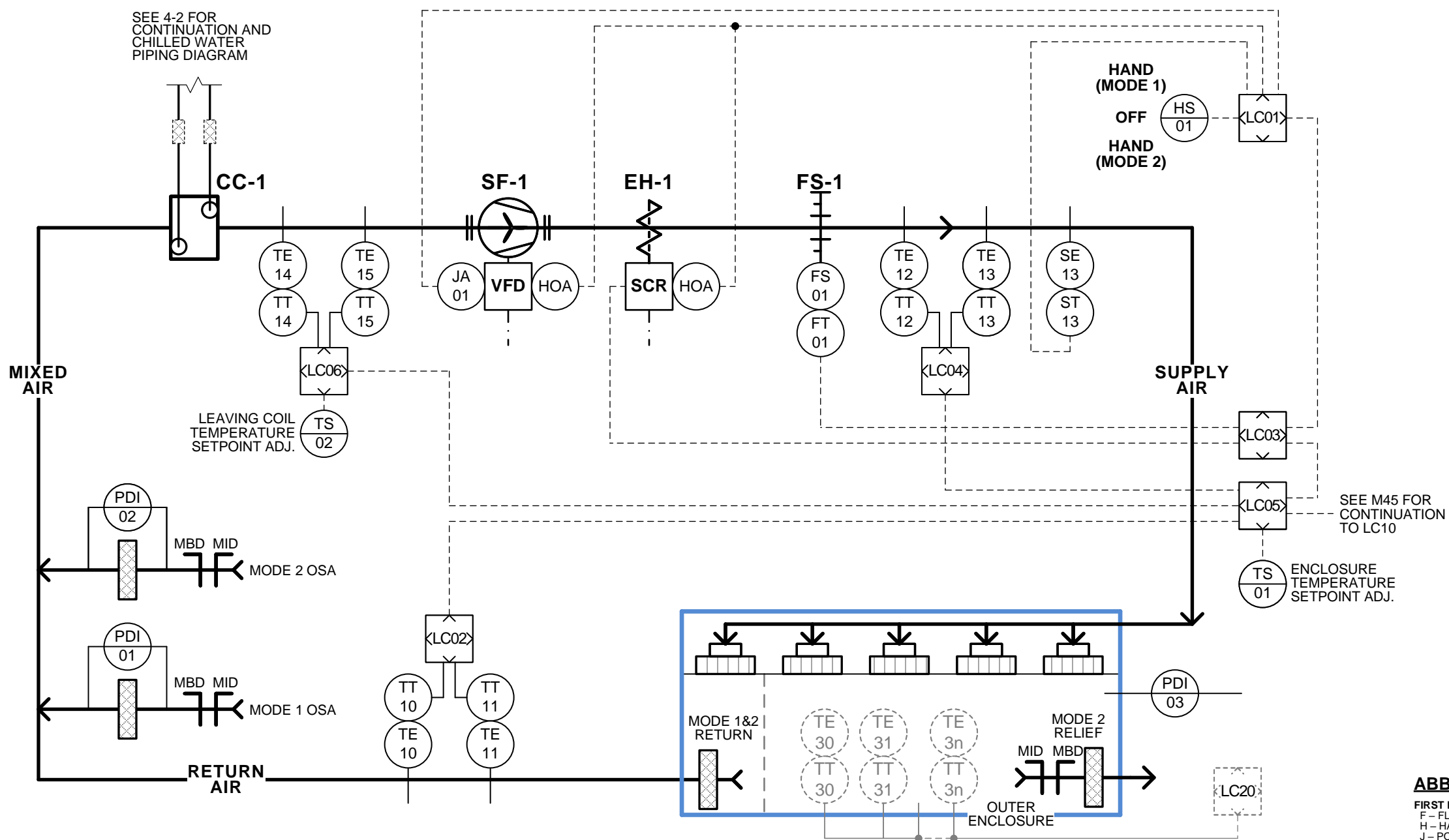
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4-1A	B

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LOGO					DGI Png.	2021110
CUSTOMER	LARGE BINOCULAR TELESCOPE CORP. ARIZONA				DATE	01/13/23
SHEET TITLE	AIR-SIDE CONTROL AND PROCESS FLOW DIAGRAM DUCTED DESIGN				CHECKED	PVDM
PROJECT NAME	ILOCATER - HVAC SUPPORT SYSTEMS				DRAWN	PVDM
SCALE	AS INDICATED				DESIGNED	PVDM
ORIGINAL SIZE	ANSI B					



ABBREVIATIONS

- FIRST LETTER:**
 F - FLOW
 H - HAND
 J - POWER
 L - LOGIC
 P - PRESSURE
 S - SMOKE
 T - TEMPERATURE
 Z - POSITION
- SECOND AND/OR THIRD LETTER:**
 A - ALARM
 C - CONTROLLER
 D - DIFFERENTIAL
 E - ELEMENT
 I - INDICATOR
 S - SWITCH
 T - TRANSMITTER
- HOA - HAND-OFF-AUTO SWITCH
 OSA - OUTSIDE AIR
 VFD - VARIABLE FREQUENCY DRIVE
 MBD - MANUAL BALANCE DAMPER

1 AIR-SIDE CONTROL P&ID (DUCTED)
SCALE: NONE

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
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CLIENT: LARGE BINOCULAR TELESCOPE CORP. ARIZONA

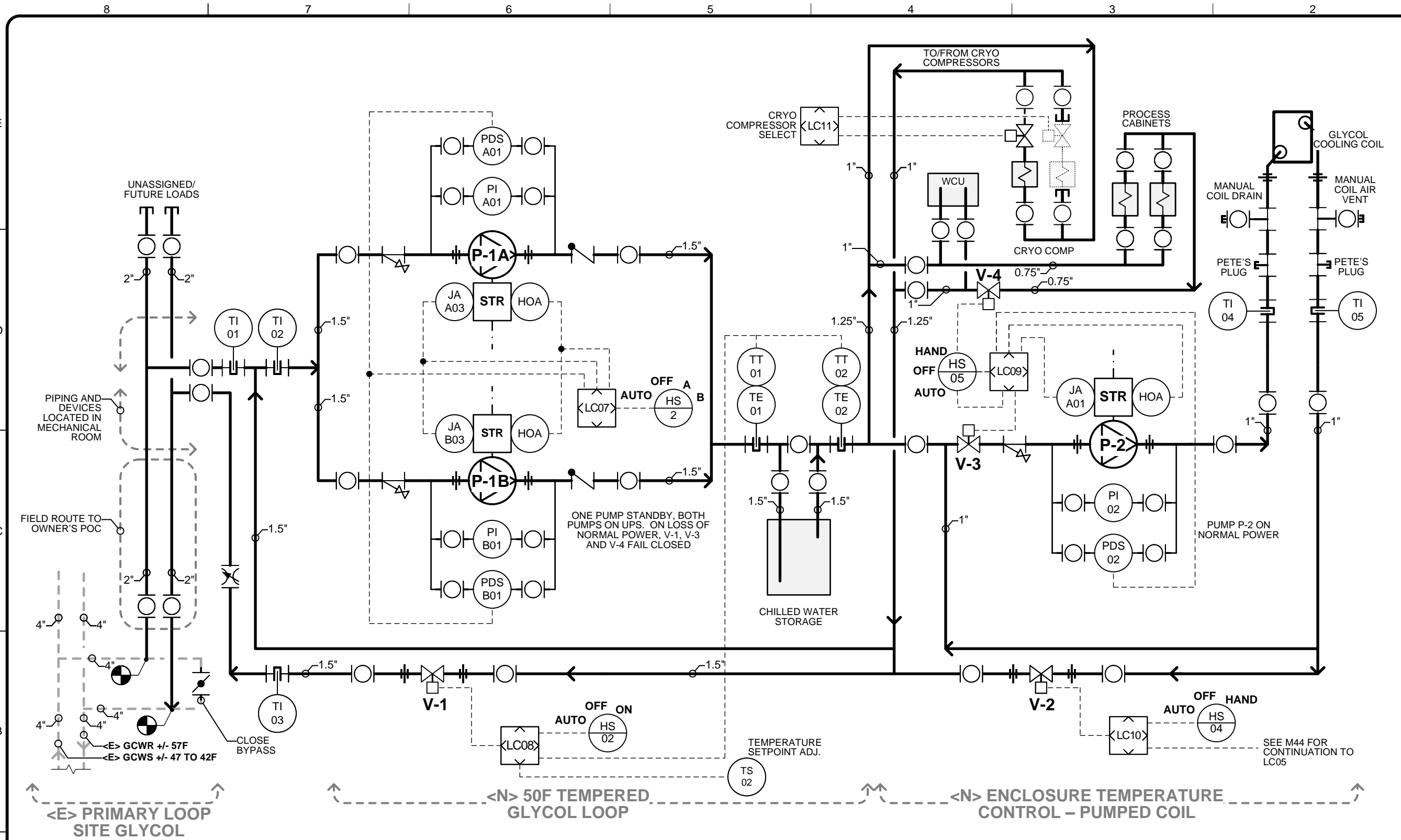
SHEET TITLE: WATER-SIDE CONTROL AND PROCESS FLOW DIAGRAM - 2-WAY VALVES

PROJECT NAME: ILOCATER - HVAC SUPPORT SYSTEMS

SCALE: AS INDICATED

LOGO	DATE	CHECKED	DRAWN	DESIGNED	ORIGINAL SIZE
	01/13/23	PVDM	PVDM	PVDM	ANSI B

DGI Png.: 2021110



1 WATER-SIDE CONTROL P&ID - 2 WAY

SCALE: NONE

ABBREVIATIONS

- FIRST LETTER:**
 H - HAND
 J - JUNCTION
 P - POWER
 T - TEMPERATURE
 Z - POSITION
- SECOND AND/OR THIRD LETTER:**
 A - ALARM
 C - CONTROLLER
 D - DIFFERENTIAL
 E - ELEMENT
 I - INDICATOR
 S - SWITCH
 T - TRANSMITTER
- HOA - HAND-OFF-AUTO SWITCH
 OSA - OUTSIDE AIR
 VFD - VARIABLE FREQUENCY DRIVE

PIPING LEGEND

- AUTOMATED BINARY BALL VALVE
- AUTOMATED 2-WAY CONTROL VALVE
- BALL VALVE
- BALANCING VALVE
- CHECK VALVE
- STRAINER W/ BLOWDOWN
- THERMOWELL
- POINT OF CONNECTION
- PRESSURE INDEPENDENT FLOW CONTROL
- UNION
- CAP

ALL PIPING THIS SHEET TO BE TYPE L COPPER, 1" UNLESS OTHERWISE NOTED AND INSULATED WITH 1 1/2" PREFORMED INSULATION AND ALL WEATHER JACKET.

DEVICES NEEDING MAINTENANCE TO HAVE REMOVAL BE INSULATION

TAPS INTO EXISTING PIPING MAY REQUIRE DIALECTRIC UNIONS. TAPS CAN BE SCHEDULED WITH SITE OPERATOR FOR DRAIN AND REFILL. NOTE THAT PIPE FLUID IS 40% ETHYLENE GLYCOL BY VOLUME.

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	B	03/08/24 TEAM REVIEW	PVDM

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DRAWING No. **4-2** REV. **B**

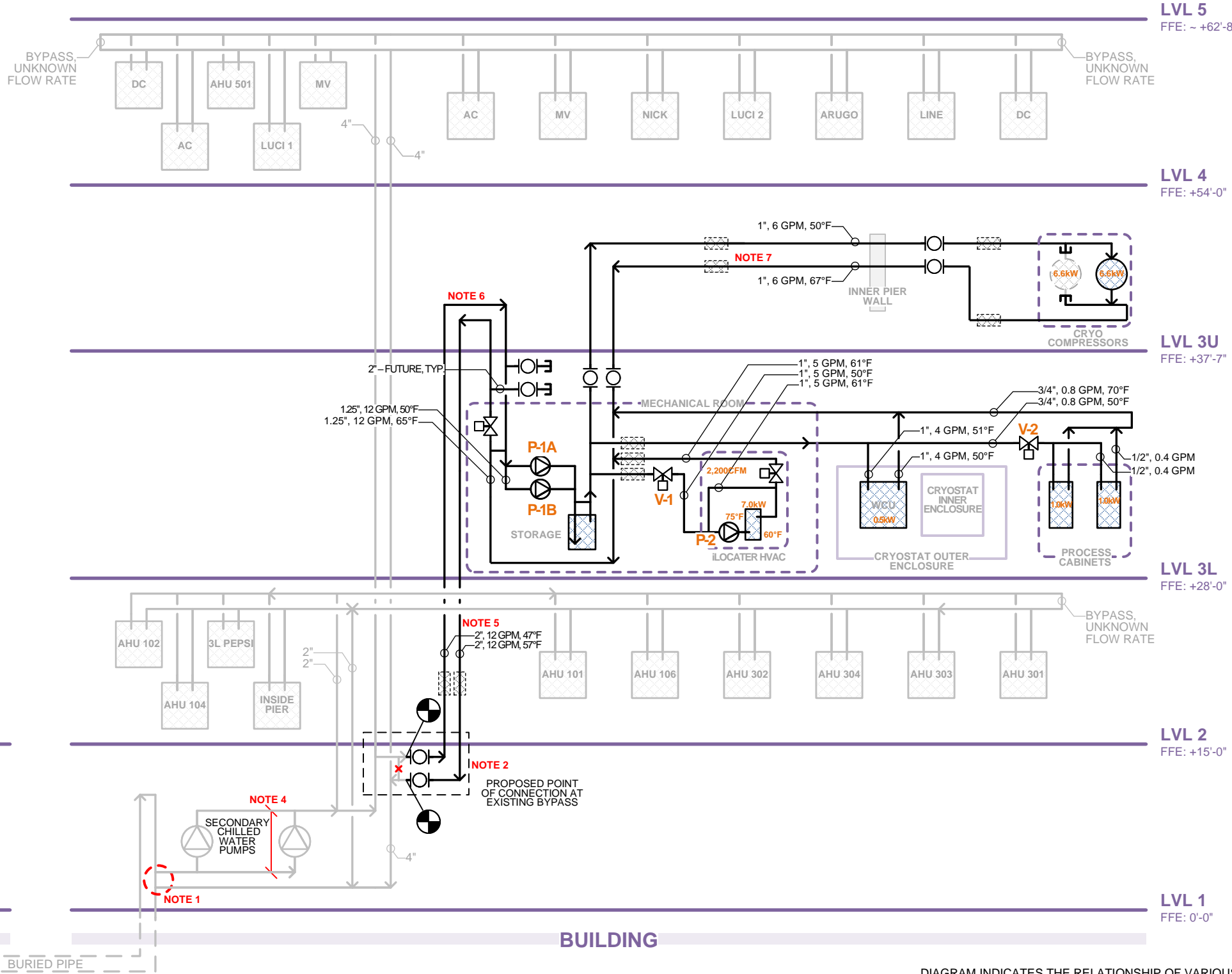
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LEGEND

- 1.5IN INSULATION W/LAGGING
- EXISTING PIPING AND EQUIPMENT
- NEW PIPING AND EQUIPMENT

NOTES

1. EXISTING PRIMARY/SECONDARY BRIDGE WITH BUTTERFLY VALVE SET TO THROTTLE (OBSERVED 3/2/21)
2. EXISTING 4 INCH BYPASS W/ISOLATION VALVES, CLOSE VALVE IN BYPASS
3. GLYCOL REPORTED TO BE DOWTHERM SR-1 ETHYLENE SITE MIXED TO 38% BY VOLUME. OPERATOR'S GOAL IS TO REDUCE CONCENTRATION TO 35% BY VOLUME WHICH FREEZE PROTECTS TO 0°F OR -18°C. CALCULATIONS ARE BASED ON 40% BY VOLUME OF DOWTHERM SR-1 INHIBITED ETHYLENE GLYCOL-BASED HEAT TRANSFER FLUID WITH A CIRCULATION TEMPERATURE OF 50°F, SPECIFIC HEAT OF 0.821 BTU/LB °F AND A SPECIFIC VOLUME OF 0.015 FT³/LB.
4. OBSERVED 3/2/21: SUCTION PRESSURE = 31PSIG, DISCHARGE PRESSURE = 89PSIG
5. PIPING INSTALLED VERTICALLY FROM POINT OF CONNECTION IN LEVEL 1 THROUGH LEVEL 2 TO ABOVE LEVEL 3U BY OWNER PRIOR TO ENCLOSURE INSTALL.
6. PIPING ROUTED HORIZONTALLY ABOVE LEVEL 3U ON INSIDE SURFACE OF PIER PRIOR TO ENCLOSURE INSTALL.
7. PIPING ROUTED HORIZONTALLY FROM MECHANICAL ROOM TO ABOVE LEVEL 3U ON INSIDE SURFACE PIER, THEN THROUGH PIER TO FUTURE CRY-COMPRESSOR LOCATION PRIOR TO ENCLOSURE INSTALL. OUTER PIER PIPING INSTALLED AS FITUP AT A FUTURE DATE.



1

PARTIAL 50F CHILLED GLYCOL WATER DIAGRAM

SCALE: NONE

DIAGRAM INDICATES THE RELATIONSHIP OF VARIOUS COMPONENTS AND PIPE TAKEOFFS AND, WHERE AVAILABLE, PIPE SIZES. THIS DIAGRAM IS NOT TO SCALE, BUT GENERALLY INDICATES WHAT FLOOR OR PLATFORM LEVEL EQUIPMENT IS LOCATED. ISOLATION VALVES SHOWN ARE THOSE REQUIRED FOR PHASING. SEE P&ID FOR ADDITIONAL VALVES AND CONTROL DEVICES.

CLIENT: LARGE BINOCULAR TELESCOPE CORP. ARIZONA

SHEET TITLE: PARTIAL 47F GLYCOL CHILLED WATER DIAGRAM

PROJECT NAME: ILOCATER - HVAC SUPPORT SYSTEMS

SCALE: AS INDICATED

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM

DATE: 0113/23
CHECKED: PVDM
DRAWN: PVDM
DESIGNED: PVDM
ORIGINAL SIZE: ANSI B

DATE: 0113/23
CHECKED: PVDM
DRAWN: PVDM
DESIGNED: PVDM
ORIGINAL SIZE: ANSI B

DATE: 0113/23
CHECKED: PVDM
DRAWN: PVDM
DESIGNED: PVDM
ORIGINAL SIZE: ANSI B

DATE: 0113/23
CHECKED: PVDM
DRAWN: PVDM
DESIGNED: PVDM
ORIGINAL SIZE: ANSI B

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DATE: 09/30/23
EXPIRES: 09/30/23

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Sequence of Operation and Control

General

An engineered environment has been designed to enclose instrumentation at a remote and often unattended facility. The environment can operate in two different modes, Mode 1; intended to control temperature within specified limits and rates of change, and Mode 2; intended to meet air cleanliness goals during instrument maintenance. Control devices, control logic, system and sensor monitoring, reporting and human machine interfaces are required to meet the requirements summarized in the sequences of operation and control. Furthermore, some system components are provided to afford some redundancy and are to be exercised periodically to confirm operation and equalize run times.

Scope

Provide all new programming, human machine interface (HMI) and necessary graphics for manual and automatic operation of temperature, fan and pump control in two modes of system operation as described below. Control systems and software is to be dedicated, self-contained and not reliant or dependent upon other systems in use at the telescope. Control and reporting systems are to be powered by an uninterruptible power source sized for 12 hours at 120% of a highest demand load. Control system front end is to be available locally at an HMI and functionally duplicated through a secure interface allowing credentialed users access to set point adjustment, all monitoring functions, event logs, temperature logs, control system and device status and alarm annunciation at remote locations. Additionally, the front end shall provide 500 days of local storage of event and temperature logs in the occasion of network failure and alarm notification and acknowledgement.

Mode 1 – General Description:

Mode of normal operation. Mode is constant volume, intended to meet temperature specifications inside the outer enclosure of 75°F (adjustable) with a +/- 0.5°F drift over a period of 1 year. A single fan, cooling coil and electric heating section are provided. Any redundant components are to be stored locally and swapped out when an element failure is detected. Fan volume will be adjusted at the fan VFD to provide approximately 200 cfm/filter or approximately 25 ft/min, 1,000 cfm total. Supply air passes through an electric heating section and ducted to HEPA filters serving the controlled space. Return air passes through a nominal 30% filter, then over multiple temperature sensors TE10 and TE11 providing feedback of space temperature to the electric resistance heating section, a glycol cooling coil and across multiple temperature sensors TE12 and TE13 providing feedback to the cooling coil setpoint. Outside air for pressurization is provided at the common return air path. Space will be manually balanced with a constant makeup to obtain 0.05 inch water column differential between the enclosure and ambient air outside the enclosure.

Mode 2 – General Description:

Operating mode during iLocater and/or WCU maintenance or calibration. Mode is intended maintain an ISO Class 7 environment but not necessarily any temperature control. The outer enclosure will remain assembled and all but the inner enclosure wall nearest the pedestal (plan north) will or can be disassembled (3 walls, roof and floor). Two gowned occupants are assumed to occupy the space and gain access through a permanent personnel door in the outer enclosure. Supply air system operates to provide circulation air to five (5) HEPA filters operating at 400 cfm or about 50 ft/min. Outer enclosure is assumed to be near air-tight construction. A nominal 1,800 cfm of return air from the enclosure will be mixed with a nominal 200 cfm of OSA to produce 2,000 cfm of supply air to the HEPA filters. Relief air will be to ambient via a dedicated path the includes filtration. Space will be balanced to obtain 0.05 inch water column differential between the enclosure and ambient air outside the enclosure.

System Select:

Two basic mechanical systems are needed to operate in Mode 1 or Mode 2

- air side components consisting of a fan, electric heat and glycol chilled water coil which utilizes hand switch 1 (HS01) to assign Hand Mode 1, Hand Mode 2 or Off functions and
- water side components consisting of tertiary loop glycol chilled water pumps (nominal 50F glycol loop) which utilizes hand switch 02 (HS02) to assign hand, off and automatic functions and pumped coil pump (AHU cooling coil) which utilizes hand switch 3 (HS03) to assign hand, off and automatic functions, both as described below.

Manual selector switch HS01 selects air side duct options and can be placed in one of three (3) positions. All HS-01 position selections are reported to the system status monitoring software and HMI.

- Off:** Deenergizes all components of the system including power to fans and electric heat.
- Mode 1:** Selection of mode 1 shall signal SF-1 VFD to operate at 1,000 cfm (adjustable) as measured at flow station FS-1. Failure of fan to operate, either as detected by current alarm (JA-01) or internal VFD fault detection (phase loss, over current, low voltage, no voltage, etc.) as a VFD output or by failure to meet flow station setpoint (FS-1) +/- 5% within 10 seconds (adjustable) shall de-energize fan and send an alarm signal to the HMI. No fault conditions reported within the time limit shall send a confirmation signal to the HMI of fan start.
- Mode 2:** Selection of mode 2 shall signal SF-1 VFD to operate at 2,000 cfm (adjustable) as measured at flow station FS-1. Failure of fan to operate, either as detected by current alarm (JA-01) or internal VFD fault detection (phase loss, over current, low voltage, no voltage, etc.) as a VFD output or by failure to meet flow station setpoint (FS-1) +/- 5% within 10 seconds (adjustable) shall de-energize fan and send an alarm signal to the HMI. No fault conditions reported within the time limit shall send a confirmation signal to the HMI of fan start.

Manual selector switch HS02 selects tertiary pump options and can be placed in one of four (4) positions. This loop is intended to control the glycol chilled water from the secondary site loop at 42-47F to an entering tertiary loop temperature of 50F, adjustable (TS-02), at the HMI. All HS-02 position selections are reported to the system status monitoring software and HMI.

- Off:** Deenergizes both tertiary pumps (P-1A and P-1B) and deenergizes valve V-1 to fail to a closed position.
- A:** Forced selection of tertiary loop pump P-1A. Upon selection, pump P-1A shall start and loop control valve V-A1 shall be energized to operate in any mode selected at HS-03.
- B:** Forced selection of tertiary loop pump P-1B. Upon selection, pump P-1B shall start and loop control valve V-A1 shall be energized to operate in any mode selected at HS-03.
- Auto:** Normal position of selector switch HS02. In auto position, the control system shall determine lead/lag assignment of pump based on accumulated hours of operation, alternate starts or calendar scheduling (selectable at HMI). Lead/lag selection made at the HMI, HS-002 placed in Auto, lead position tertiary loop pump shall start, control valve V-1 shall be permitted to operate in any mode selected at HS-03. On a detected failure of the lead pump (detected pressure differential switch PDSx01 after 5 seconds (adjustable at HMI)), the lead pump shall be deenergized and lag pump shall be energized. On failure of either lead or lag pumps, an audible local system alarm annunciator shall be energized at the HMI and a remote alarm notice transmitted to the network including the time, date and nature of the failure logged.

Manual selector switch HS04 selects pumped coil loop pump options and can be placed in one of three (3) positions. This loop is intended to maintain a constant flow rate of glycol chilled water through AHU cooling coil CC-1, regardless of actual energy transfer, thereby minimizing leaving air temperature stratification. All HS-04 position selections are reported to the system status monitoring software and HMI.

- Off:** Deenergizes pump P-2 and deenergizes valve V-2 to fail to a closed position.
- Hand:** Forced selection of loop pump P-2. Upon selection, pump P-2 shall start and loop control valve V-2 shall be energized to operate in any mode selected at HS-05.
- Auto:** Normal position of selector switch HS04. In auto position, pump operation shall be managed by the control system and HMI. On a detected failure of the pump (detected pressure differential switch PDS-02 after 5 seconds (adjustable at HMI)), pump shall be deenergized and an audible local system alarm annunciator shall be energized at the HMI and a remote alarm notice transmitted to the network including the time, date and nature of the failure logged.

Manual selector switch HS05 allows manual positioning and automatic positioning of the pumped glycol chilled water control valve V-2 regulating loop bypass, thereby maintaining leaving air temperature at CC-1 and can be placed in one of three (3) positions. All HS-05 position selections are reported to the system status monitoring software and HMI.

- Off:** Deenergizes valve V-2, failing to a closed position.
- Hand:** Forced control of V-2, allowing local positioning from full closed to full open positions.
- Auto:** Normal position of selector switch HS05, providing automatic positioning of V-2 via PID control. On a rise in average temperature at TE-12 and TE-13 above setpoint established at TS-02 (nominal 72F, adjustable at HMI), V-2 shall modulate towards an open position to maintain setpoint. On a fall in average temperature at TE-12 and TE-13 from setpoint established at TS-02, V-2 shall modulate towards a closed position to maintain setpoint. On a failure to meet or maintain +/- 1F (adjustable at HMI) setpoint a remote alarm notice shall be transmitted to the network including the time, date and nature of the failure logged.

Manual positioning of HS-01, HS-02, HS-03, HS-04 and HS-05

When switching between positions, no control action shall be executed for 10 seconds (adjustable at the HMI). Position selection status shall be reported to the system status monitoring software immediately.

System Start – Mode 1 - Fan

All permissives met (normal power, control systems operational, smoke detector clear), HS-01 set to Mode 1 and Fan SF-1 local HOA set in Auto position, SF-1 shall start and maintain Mode 1 volume setpoint. Fan shall prove start by achieving setpoint flow volume (adjustable at HMI) as measured at FS-1 of +/- 5% within 10 seconds (adjustable). Failure of SF-1 to meet and maintain flow setpoint within time limits or internal VFD fault detection (phase loss, over current, low voltage, no voltage, etc.) as a VFD output shall de-energize fan and send a first failure to start alarm signal to the HMI, recorded with time and reason for failure. After a time-out period of 30 seconds (adjustable at HMI) the above sequence shall be reinitiated. Should SF-1 fail to start a second time, SF-1 shall be deenergized, an alarm condition for second failure to start will be transmitted to the HMI.

System Start – Mode 2 - Fan

All permissives met (normal power, control systems operational, smoke detector clear), HS-01 set to Mode 2 and Fan SF-1 local HOA set in Auto position, SF-1 shall start and maintain Mode 2 volume setpoint. Fan shall prove start by achieving setpoint flow volume (adjustable at HMI) as measured at FS-1 of +/- 5% within 10 seconds (adjustable). Failure of SF-1 to meet and maintain flow setpoint within time limits or internal VFD fault detection (phase loss, over current, low voltage, no voltage, etc.) as a VFD output shall de-energize fan and send a first failure to start alarm signal to the HMI, recorded with time and reason for failure. After a time-out period of 30 seconds (adjustable at HMI) the above sequence shall be reinitiated. Should SF-1 fail to start a second time, SF-1 shall be deenergized, an alarm condition for second failure to start will be transmitted to the HMI.

System Stop

HS-01 set to Off position or commanded off at the HMI, SF-1 shall be deenergized and electric heating elements deenergized.

Loss of Power

No control action shall be executed for a minimum of 10 seconds (adjustable) while waiting for an intermittent transient to pass. After 10 seconds, the control system shall allow automated valves V-1, V-3 and V-4 via LC09 to fail closed and an alarm condition transmitted to the HMI. When power is restored, start sequences shall proceed automatically from the most recent system select switch position as described elsewhere. Sufficient uninterruptible power (UPS) shall be provided the control system to continue to log temperatures at 0.1 hour intervals (6 minutes) and maintain system integrity for a period of 12 hours minimum. Supply fan, electric resistance heating, and automated valve operation are not part of the UPS load.

Outer Enclosure Temperature Control

TE14 and TE15 located in the leaving air stream of the cooling coil shall be either selected individually at the HMI or averaged via logic controller LC06 to obtain the measured leaving air temperature downstream of the glycol cooling coil. This value shall be compared with setpoint TS02 at LC06. On a call to lower temperature as measured by TE14 and/or TE15 to meet setpoint, control valve V-2 shall modulate toward an open position under PID control. On a call to raise temperature as measured by TE14 and/or TE15 to meet setpoint, control valve V-2 shall modulate toward a closed position under PID control to meet setpoint. Setpoint shall be chosen to allow up to 2F of subcooling to be made up by EH-1. TE10 and TE11 located in the return air path from the outer enclosure shall be either selected individually at the HMI or averaged via logic controller LC02 to obtain the measured outer enclosure temperature, herein referred to enclosure temperature. Similarly, TE12 and TE13 located in the leaving air stream shall be either selected individually at the HMI or averaged via logic controller LC04 to obtain the measured leaving air temperature downstream of fans, electric resistance heaters and cooling coil, herein referred to as supply air temperature. HS-01 set to Mode 1, Mode 2 or Auto and supply fan SF-1 energized, fan flow proven via flow elements FS-1, enclosure temperature at LC02 shall be compared with enclosure temperature set point (nominal 75F with adjustable range of +/- 5F) selected at TS01 and used to reset the PID loop variables of the fast loop at LC04 (leaving air temperature) to sequence the electric heating elements via LC03 to meet set point. On a rise in temperature at LC02, EF-1 controllers shall sequence to reduce output using PID control and on a drop in temperature at LC02, EF-1 controllers shall sequence to increase output using PID control.



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							01/13/23	PVDM	PVDM	PVDM	PVDM	AS INDICATED	2021110

REV.	NO.	DATE / DESCRIPTION	BY / CHK
A	1	02/02/24 PRESENTATION	PVDM
B	1	03/08/24 TEAM REVIEW	PVDM

FOR CONTINUATION, SEE THIS SHEET

SEAL

DGI Png.: 2021110, EXPIRES: 09/30/23

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5-1	B

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Sequence of Operation and Control

DeMARS GROUP, INC.
Engineering + Architecture + Planning
Tucson + Phoenix + San Francisco



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Tertiary Glycol Loop Temperature Control

Control valve V-1 is provided in the tertiary loop to meet a constant leaving water temperature setpoint of 50F (adjustable at the HMI) to prevent condensation at the glycol cooling coil and other devices connected to the cooling system. HS-02 set to Auto position, control system shall determine lead/lag assignment of pumps P-1A and P-1B based on accumulated hours of operation, alternate starts or calendar scheduling (selectable at HMI) and lead pump shall start any time HS01 is in any position other than Off. Control valve V-1 shall receive the same input from LC08 and shall modulate the control valve to maintain set point temperature in the tertiary glycol loop, nominally 50F, adjustable at the HMI. On a failure to maintain setpoint within tolerance (+/-2F adjustable at the HMI), the lead pump shall be deenergized and the lag pump placed into lead position and the condition logged at the HMI. Further failure to maintain setpoint shall generate an alarm at the HMI, logging the condition.

Notes **

AHU duct smoke detection is normally required by NFPA 90A for systems greater than 2,000 cfm. This system is at that threshold for fan volume. However, there is an exception where the air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space where the smoke is generated. That said, the University, its insurers, and/or the safety oversight team may require the system anyway given conditions of remote access. Open for discussion.

Pumped Coil Glycol Loop Temperature Control

Control valve V-2 is provided in the pumped coil loop to meet a setpoint established at the HMI, nominally 2F (adjustable) below the temperature required to meet the outer enclosure temperature setpoint. HS-03 set to Auto position, control system shall be in control any time HS01 is in any position other than Off. Control valve V-2 shall receive input from LC10 and shall modulate the control valve satisfy the output of LC05. On a failure to maintain setpoint within tolerance (+/-2F adjustable at the HMI), an alarm condition shall be logged at the HMI.

Safeties and Permissives

Electric resistance heating element EH-1 shall be enabled only if supply fan SF-1 is energized and proven operational via duct mounted flow station FS-1. Fan FS-1 shall be deenergized on detection of smoke be smoke detector in supply duct.

AHU Smoke Detection **

On detection of smoke by detector in supply air duct, SF-1 shall be deenergized, an alarm condition sent to the building fire alarm panel and to the HMI. Restart of the AHU shall first require manual reset of the detector and the alarm conditions at the building fire alarm pane and the HMI.

Enclosure Pressure Control

Space pressure control shall be entirely manual; outside air flow set to achieve approximately 0.05 inches of water column. Orifice plate with pressure differential indicator and a manual balance damper are provided to assist in achieving the differential pressure desired. Note that this adjustment will need to be revised when transitioning between Mode 1 and Mode 2 operations.

Alarms

The following alarms shall be reported, along with time:

- Fan SF-1: fault detected at VFD (over current, under voltage, VFD fault, loss of power)
- Fan SF-1: failure to reach minimum air volume measured at FS-1
- Out of temperature range level 1 as reported by TE10 and/or TE11, nominal 75F+/- 0.2F
- Out of temperature range level 2 as reported by TE10 and/or TE11, nominal 75F+/- 0.4F
- Out of temperature setpoint tolerance for secondary glycol chilled water loop (LC08).
- Presumed pump or control valve failure for tertiary glycol chilled water loop (LC07, LC08).
- Presumed pump or control valve failure for pumped coil glycol chilled water loop (LC09, LC10).
- Smoke detection in AHU supply duct **

Alarm silence and reset shall be logged with time and a field for ID of person responding and taking corrective action.

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SHEET TITLE	PROJECT NAME				CHECKED	
	SEQUENCE OF OPERATION AND CONTROL				PVDM	
SCALE	DESIGNED				DRAWN	
	ANSI B				PVDM	
AS INDICATED				ORIGINAL SIZE		

REVISIONS	No.	DATE / DESCRIPTION	BY / CHK
	A	02/02/24 PRESENTATION	PVDM
	B	03/08/24 TEAM REVIEW	PVDM

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Mechanical Schedules and Notes



Supply Air Fan (CFCI)



Greenheck model SQ-12-VG operating at 2,000 cfm, 2inwc external static pressure, 2694 rpm, 1.12 bhp, USE 2.0 hp. 208/60/1 TEFC motor, 12.5 FLA, 16 MCA, 30 MOP. Complete with Variable Speed Drive

HEPA Filters – 5 Req. (CFCI)

Nominal 24" x 48" HEPA filters with 2" medial pack, 99.9995% efficient at 0.12 microns. Roomside replaceable, framed for hard ceiling. Face grill with 65% open mesh, powder coated white finish, aluminum center divider with challenge port and opening for adjusting distribution plate in collar. Aluminum housing and 14 inch collar, initial resistance to be 0.52 inwc at 610 cfm, or 0.22 inwc at 400 cfm. Maximum can height 5.5", 6.5" maximum height from face to top of collar. To include long side ducted connection AFF Flanders TH Series or approved equal.

Glycol Cooling Coil - 1 Req. (CFCI)



Coil must meet both duties:
Mode 1: 6,000 btu/hr sensible using 1,000 cfm with 75.0Fdb/54Fwb EAT, 67.6Fdb, LAT using 8.0 gpm of 40% ethylene glycol with 60F EWT, 67.6F LWT.
Mode 2: 16,000 btu/hr sensible using 2,200 cfm with 75.0Fdb/54Fwb EAT, 65.2Fdb, LAT using 8.0 gpm of 40% ethylene glycol with 60F EWT, 64.5F LWT.
Maximum airside pressure drop at 2,000 cfm of 0.2 inwc, maximum waterside pressure drop, 8 ftwc. Dimensions per drawings, nominal 48 in wide x 10 high face surface, 600 ft/min maximum face velocity.

Tertiary Circulating Pumps – 2 Req. (CFCI)



12 gpm at 20 ftwc, 120V, 1Ph, 60Hz 200W, 1.8A circulator. Grundfos Model UPS 26-99



Pump Cooling Coil Pump (CFCI)



12 gpm at 20 ftwc, 120V, 1Ph, 60Hz 200W, 1.8A circulator. Grundfos Model UPS 26-99

Prefilters – 1 Req. (CFCI)



General prefilter – Camfil Farr 30/30 or approved equal. Size as noted

In-line Filter Boxes – 3 Req. (CFCI)



HVACQuick inline filter box model IFB-8 or size as noted on the drawings, HVACQuick or approved equal



HVACQuick inline filter box model IFB-6 or size as noted on the drawings, HVACQuick or approved equal



HVACQuick inline filter box model IFB-6 or size as noted on the drawings, HVACQuick or approved equal

Electric Resistance Heat - 2 Req. (CFCI)



2 KW, 120V, 1PH, 60Hz, SCR controller with 24 volt control input, flanged connection Greenheck Model IDHE or approved equal.

Galvanized Sheet Metal (CFCI)

Gauge and supports and construction per SMACNA, provide flanged connections (Ductmate or similar) where shown on the drawings. Double thickness turning vanes in all elbows unless noted otherwise. Clean duct interior with 10% IPA prior to installation.

Duct Insulation (CFCI)

Provide 4 inches rigid ISO insulation over all ductwork on exterior of outer enclosure except for serviceable components (damper operators, controllers, filter access, etc.). Minimum R 22. Provide breakpoints in insulation so failed hardware can be removed with minimal damage to insulation.

Outer and Inner Enclosure (OFOI)

4 inch panels. Metal skin each side. Bally or approved equal. Some openings through the walls or ceilings may need to be field cut for ducts, conduit or wire/cable trays by the mechanical contractor and sealed air-tight with an expanding foam product if permanent or with closed cell removable foam if there is a need for future modification (cable tray)

Lighting Fixtures – 10 Req. (CFCI)

LED Tear drop for clean room applications. 4' length, sealed acrylic UV stabilized lens, 3500 Kelvin, 120V, 1Ph, 60Hz., 53W, 100,000 hour life. Kenall model number CTD 4 45L 35K8 DIM1 DV or approved equal.

Clean Room Strip Curtain (CFCI)

Clear PVC 8in panels, 0.08in thickness, low ESD for clean room applications, Suspend from ceiling mounted track while operating in Mode 2 only, remove while in Mode 1. Trim to 2" above outer enclosure floor. Envirobarrier or approved equal.

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		SCALE	AS INDICATED																
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