Fermilab

Particle Physics Division
Mechanical Department Engineering Note

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Project Internal Reference:

Project: NuMI

Title: ODH analysis for the refrigerant in the Trane refrigerant cooling system used for the downstream end of the decay pipe cooling system.

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Reviewer(s):

Key Words: ODH analysis, NuMI, Decay Pipe Cooling System, Refrigerant

Abstract Summary:
This is an analysis of the effects of the refrigerant (R22) being released from the refrigeration system of the NuMI decay pipe cooling system. Refrigerant releases are not planned. Likely cause of a refrigerant release is a failure of the piping or the relief valve opening.

The refrigeration system manufacture has told Lee Hammond of FESS that this system contains 50 pounds of R22. Refrigerant property data was found in an ASHRAE book Titled Thermodynamic Properties of Refrigerants. This book is in my office.

Result of this analysis is that the area remains ODH class 0.

Applicable Codes: FESHM 5064

Concentration of O2 in the Absorber Tunnel as a function of time for normal ventilation and loss of ventilation conditions with the abnormal release of Refrigerant from the Trane Chiller used for the decay pipe cooling system.

This area is ventilated by the main air handling equipment located in the MINOS service building. The MINOS HVAC equipment moves approximately 3200 cfm through the absorber access tunnel. The ductwork does not extend to the sub end of the tunnel where the Trane refrigerent chiller is located. The dead end of the absorber access tunnel (where the Trane chiller is located) is at an elevation of approximately 464 feet, the bottom of the absorber access tunnel is at an elevation of 406 feet. The total refrigerent capacity is 50 pounds of R22 per Lee Hammond of FESS. At one atmosphere and 70 F, the specific volume of refrigerant is 4.31 ft3/#. The refrigerent is heavier than air and will (if released from the refrigerator, tend to run downhill to the bottom of the absorber access tunnel. Base the volume on a tunnel 21 feet in diameter with an invert floor slab to give a cross sectional area of 260 square feet. Use the length of the tunnel near the bottom of the absorber access tunnel of 100 feet. Actual length is a couple of hundred feet as this floor extends all the way back to the near detector. Total volume is then 26000 cubic feet.

Volume of room is 26000 cubic feet 26000 ft^3
Volume of refrigerant is 50# * 4.31 ft3/# = 215.5 ft^3

O2 concentration with instant leak, perfect mixing and no ventilation = 20.82737 % oxygen

Since the oxygen concentration does not fall below 18% even with an instaneous release of the full refrigerent capacity, the ODH classification remains Class 0.

Consider finite relief valve capacity and various ventilation rates (normal, complete failure):
Assumed Relief Valve Capacity (SCFM) 100 scfm

$$f_{O2}(t) = \frac{0.21}{Q+R} \cdot (Q + R \cdot \exp(-\frac{(Q+R)}{V} \cdot t)) \cdot 100\%$$

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room Vent rate Q, cfm	Normal Spill Rate R, cfm	Room Volume V, cf
3200	100	26000

Just enter Q, R, V and see the O2(t)

Concentration, O2 % at (time = 2 minutes) when refrigerent is all released = 20.8573

This does not cause an ODH condition since the oxygen concentration remains above 18%

* O2 as a f(t) for the release of refrigerent in the NuMI Mechanical Support Room

t, min	t, hrs	t, days	C, %
0	0	0	21.00
1	0.02	0.00	20.92
2	0.03	0.00	20.86

Complete Loss of Ventilation:

Room Vent rate Q, cfm	Normal Spill Rate R, cfm	Room Volume V, cf
0	100	26000

Just enter Q, R, V and see the O2(t)

Concentration, O2 % at (time = 2 minutes) when refrigerent is all released = 20.8391

This does not cause an ODH condition since the oxygen concentration remains above 18%

* O2 as a f(t) for the release of refrigerent in the with worst case ventilation loss of NuMI Mechanical Support Room.

t, min	t, hrs	t, days	C, %
0	0	0	21.00
1	0.02	0.00	20.92
2	0.03	0.00	20.84

Conclusion, the presence of the ventilation and the finite relief valve refrigerent release rate results in marginally higher oxygen concentrations than predicted by the simple (no ventilation, instant release) case. ODH classification remains class 0.

ABBREVIATIONS

AAV	AUTOMATIC AIR VENT
ABV	ABOVE
AC	AIR CONDITIONING
ACU	AIR CONDITIONING UNIT
AD	ACCESS DOOR
ADJ	ADJUSTABLE FLOOR
AHU	AIR HANDLING UNIT
AI	AIR INTAKE
AL	ACOUSTICALLY LINED
ALUM	ALUMINUM
AMU	AIR MAKE-UP UNIT
AP	ACCESS PANEL
APD	AIR PRESSURE DROP
ATT	ATTENUATOR
AV	AIR VENT
B	BOILER
BC	BALANCING COCK
BFV	BUTTERFLY VALVE
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BOS	BOTTOM OF STEEL
BOT	BOTTOM
BTU(H)	BRITISH THERMAL UNIT(HOUR
BV	BALL VALVE
CAP	CAPACITY
CC	CHILLED COIL
CFM	CUBIC FEET PER MINUTE
CH	CHILLER
CLG	CEILING
COND	CONDENSER
CONN	CONNECTION
CONTR	CONTRACTOR
CO	CONDUIT SETTER
CT	COMPRESSION TANK
CV	CHECK VALVE
DBT	DRY BULB TEMPERATURE
DET	DETAIL
DC	DOUBLE CABLE
DIA	DIAMETER
DIFF	DIFFUSER
DN	DOWN
DPR	DAMPER
DPT	DEW POINT TEMPERATURE
DWW	DOMESTIC HOT WATER
DX	DIRECT EXPANSION COIL
DWG	DRAWING
DX	DIRECT EXPANSION
EA	EXHAUST AIR
EAG	EXHAUST AIR GRILLE
EAR	EXHAUST AIR REGISTER
EAT	ENTERING AIR TEMPERATURE
EAV	EXHAUST AIR VENT
EBS	ENTERING DRY BULB
EDH	ELECTRIC DUCT HEATER
EF	EXHAUST FAN
EHC	ELECTRIC HEATING COIL
EJ	EXPANSION JOINT
EL	ELEVATION
ESP	EXTERNAL STATIC PRESSURE
EWB	ENTERING WET BULB
EWT	ENTERING WATER TEMPERATURE
EUH	ELECTRIC UNIT HEATER
FWT	ENTERING WATER TEMPERATURE
F	FAN
FAT	FLOAT AND THERMOSTATIC
FAT	FINAL AIR TEMPERATURE
FC	FAN COIL UNIT
FCO-1	FOOD CLEAN-OUT/SINK
FD-1	FLOOR DRAIN/SINK
FCU	FAN COIL UNIT
FHV	FIRE HOSE VALVE
FL	FLOOR
FLA	FULL LOAD AMPS
FO	FLUSH OVERHEAD
FOB	FLAT ON BOTTOM
FOT	FLAT ON TOP
FPW	FIRE PROTECTION WATER
FRP	FIBER REINFORCED PLASTIC
FT	FOOT/FEET
FTHD	FEET OF HEAD
GA	GAUGE
GPM	GALLONS PER MINUTE
GR	GRILLE
GRND	GROUND
H	HUMIDIFIER
HC	HEATING COIL
HD	HEATING COIL
HP	HORSE POWER
HPU	HEAT PUMP UNIT
HTG	HEATING
HVAC	HEATING, VENTILATION & AIR CONDITIONING
HV	HEATING AND VENTILATING UNIT
HWC	HOT WATER COIL
HX	HEAT EXCHANGER
HZ	HERTZ
IA	INSTRUMENT AIR
INV	INVERTED ELEVATION
IRM	INNER RUNWAY
IS	INCHES
IN WG	INCHES WATER GAGE
KW	KILOWATT
LAT	LEAVING AIR TEMPERATURE
LAV	LAVATORY/WASHER
LBS	POUNDS
LDB	LEAVING DRY BULB
LPC	LOW PRESSURE CONDENSATE
LRA	LOCKED ROTOR AMPS
LWB	LEAVING WET BULB
LWT	LEAVING WATER TEMPERATURE
MAX	MAXIMUM
MIN	MINIMUM
MBD	MANUAL BALANCING DAMPERS
MBF	1000 BTU/HR
MBH	1000 BTU/HR
MC	MOTOR COLLAR
MVD	MANUAL VOLUME DAMPER
NA	NOT APPLICABLE
NC	NORMALLY CONTACT
NE	NOT ENGAGED
NLC	NORMALLY CLOSED
NTS	NOT TO SCALE
NO	NUMBER
N.O.	NORMALLY OPEN
OA	OUTDOOR AIR
OAT	OUTDOOR AIR TEMPE
OBD	OPPOSED BLADE DAMPER
OC	OVERFLOW
OD	OUTSIDE DIAMETER
OVERHD	OVERHEAD
P	PUMP
PD	PRESSURE DROP
PG	PURGE FAN
PH	PHASE
PHC	PREHEAT COIL
PPH	POUNDS PER HOUR
PRV	PRESSURE REDUCING VALVE
PSIG	POUNDS PER SQUARE INCH GAUGE
PSV	PRESSURE/SAFETY VALVE
QTY	QUANTITY
RA	RETURN AIR
RAD	RETURN AIR DAMPER
RAG	RETURN AIR GRILLE
RAD	RETURN AIR DIFFUSER
RAR	RETURN AIR REGISTER
RED	REDUCER
REG	REGISTER
RF	RETURN FAN
RLC	ROOM LOW COIL
RPM	ROTOR LOCK AMPS
RPM	REVOLUTIONS PER MINUTE
RV	RELIEF VENT
SA	SUPPLY AIR
SAD	SUPPLY AIR DIFFUSER
SAG	SUPPLY AIR GRILLE
SAR	SUPPLY AIR REGISTER
SP	SUMP PUMP
SENS	SENSIBLE HEAT
SF	SUPPLY FAN
SHT	SHEET
SPEC	SPECIFICATIONS
SQFT	SQUARE FEET
SS	STAINLESS STEEL
STRUCT	STRUCTURAL
SYS	SYSTEM
TD	TEMPERATURE DIFFERENCE
TOD	TOP OF DUCT
TOP	TOP OF PIPE
TOS	TOP OF STEEL
TP	TOP OF PIPE
TSP	TOTAL STATIC PRESSURE
TYP	TYPICAL/TYPE
UC	UNDERCUT
UH	UNIT HEATER
UN	UNLESS NOTED
V	VACUUM, VOLT
VAV	VARIABLE AIR VOLUME UNIT
VD	VOLUME DAMPER
VEL	VELOCITY
WBT	WET BULB TEMPERATURE
WC	WATER COLUMN
WG	WATER GAGE
WPD	WATER PRESSURE DROP
WS	WATER SENSOR
W/	WITH
W/O	WITHOUT
WT	WEIGHT
ΔT	TEMPERATURE DIFFERENCE
ΔP	PRESSURE DIFFERENCE

SYMBOLS

- FLEXIBLE CONNECTION
- FLOW DIRECTION
- EXHAUST FAN
- MAKE-UP AIR UNIT
- 3.3-102 | 5-9-7 — WORK UNDER SEPARATE SUB-CONTRACTS
- REVISIONS
- SECTION DESIGNATION (LETTER) — DRAWING NUMBER ON WHICH SECTION IS SHOWN
- SECTION — SCALE — SECTION DESIGNATION (LETTER) — DRAWING NUMBER ON WHICH SECTION IS CALLED OUT
- DETAIL — SCALE — DETAIL DESIGNATION (NUMBER) — DRAWING NUMBER ON WHICH DETAIL IS SHOWN
- SHEET RELATED PLAN — SHEET RELATED PLAN IS DRAWN ON
- FD — FIRE DAMPER
- SD — FIRE / SMOKE DAMPER
- VAV BOX

INSTRUMENT SYMBOLS

CENTRAL INSTRUMENT PANEL MOUNTED	HD HEAT DETECTOR	TS TAMPER SWITCH
ELECTRICAL SIGNAL	SD SMOKE DETECTOR	OS OFF HAND SWITCH
PA PULL ALARM	FS FLOW SWITCH	H HUMIDISTAT
T THERMOSTAT OR TEMPERATURE SENSOR	TI THERMOMETER	

EQUIPMENT NUMBER IDENTIFICATION

EQUIPMENT IDENTIFICATION

EF-3

- LOCATION M CONNECTIONWAY-SPACES SERVED BY MINOS ACCESS SHAFT
- LOCATION T UPSTREAM-SPACES SERVED BY TARGET ACCESS SHAFT
- EQUIPMENT NUMBER (SEE EQUIPMENT LIST)
- 3 - DENOTES TYPICAL

EQUIPMENT CATEGORY IDENTIFICATION

EF	EXHAUST AIR VENTILATOR
FC	FAN COIL UNIT
IF	SUPPLY AIR VENTILATOR
EUH	ELECTRIC UNIT HEATER
EDH	ELECTRIC DUCT HEATER
VAV	VARIABLE AIR VOLUME UNIT
SP	SUMP PUMP

NOTE: SEE DWG. M-2 FOR EQUIPMENT SCHEDULES

PIPE SERVICE DESIGNATIONS

SYMBOL	SERVICE
CD	CONDENSATE DRAIN
FP	FIRE PROTECTION WATER
LCWR	LOW CONDUCTIVITY WATER RETURN
LCWS	LOW CONDUCTIVITY WATER SUPPLY
SD	SUMP PUMP DISCHARGE
SCPWR	SECONDARY COOLING POND WATER SUPPLY
SCPWR	SECONDARY COOLING POND WATER RETURN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
SCHWR	SECONDARY CHILLED WATER RETURN
SCHWS	SECONDARY CHILLED WATER SUPPLY

GENERAL SYMBOLS

GV GATE VALVE	N.O. NORMALLY OPEN	SC SAMPLE CONNECTION	UNION
GLOBE VALVE	N.C. NORMALLY CLOSED	BV BALANCING VALVE	FS FLOW SWITCH
BALL VALVE	BFV BUTTERFLY VALVE	FUTURE PIPING OR EQUIPMENT	HC HOSE OR PLASTIC TUBING CONNECTION
ANGLE VALVE	AAV AUTOMATIC AIR VENT-SEALED AIR VENT	OPEN DRAIN OR FUNNEL	
CHECK VALVE	THREE-WAY VALVE	VENT	
BACK FLOW PREVENTER	PORT INDICATING VALVE	ECCENTRIC REDUCER	
OR PIPE END WITH CAP	STRAINER	CONCENTRIC REDUCER	
FIRE HYDRANT	SPRINKLER	F.D.C. FIRE DEPT. CONN.	

UTILITIES IN TARGET SHAFT

SYSTEM	DIA.	INS.	MATL	PRESSURE RATING	PRESSURE	FLOW	TEMP
PP	4"	NO	SCH40 STL.	350 PSI	0	0	N/A
LCWS	3"	NO	SCH100 STL.	350 PSI	NOT REQ'D	45 GPM	95°F
LCWR	3"	NO	SCH100 STL.	350 PSI	NOT REQ'D	45 GPM	135°F
SCHWS	4"	1 1/2"	SCH40S STL.	150 PSI	> Δ P=15 PSI	212 GPM	50°F
SCHWR	4"	1 1/2"	SCH40S STL.	150 PSI		212 GPM	60°F
AHU-TS9-4	22"	NO	GALV. STL.	+2" WC	0.75" WC	4800 CFM / 4800 CFM	60°F MIN.
AHU-TS9-5	14"	NO	GALV. STL.	+2" WC	0.75" WC	1800 CFM	60°F MIN.

* TO BE DETERMINED BY FP SUB-CONTRACTOR

UTILITIES IN MINOS SHAFT AND ENCLOSURE

SYSTEM	DIA.	INS.	MATL	PRESSURE RATING	PRESSURE	FLOW	TEMP
PP	NOTE 1	NO	SCH40 STL.	350 PSI	NOTE 1	NOTE 1	N/A
GWR	VARIES	1"	SCH40 STL.	150 PSI	> Δ P=50 PSI	210 GPM	60°F
GWR	VARIES	NOTE 2	SCH40 STL.	150 PSI		210 GPM	80°F
SD	4" - 6"	NO	SCH40 STL.	350 PSI	N/A	450 GPM	N/A
~~SCPWR~~	~~2"~~	~~NO~~	~~SCH40 STL.~~	~~350 PSI~~	~~NOT REQ'D~~	~~21 GPM~~	~~100°F~~
~~SCPWR~~	~~2"~~	~~NO~~	~~SCH40 STL.~~	~~350 PSI~~	~~NOT REQ'D~~	~~21 GPM~~	~~80°F~~
AHU-MS9-2	28"	NO	GALV. STL.	+2" WC	1.5" WC	5600 CFM	60°F MIN.
AHU-MS9-3	30"	NO	GALV. STL.	+2" WC	1.5" WC	3600 CFM	60°F MIN.

NOTE 1: TO BE DETERMINED BY FP SUB-CONTRACTOR
NOTE 2: INSULATE RETURN PIPING WHERE NOTED ON DRAWINGS

HVAC GENERAL NOTES

1. ALL DUCTWORK SHALL BE FURNISHED AND INSTALLED IN ACCORDANCE WITH SECTION 15812 OF THE SPECIFICATIONS.
2. HVAC SUBCONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING AND INSTALLING ALL DUCTWORK, FASTENERS, REFRIGERANT TUBING, HANGERS, SUPPORTS, VIBRATION ISOLATORS, ANCHOR BOLTS, DIFFUSERS, GRILLES, REGISTERS, DAMPERS, COOLING COIL, CONDENSATE PIPING, VALVES, OPERATORS, NECESSARY LINKAGES AND FLEXIBLE CONNECTIONS.
3. HVAC SUBCONTRACTOR SHALL BE RESPONSIBLE FOR SEALING AIRTIGHT ALL DUCTWORK, AND EQUIPMENT PENETRATIONS THROUGH NEW AND EXISTING STRUCTURES.
4. INSTALLATION OF MATERIALS, EQUIPMENT, AND SYSTEMS NOT IN ACCORDANCE WITH THE PLANS, SPECIFICATIONS, AND INTENT OF DESIGNS MUST HAVE PRIOR WRITTEN APPROVAL FROM FERMILAB.
5. HVAC SUBCONTRACTOR SHALL VERIFY ALL EXISTING DIMENSIONS PRIOR TO FABRICATION, ERECTION, OR CONSTRUCTION OF EQUIPMENT & DUCTWORK.
6. LOCATE THERMOSTATS AND SWITCHES AT 4'-0" ABOVE FINISHED FLOOR, WHERE REQUIRED.
7. HVAC SUBCONTRACTOR SHALL BE RESPONSIBLE FOR START-UP AND BALANCING OF THE SYSTEM PER FERMILAB INSTRUCTION, COMPLETE START-UP, SPARE PARTS, AND TROUBLESHOOTING MANUALS FOR ALL SYSTEMS SHALL BE PROVIDED BY SUBCONTRACTOR.
8. HVAC SUBCONTRACTOR TO COORDINATE ALL WALL AND ROOF PENETRATION LOCATIONS AND SIZES.
9. HVAC SUBCONTRACTOR TO TRANSITION DUCT WORK AS REQUIRED TO FIT EQUIPMENT ACTUALLY PURCHASED.
10. HVAC SUBCONTRACTOR SHALL FURNISH ALL SUPPORT STEEL FOR HVAC EQUIPMENT, AND MISCELLANEOUS SUPPORT STEEL. SUBCONTRACTOR TO RECEIVE AND INSTALL PER MFRS. REQUIREMENTS.
11. HVAC SUBCONTRACTOR SHALL COORDINATE THE DAMPER SIZES AND INSTALL ALL DAMPERS.
12. ALL DUCTS TO BE CONSTRUCTED FOR +2" W.G. PRESSURE CLASS.

REV.	DATE	DESCRIPTIONS
1	1/31/03	REVISION 0
	9/15/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	R. WINNER	10/22/01
DRAWN	P. ABAD	10/22/01
REVIEWED	S. HOCKNAUER	10/22/01
APPROVED	M. BRAUN	10/22/01

FLUOR DANIEL GENAIS LLINES — CHICAGO, ILLINOIS

MWH MONTGOMERY WATSON HARZA

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	R. JEDZINIAK	7/24/02
CHECKED	J. SANTIS / R. BRUNTON	7/24/02
APPROVED		

FERMILAB		DATE
FINAL REVIEW	J. SHIG	01/10/02
ENG. ACCEPTED	S. CRUMPLEY	01/10/02
PERM ACCEPTED	S. HEVIN	01/10/02
SUBMITTED	R. PLUNKETT/S. BOBBIT	01/10/02

PROJECT NORTH

SCALE: NONE

PART OF PROJECT 6-7-6

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
MECH. LEGEND & GENERAL NOTES

DRAWING NO. 6-7-6 M-1 REV. 0

01 AUG. 2003

FAN COIL UNIT SCHEDULE

TAG NO.	AREA SERVED	MFR./ MODEL NO.	SUPPLY FAN					COOLING COIL								ELECTRIC HEATING COIL				REMARKS
			CFM	HP	V / Ø / HZ	FLA	ESP	MBH TOTAL	MBH SENS.	FACE AREA (SQ.FT.)	ROWS	G/PM	EWT	ΔT	PD	MBH OUTPUT	KW	FLA	ELECT. V/Ø/HZ	
FC-T-1	TARGET POWER SUPPLY ROOM	TRANE / LPC	4000	5	480 / 3 / 60	6.8	0.35	202	132	7.5	8	40.5	50°F	10	8.44' WC	108	32	38	480 / 3 / 60	6-STAGE ELECTRIC REHEAT, 2" THROW AWAY FILTER
FC-M-1	MINOS HALL	TRANE / LPC	3200	2	480 / 3 / 60	3.2	0.1	96.1	78.8	7.5	8	40.0	56°F	3.9	15.0' WC	88	26	31	480 / 3 / 60	6-STAGE ELECTRIC REHEAT, 2" THROW AWAY FILTER
FC-M-2 FC-M-3 FC-M-4 FC-M-5	MINOS HALL	McQUAY TSF121D	HI - 1180 MED - 795 LO - 587	1/4	277 / 1 / 60	HI - 3.3 MED - 2.4 LO - 1.8	0.0	22.9	16.3	N/A	N/A	13.0	55°F	3.6	46.0' WC	20	6.0	21.7	277 / 1 / 60	

POWER EXHAUST VENTILATOR SCHEDULE

TAG NO.	LOCATION	PERFORMANCE DATA		MANUFACTURER	SELECTION DATA				MOTOR DATA				REMARKS
		CFM	EXTERNAL S.P. IN. W.G.		TYPE & MODEL #	SIZE	RPM	DRIVE	HP	VOLTS	PHASE	CYCLE	ACCESSORIES PROVIDED WITH UNIT
SF-M-1	MUON ALCOVE 2	580	0.15	COOK	CENTRI - VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/8	120	1	60	INLET SCREEN
SF-M-2	MUON ALCOVE 3	580	0.15	COOK	CENTRI - VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/8	120	1	60	
SF-M-3	MUON ALCOVE 4	580	0.15	COOK	CENTRI - VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/8	120	1	60	
EF-6	MUON ALCOVE VENTILATION	720	1.25	AEROVENT	CENTAXIAL INLINE CENTRIFUGAL CDD	12	1725	DIRECT	1/2	120	1	60	
EF-1	UPSTREAM PRE-TARGET	1900	1.75	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	181XP-15	1725	BELT	1-1/2	460	3	60	
EF-2	UPSTREAM DECAY	3070 1000	0.66 0.15	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	181-10	VFD	BELT	1	460	3	60	
EF-3	DOWNSTREAM DECAY	3500	2.35	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	300XP-30	1290	BELT	3	460	3	60	
EF-4	MINOS HALL	5000 4000	3.00 2.05	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	300XP-50	VFD	BELT	5	460	3	60	
SF-T-1	CARRIER TUNNEL	1000	0.40	GREENHECK	WALL MOUNT PROPELLER FAN MODEL S1	12-432-A4	1750	DIRECT	1/4	120	1	60	INLET SCREEN, VARIABLE SPEED CONTROLLER, SUPPLY CONFIGURATION, WALL HOUSING WITH GUARD
SF-T-2	PRE-TARGET TUNNEL	1000	0.60	GREENHECK	WALL MOUNT PROPELLER FAN MODEL S1	14-536-A3	1750	DIRECT	1/3	120	1	60	INLET SCREEN, VARIABLE SPEED CONTROLLER, SUPPLY CONFIGURATION, WALL HOUSING W/O GUARD FOR DUCT CONNECTION

PUMP SCHEDULE

TAG NO.	LOCATION	PERFORMANCE DATA			SELECTION DATA			MOTOR DATA					REMARKS
		GPM	TOTAL FT. HD.	WATER TEMP.	DESIGN BASIS MANUFACTURER	TYPE	MODEL	RPM	HP	VOLTS	PHASE	CYCLE	
SP-M-1 SP-M-2	MINOS ACCESS SHAFT SUMP PIT	380	400	55° - 60° F	GOULD	SUBMERSIBLE TURBINE	V18-7CLC	3600	50	460	3	60	FLOAT CONTROLLED. SIMPLEX UNITS. EACH PUMP SHALL HAVE DEDICATED CONTROLLER. PROVIDE SEPARATE CONTROL PANEL FOR LEAD/LAG BETWEEN THE TWO PUMPS.
SP-T-1 SP-T-2	TARGET AREA SUMP PIT	40	37	65° F	FLYGT	DUPLEX SUBMERSIBLE	SS2062.170	3450	0.5	460	3	60	40S
SP-T-3	TARGET ELEVATOR PIT	5	12	65° F	FLYGT	DEWATERING PUMP	SX-2	3450	0.25	115	1	6	
SP-M-3	MINOS ACCESS SHAFT SUMP PIT	460	400	55° - 60° F	GOULD	SUBMERSIBLE TURBINE	V18 7CHC	3450	60	460	3	60	FLOAT CONTROLLED. SIMPLEX UNIT. SEE CONTROL SEQUENCE FOR SPECIAL ELECTRICAL PROTECTION
SP-M-4 SP-M-5	ABSORBER & MINOS HALL COOLING LOOP	280	214	65° F	FLYGT	SUBMERSIBLE CIRCULATOR	SS2151.011	3450	30	460	3	60	SEE CONTROL NOTE:
GWP-M1 GWP-M2	DECAY PIPE COOLING	70	180	70° F	BELL & GOSSETT	CIRCULATOR	SERIES 60 1½"x1½"x7⅞	3600	10	460	3	60	MUST BE INTERLOCKED WITH SP-M-4 & SP-M-5. GWP-M1 (OR M2) DO NOT OPERATE WHEN SP-M-4 & SP-M-5 ARE "OFF"

CONTROLS NOTES

Sequence of control for SP-M-4/SP-M-5 and GWP-M-1/GWP-M-2

1. Controller for SP-M-4 and SP-M-5 shall have a low level alarm at 24" sump depth (adjustable) and a pump shutoff sensing point at 12" sump depth. At any level above the low water cutoff the lead pump shall be enabled to run by the duplex control panel. Leading selection shall be based on run time as clocked and controlled by the duplex control panel. Leading switchover shall be accomplished by starting the lag pump and proving flow for approx. 60 seconds(adjustable) before the previously lead pump is shut off.
2. The lead pump shall be started and stopped at the control panel based on the need to provide ground water to various heat injection equipment located in the Minos underground. Run verification shall be determined by individual pressure sensors located in each pumps discharge piping upstream of the check valve. If the lead pump's discharge pressure is below 40psi (20-100psi adjustable), the lag pump shall be energized and the lead pump shall be de-energized and alarm. If neither pump produces 40psi then both pumps shall be energized and alarmed to the control panel. Auxiliary contacts in the panel shall allow for monitoring of pump status and alarms by Fermi's DDC system.
3. GWP-M-1 or GWP-M-2 (based on leading) shall be energized to run and the associated 2 position valve shall open only when SP-M-4 or SP-M-5 is running. The associated 3 way valve shall be controlled by a discharge temperature sensor located in the common discharge piping of pumps GWP-M-1 and GWP-M-2. The valve shall maintain the discharge at 60°F (adjustable). If either SP-M-4 or SP-M-5 is not running for any reason then GWP-M-1 and GWP-M-2 shall stop and the associated 2 position valve shall close.

ELECTRIC UNIT HEATER SCHEDULE

TAG NO.	LOCATION	MFR./ MODEL NO.	KW	TEMP. RISE	HEATER VOLT/Ø/HZ.	FLA	MOTOR H.P.	CFM	THROW FT.	MTG. HT. BOTTOM OF UNIT	REMARKS
EUH-T-1,2	PRETARGET TUNNEL	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-T-3,4	TARGET EXIT STAIRWELL	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-T-5	TARGET COMMON AREA	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-T-6, 7, 8, & 9	TARGET HALL	TRANE UHEC-0615C0C0	6.0	40°F	277/1/60	18.1	1/125	400	12	8'-0"	
EUH-M-1, 2 & 3	MUON ALCOVES	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-4	ABSORBER ENCLOSURE	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-5, 6, 7 EUH-M-8, 9, 10	ABSORBER ACCESS TUNNEL	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-11, 12, 13	MINOS ACCESS TUNNEL	TRANE UHEC-0515C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-14	MINOS ELEVATOR SHAFT	TRANE UHEC-0615C0C0	6.0	40°F	277/1/60	18.1	1/125	400	12	8'-0"	
EDH-T-1	TARGET EXIT PASSAGEWAY	INDEECO/TTQU	3.75	16.9°F	277/1/60	14.4	N/A	700	N/A	N/A	2 STEP CONTROL W / PANEL
EDH-M-1	MINOS EXIT PASSAGEWAY	INDEECO/TTQU	3.0	9.5°F	277/1/60	10.8	N/A	1000	N/A	N/A	2 STEP CONTROL W / PANEL

VARIABLE AIR VOLUME TERMINAL UNIT SCHEDULE

TAG NO.	LOCATION	SERVICE	TYPE	CFM FIELD SETTING	CFM RANGE		CONTROLS		INLET SIZE DIA.	MANUFACTURER AND MODEL NO.	UNIT SIZE	REMARKS
					MINIMUM	MAXIMUM	TYPE	HAND				
VAV-T-1	UPSTREAM	COMMON AREA	SINGLE DUCT PRESS. INDEPEN.	100	80	500	DDC	RIGHT	5"Ø	TITUS #DESCV-3000	5	VARIABLE AIR VOLUME TERMINAL UNIT, ACTUATOR, DIFFERENTIAL PRESSURE SENSORS AND DDC CONTROLS WILL BE FACTORY ASSEMBLED AS ONE COMPLETE UNIT.
VAV-T-2	UPSTREAM	TARGET SUPPORT ROOM		440	80	500			5"Ø		5	
VAV-T-3	UPSTREAM	SINGLE DUCT PRETARGET TUNNEL		210	80	500			5"Ø		5	
VAV-M-1	DOWNSTREAM	ABSORBER ACCESS TUNNEL		3500	580	4000			18"Ø		18	

WATER COOLED CHILLER SCHEDULE

TAG NO.	AREA SERVED	MFR. MODEL NO.	COOLING CAP. TONS REQ.	REFRIGERANT	WATER FLOW GPM	EWT °F	LWT °F	SUCTION TEMP.°F	COIL WATER TEMP.°F	COMP.	KW	EER	POWER V/Ø/HZ	RLA/ CKT.	LRA/ CKT.	REMARKS
CH M-1	DECAY PIPE COOLING	TRANE CGWE-30	22	HCFC-22	40	62	50	–	60	2	14.8	19	460/3/60	14/14	117/117	SEE NOTES

NOTE:
1. CAPACITY CONTROL TO 50% OF FULL LOAD
2. INTEGRAL MICROPROCESSOR CONTROLLER WITH MONITORING AND ALARM OUTPUTS

NOTES:

1. SEE PROJECT 6-7-5 FOR SURFACE EQUIPMENT SERVICING THE UNDERGROUND FACILITY OTHER THAN EXHAUST VENTILATORS.

REV.	DATE	DESCRIPTION
4	9/16/2003	REVISION 11
3	1/31/03	REVISION 6
2	10/11/02	CARRIER TUNNEL
1	9/19/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	S. WINSER	10/02/01
DRAWN	P. JUAS	10/02/01
REVIEWED	S. HOORNAERT	10/02/01
APPROVED	M. BRUSH	10/02/01

FLUOR DANIEL INDIA

MWH MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	R. JEDZINIAK	7/24/02
CHECKED		
APPROVED		

FERMI LAB		DATE
FINAL REVIEW	J. SHEE	01/16/02
ENG. ACCEPTED	E. CRUMPLEY	01/16/02
FERM ACCEPTED	D. REVIER	01/16/02
SUBMITTED	R. PLUNKETT/D. BOBBIT	01/16/02

SCALE: NONE

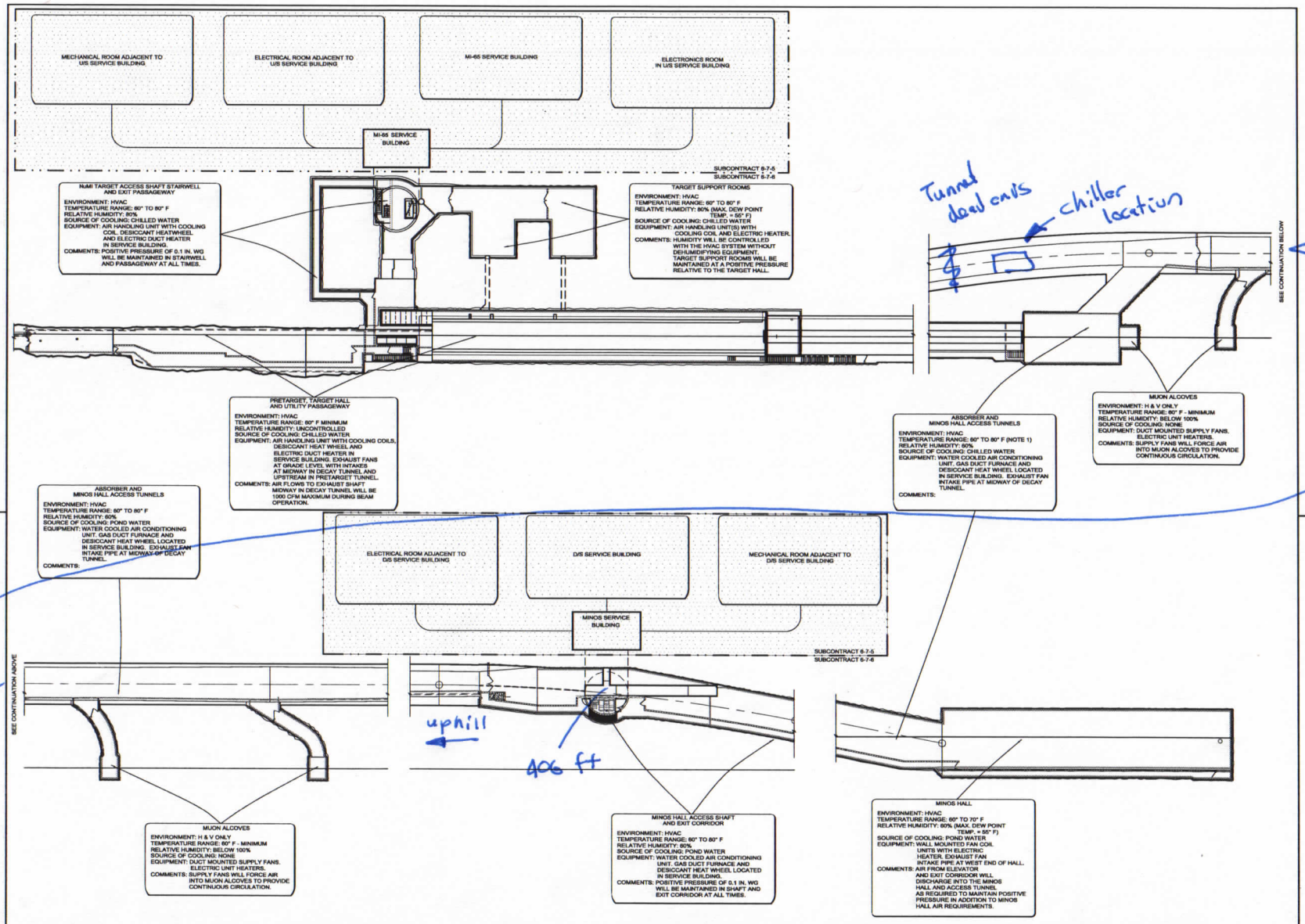
SK-101

PART OF PROJECT 6-7-9

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
MECHANICAL EQUIPMENT SCHEDULES

DRAWING NO. 6-7-6 M-2 REV. 11



PART OF PROJECT 6-7-9

REV.	DATE	DESCRIPTIONS
1	10/30/02	REVISION 3
	8/15/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	R. WIMMER	10/22/01
DRAWN	P. ABAD	10/22/01
REVIEWED	G. HOORNAERT	10/22/01
APPROVED	M. BRUEN	10/22/01

FLUOR DANIEL CHICAGO ILLINOIS

MWH MONTGOMERY WATSON HARZA CHICAGO ILLINOIS

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	R. JEDZINIAK	7/24/00
CHECKED	J. SANTIC / R. BRUNTON	7/24/00
APPROVED		

FERMI LAB		DATE
FINAL REVIEW	J. SIMS	01/16/02
ENG. ACCEPTED	E. CRUMPLEY	01/16/02
FERM ACCEPTED	D. NEVIN	01/16/02
SUBMITTED	R. PLUNKETT/D. BOGERT	01/16/02

PROJECT NORTH

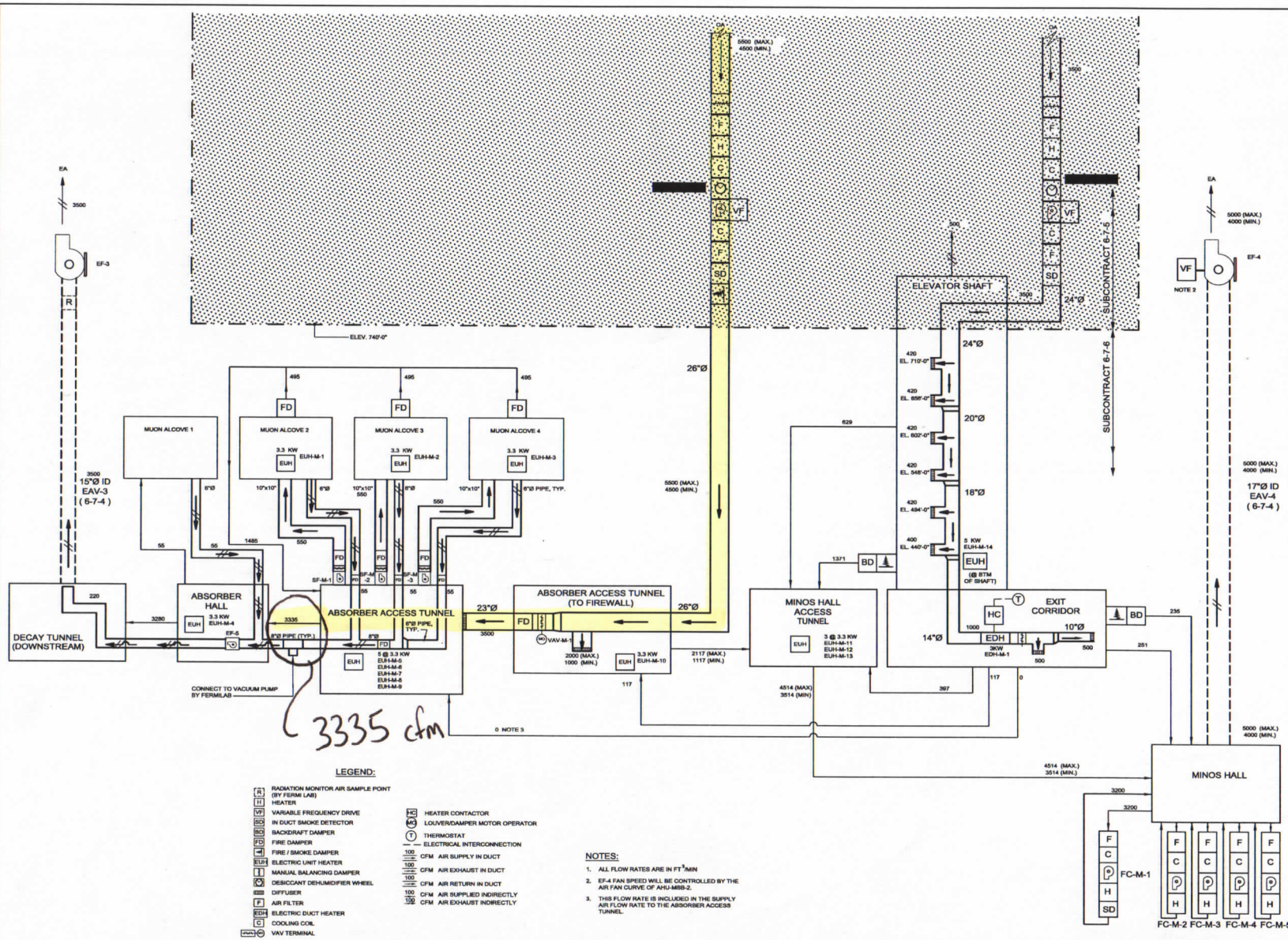
SCALE: 1/16"=1'-0" 0 8 16 24 32 40 SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
HVAC CRITERIA

DRAWING NO. 6-7-6 M-3 REV. 3

30 OCT, 2002



LEGEND:

- R — RADIATION MONITOR AIR SAMPLE POINT (BY FERMI LAB)
- H — HEATER
- VF — VARIABLE FREQUENCY DRIVE
- SD — IN DUCT SMOKE DETECTOR
- BD — BACKDRAFT DAMPER
- FD — FIRE DAMPER
- FIRE / SMOKE DAMPER
- EUH — ELECTRIC UNIT HEATER
- MANUAL BALANCING DAMPER
- DESICCANT DEHUMIDIFIER WHEEL
- DIFFUSER
- F — AIR FILTER
- EDH — ELECTRIC DUCT HEATER
- C — COOLING COIL
- VAV — VAV TERMINAL
- HC — HEATER CONTACTOR
- MO — LOUVER/DAMPER MOTOR OPERATOR
- T — THERMOSTAT
- ELECTRICAL INTERCONNECTION
- 100 CFM — AIR SUPPLY IN DUCT
- 100 CFM — AIR EXHAUST IN DUCT
- 100 CFM — AIR RETURN IN DUCT
- 100 CFM — AIR SUPPLIED INDIRECTLY
- 100 CFM — AIR EXHAUST INDIRECTLY

NOTES:

1. ALL FLOW RATES ARE IN FT^3/MIN
2. EF-4 FAN SPEED WILL BE CONTROLLED BY THE AIR FAN CURVE OF AHU-M6B-2.
3. THIS FLOW RATE IS INCLUDED IN THE SUPPLY AIR FLOW RATE TO THE ABSORBER ACCESS TUNNEL.

REV.	DATE	DESCRIPTIONS
	8/15/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	R. WIMMER	10/22/01
DRAWN	E. SIMBOL	10/22/01
REVIEWED	G. HOORNAERT	10/22/01
APPROVED	M. BRUEN	10/22/01

FLUOR DANIEL — CHICAGO ILLINOIS

MWH — MONTGOMERY WATSON HARZA

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	Z. SILJKOVIC	7/24/00
CHECKED	J. SANTIC / R. BRUNTON	7/24/00
APPROVED		

FERMI LAB		DATE
FINAL REVIEW	J. SIMS	01/16/02
ENG. ACCEPTED	E. CRUMPLEY	01/16/02
FERMI ACCEPTED	D. NEVIN	01/16/02
SUBMITTED	R. PLUNKETT/D. BOGERT	01/16/02

SCALE: NONE

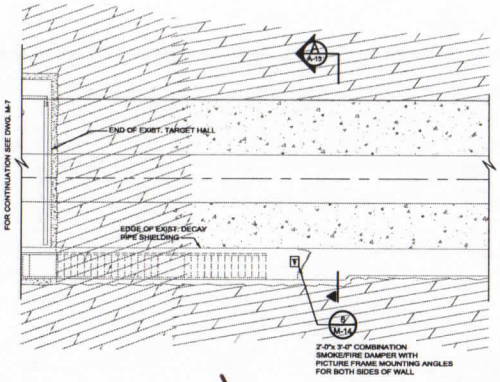
PART OF PROJECT 6-7-9

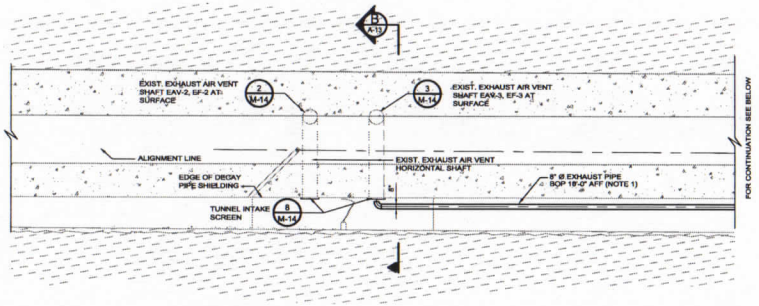
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
HVAC FLOW DIAGRAM - SHT. 2

DRAWING NO. 6-7-6 — M-5 REV.

15 AUG, 2002





NOTES:

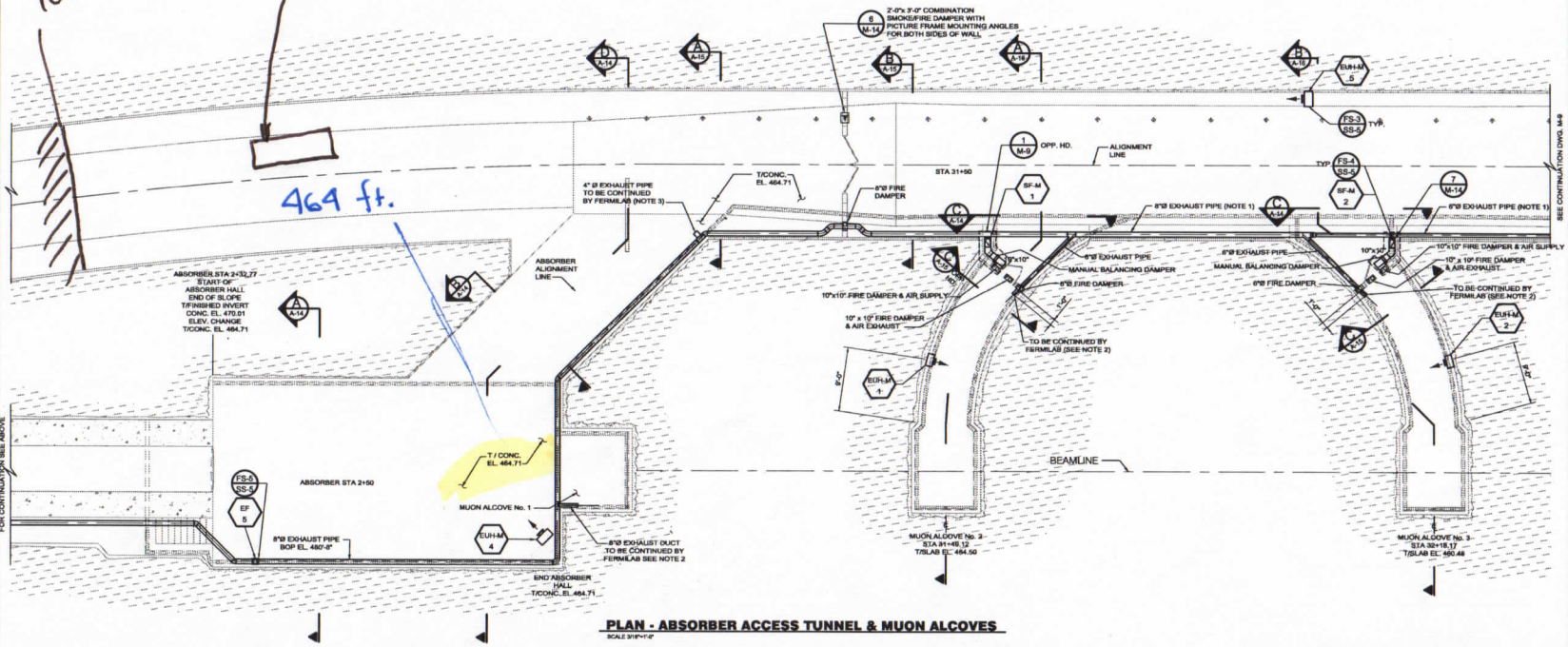
1. EXHAUST PIPE TO BE SCHEDULE 40 GALVANIZED STEEL PIPE, MECHANICAL JOINTS.
2. FERMILAB TO CONTINUE EXHAUST PIPE TO MUON DETECTOR HELIUM GAS EXHAUST.
3. FERMILAB TO TIE VACUUM PUMP EXHAUST TO 8"Ø EXHAUST PIPE HEADER.

PLAN - DECAY ACCESS TUNNEL

SCALE 3/16"=1'-0"

Tunnel dead ends

TRANE CHILLER LOCATION



PLAN - ABSORBER ACCESS TUNNEL & MUON ALCOVES

SCALE 3/16"=1'-0"

PART OF PROJECT 6-7-9

REV.	DATE	DESCRIPTIONS
3	10/30/02	REVISION 3
2	8/15/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	R. WIMBER	10/22/01
DRAWN	E. SIMBOL	10/22/01
REVIEWED	S. HOORNAERT	10/22/01
APPROVED	M. BRUEN	10/22/01

FLUOR DANIEL CHICAGO ILLINOIS

MWH MONTGOMERY WATSON HARZA CHICAGO ILLINOIS

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	Z. SILJKOVIC	7/24/00
CHECKED	J. SAMTIC / R. BRUNTON	7/24/00
APPROVED		

FERMI LAB		DATE
FINAL REVIEW	J. SIMS	01/16/02
ENG. ACCEPTED	E. CRUMPLEY	01/16/02
FERM ACCEPTED	D. NEVIN	01/16/02
SUBMITTED	R. PLUNKETT/D. BOGERT	01/16/02

PROJECT NORTH

SCALE: 3/16"=1'-0"

FERMI NATIONAL ACCELERATOR LABORATORY

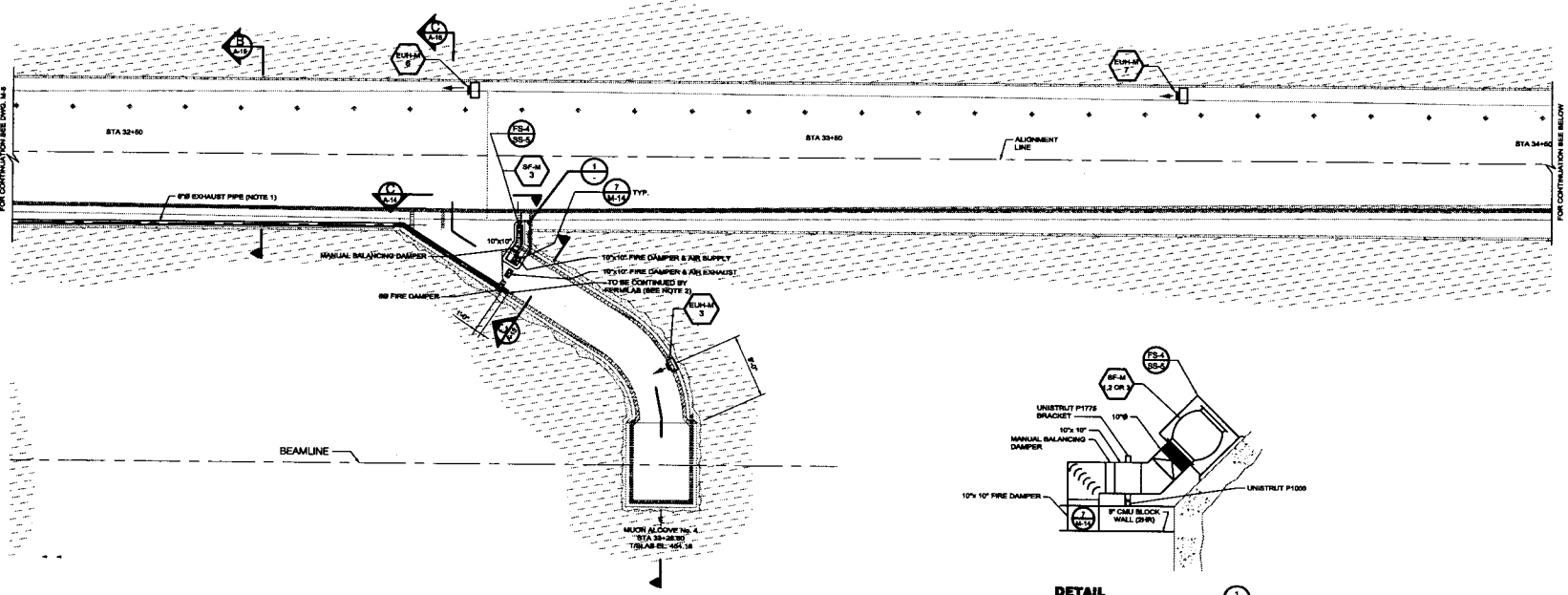
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

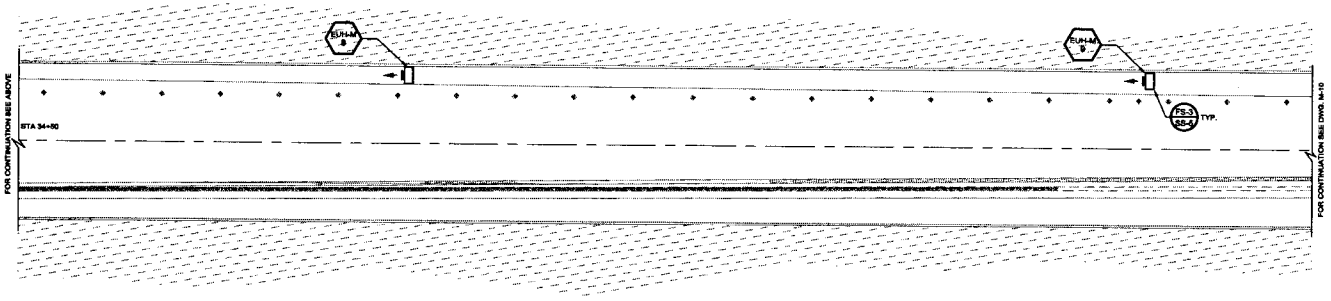
DECAY, ABSORBER & ALCOVES HVAC

DRAWING NO. 6-7-6 M-8 REV. 3

30 OCT, 2002



DETAIL
MUON ALCOVE SUPPLY FAN 1 M-8 / M-9
SCALE: 1"=1'-0"



NOTES:

1. EXHAUST PIPE TO BE SCHEDULE 40 GALVANIZED STEEL PIPE, MECHANICAL JOINTS.
2. FERMILAB TO CONTINUE EXHAUST PIPE TO MUON DETECTOR HELIUM GAS EXHAUST.

PLAN - ABSORBER ACCESS TUNNEL & MUON ALCOVE

SCALE: 1"=1'-0"

REV.	DATE	DESCRIPTIONS REVISIONS
3	10/30/02	REVISION 3
	5/15/02	CONFORMED SET

	AE CONSULTANT	DATE
DRAWN	R. WAGNER	10/22/01
CHKD	E. SIMICK	10/22/01
REVIEWED	S. HOORMANNET	10/22/01
APPROVED	M. BRUNN	10/22/01

FLUOR DANIEL DESIGN
MWH MONTGOMERY WATSON HARZA
CHICAGO ILLINOIS

	AE CONSULTANT	DATE
DESIGNED		
DRAWN	Z. SILJKOVIC	7/24/02
CHECKED	J. SANTIO / R. BRUNTON	7/24/02
APPROVED		

	FERMILAB	DATE
PHYS. REVIEW	J. [illegible]	01/15/02
ENG. ACCEPTED	E. CRUMPLEY	01/15/02
FERM ACCEPTED	S. NEVEN	01/15/02
SUBMITTED	R. PLUNKETT/S. ROBERT	01/15/02

PROJECT NORTH

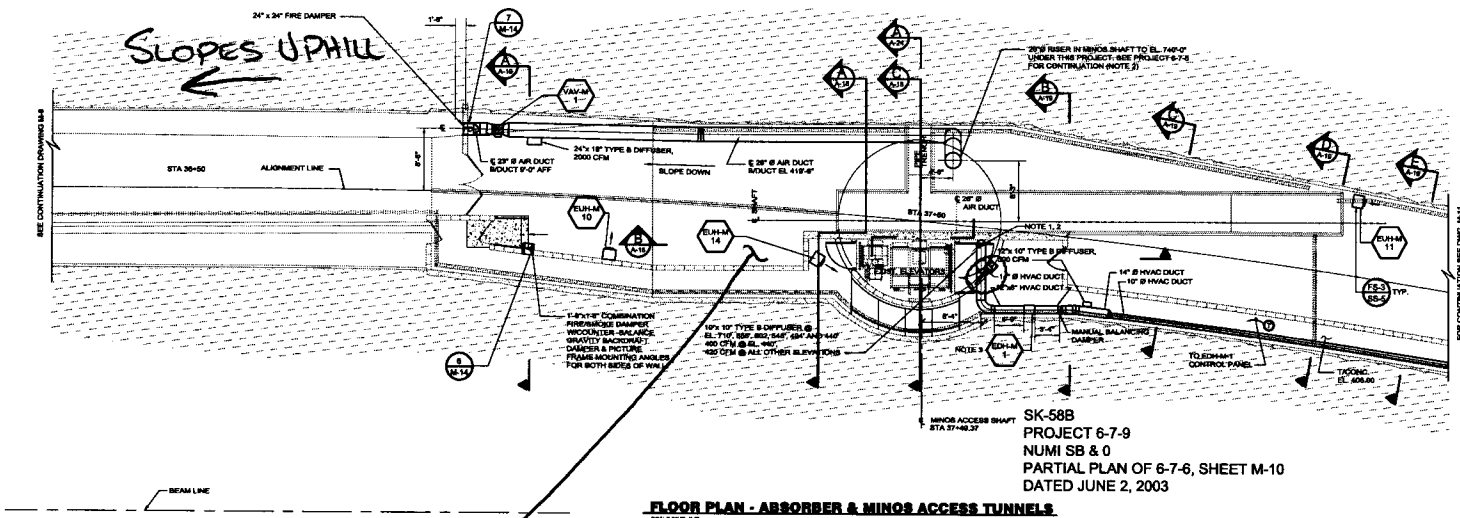
SCALE:

PART OF PROJECT 6-7-9

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
MUON ALCOVE 4 - HVAC

DRAWING NO. 6-7-6 M-9 REV. 3



SK-58B
PROJECT 6-7-9
NUMI SB & 0
PARTIAL PLAN OF 6-7-6, SHEET M-10
DATED JUNE 2, 2003

FLOOR PLAN - ABSORBER & MINOS ACCESS TUNNELS

SCALE 3/16"=1'-0"

FLOOR ELEVATION ≈ 406 FT

NOTES:

1. THE AIR DUCT SIZE VARIES INSIDE THE MINOS ELEVATOR SHAFT. REFER TO DWG. M-5 FOR AIR DUCT SIZES AT VARIOUS ELEVATIONS.
2. FLEXIBLE CONNECTIONS TO BE INSTALLED ABOVE EACH DUCT ANCHOR POINT IN THE SHAFT.
3. DUCT HEATER TO BE SLIP-IN DUCT MOUNTED.

REV.	DATE	DESCRIPTIONS
1	2/10/03	REVISION 2
	8/15/02	CONFORMED SET

REVISIONS

AE CONSULTANT		DATE
DESIGNED	R. WRIGHT	10/22/01
DRAWN	A. ZIVKOVIC	10/22/01
REVIEWED	G. ROORDAMET	10/22/01
APPROVED	M. INSUK	10/22/01

FLUOR DANIEL INDIANA

MWH MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

AE CONSULTANT		DATE
DESIGNED		
DRAWN	Z. SELIKOVIC	7/24/02
CHECKED	J. SANTIO/ R. BRUNTON	7/24/02
APPROVED		

FERMILAB		DATE
FNAL REVIEW	J. SEGO	01/15/03
ENG. ACCEPTED	E. CRUMPLEY	01/15/03
FNAL ACCEPTED	E. NEVIN	01/15/03
SUBMITTED	R. PLANKETT/D. BOSENT	01/15/03

PROJECT NORTH

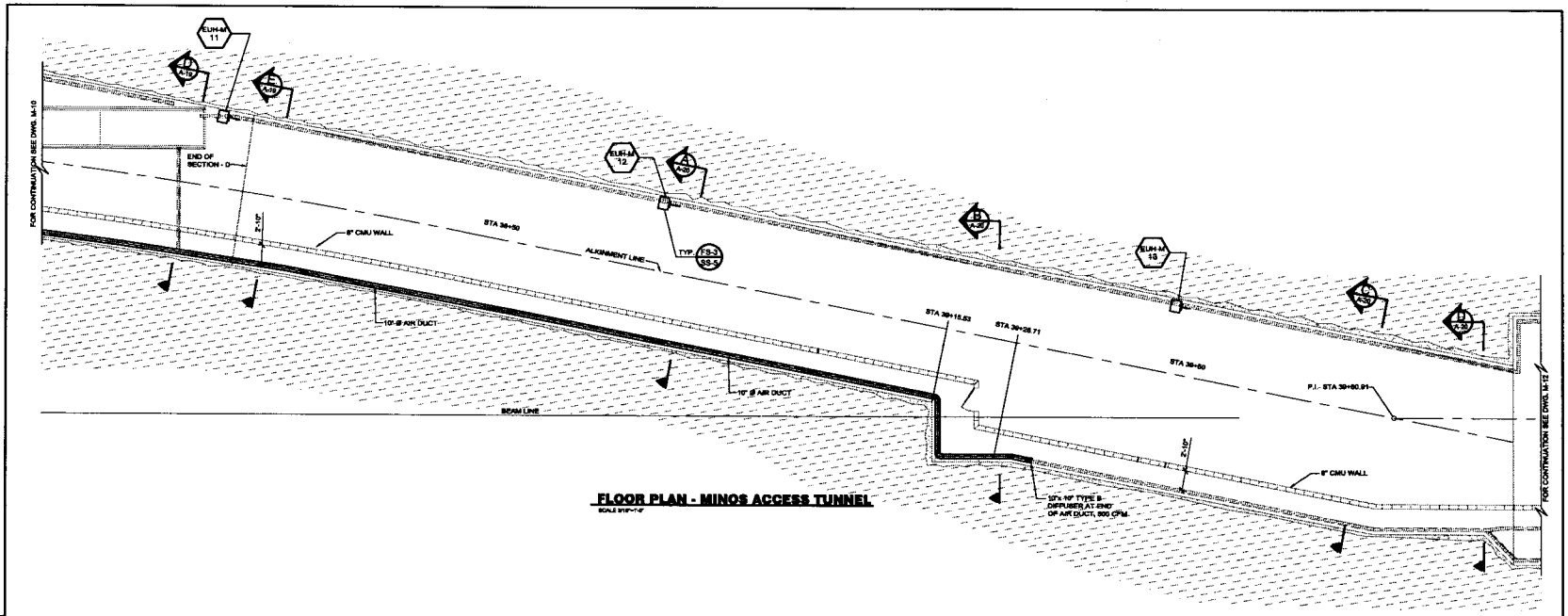
SCALE: 3/16"=1'-0" 0 2 4 6 8 10 12 14 SCALE FEET

PART OF PROJECT 6-7-9

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
MINOS ACCESS TUNNELS - HVAC

DRAWING NO. 6-7-6 M-10 REV. 2



FLOOR PLAN - MINOS ACCESS TUNNEL

SCALE 3/16"=1'-0"

REV.	DATE	DESCRIPTIONS / REVISIONS
	8/15/02	CONFORMED SET

AE CONSULTANT		DATE
DESIGNED	B. WIMMER	10/22/01
DRAWN	P. ABAD	10/22/01
REVIEWED	G. HOORNAERT	10/22/01
APPROVED	M. BRUSH	10/22/01

FLUOR DANIEL WWINSTON LUND

MWH MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

AE CONSULTANT		DATE
DESIGNED		
DRAWN	Z. SELJKOVIC	7/24/02
CHECKED	J. SANTICI/ R. SWINTON	7/24/02
APPROVED		

FERMILAB		DATE
PROJ. REVIEW	J. [illegible]	01/16/02
ENG. ACCEPTED	S. CRUMPLEY	01/16/02
FERM ACCEPTED	S. NEVIN	01/16/02
SUBMITTED	R. PLUNKETT/S. BOBERT	01/16/02

PROJECT NORTH

SCALE: 3/16"=1'-0" FLOOR PLAN SCALE FEET

PART OF PROJECT 6-7-9

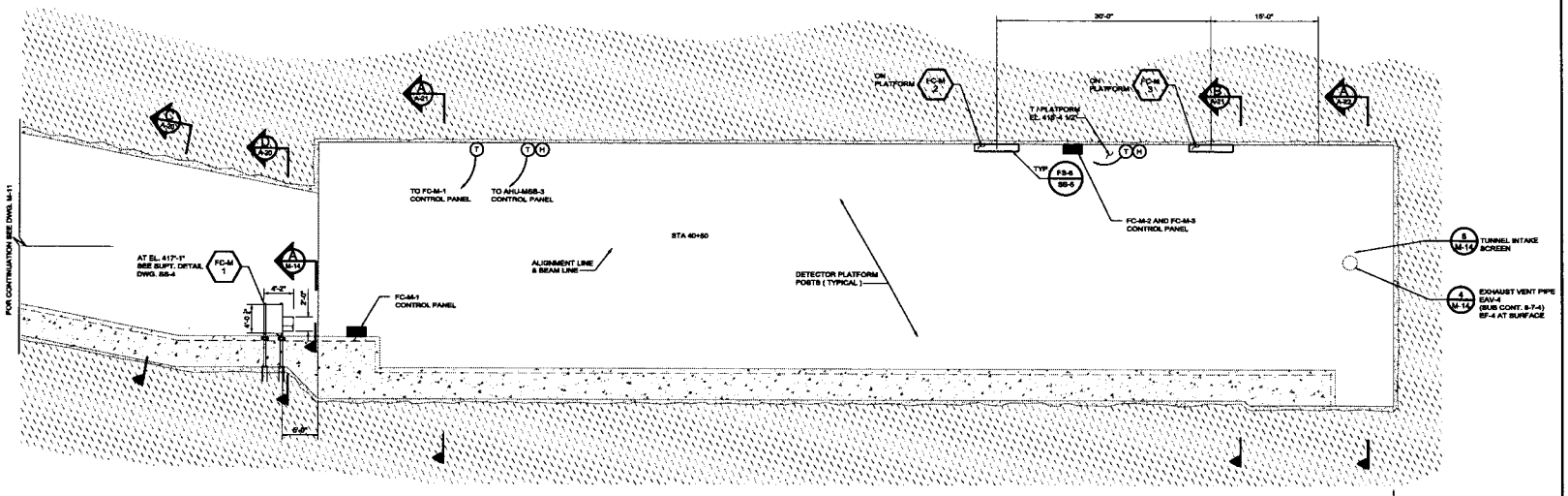
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

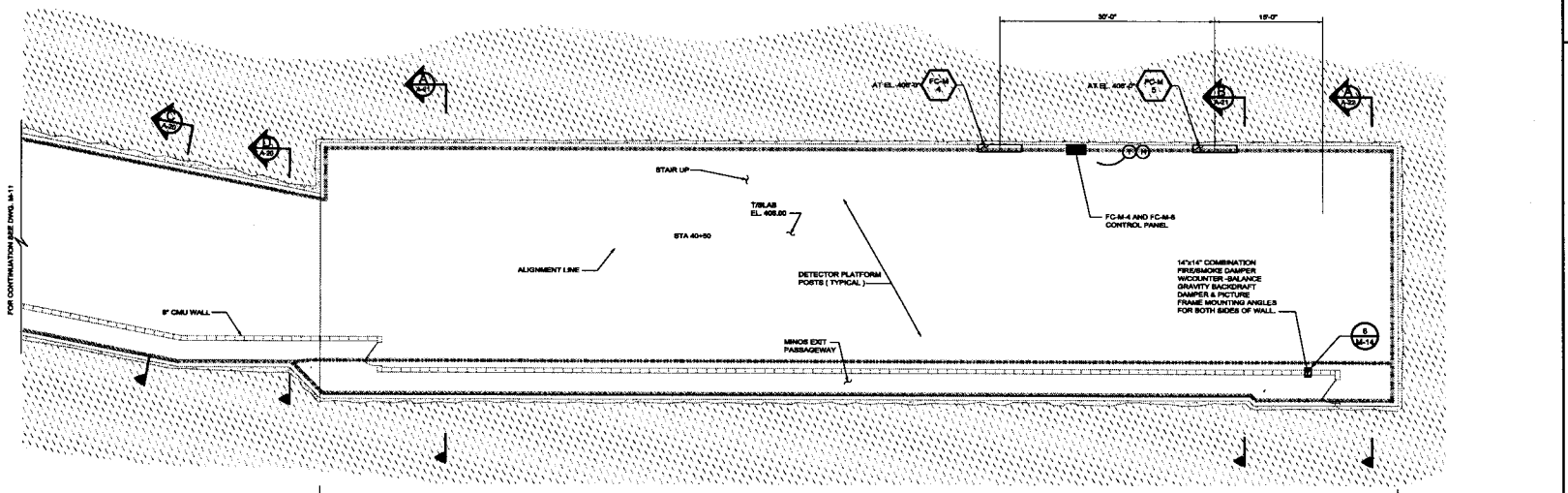
MINOS ACCESS & TUNNEL HVAC

DRAWING NO. 6-7-6 M-11 REV.



CEILING PLAN - MINOS HALL

SCALE 3/16"=1'-0



FLOOR PLAN - MINOS HALL

SCALE 3/16"=1'-0

PART OF PROJECT 6-7-9

REV.	DATE	DESCRIPTION
	5/15/02	CONFORMED SET

REVISIONS

A/E CONSULTANT		DATE
DESIGNED	R. WIMMER	10/22/01
DRAWN	J. MARRAYRAY	10/22/01
REVIEWED	S. HOORNAERT	10/22/01
APPROVED	M. SHLIEN	10/22/01

FLUOR DANIEL — DESIGN — CHICAGO, ILLINOIS

MWH — MONTGOMERY WATSON HARZA

A/E CONSULTANT		DATE
DESIGNED		
DRAWN	Z. SILJKOVIC	7/24/02
CHECKED	J. SANTIO/ R. BRUNTON	7/24/02
APPROVED		

FERMI LAB		DATE
FINAL REVIEW	J. DIRR	01/16/02
PMS ACCEPTED	S. CRUMPLEY	01/16/02
FERM ACCEPTED	S. MEYER	01/16/02
SUBMITTED	R. PLUNKETT/D. BOBBIT	01/16/02

PROJECT NORTH

SCALE:

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

MINOS HALL - HVAC

DRAWING NO. 6-7-6 — M-12 — REV.

TARGET CONTROL NOTES:

CONTROL WIRING, CABLE, DEVICES, AND SENSORS SHALL BE INSTALLED BY THE SUBCONTRACTOR.

CONTROL SYSTEMS FOR EF-1, FC-T-1, VAV-T-1 THROUGH VAV-T-3, AND EF-2 SHALL BE PROGRAMMED AND COMMISSIONED BY FERMILAB.

VAV BOXES SHALL BE INSTALLED TO CONTROL THE AIRFLOW IN THE DIFFERENT DUCT BRANCHES OF DEHUMIDIFIER AHU-TSB-3. VAV-T-1 THROUGH VAV-T-3 SHALL BE SUPPLIED WITH FACTORY MOUNTED JOHNSON CONTROLS VAV CONTROLLERS, DAMPER MOTORS, AND DIFFERENTIAL PRESSURE SENSORS. 24 VAC FOR THESE VAV BOXES SHALL BE SUPPLIED BY A TRANSFORMER LOCATED IN PANEL NC-35 EN-5.

CABLE, CONDUIT, INSTALLATION MATERIALS, ETC., SHALL BE PROVIDED BY THE SUBCONTRACTOR. REFER TO BILLS OF MATERIALS FOR FERMILAB SUPPLIED MATERIALS TO SUBCONTRACTOR

LOW VOLTAGE CONTROL CABLE (LESS THAN 30 VOLTS) SHALL BE #18 SHIELDED, STRANDED CABLE, 2 OR 3 CONDUCTORS AS NEEDED. CONDUIT IS REQUIRED FOR CABLE BELOW 9' ABOVE FINISHED FLOOR LEVEL.

CONDUIT IS REQUIRED FOR HIGH VOLTAGE CABLE (GREATER THAN 30 VOLTS). HIGH AND LOW VOLTAGE CABLE SHALL NOT BE MIXED IN THE SAME CONDUIT.

CABLE TERMINATIONS ARE NOT REQUIRED AT CONTROL PANELS. SUBCONTRACTOR SHALL LEAVE AN EXTRA LOOP OF CABLE INSIDE THE PANEL.

LOW VOLTAGE CABLES INSTALLED WITHIN CONCEALED-ACCESSIBLE LOCATIONS DO NOT REQUIRE CONDUIT. USE OF WIREWAYS OR CABLE HOOKS EVERY 4' IS ACCEPTABLE

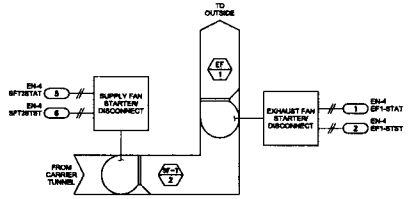
LOW VOLTAGE CABLE SHALL NOT BE TIE-WRAPPED OR TAPED TO EXISTING CABLE, PIPE, OR CONDUIT.

CABLE SHALL BE NUMBERED AT BOTH ENDS ACCORDING TO NUMBERS SHOWN ON DRAWINGS.

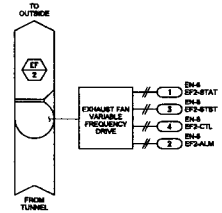
CABLES INSTALLED WITHIN AIR PLENUMS SHALL BE PLENUM RATED.

N2 NETWORK CABLE SHALL BE #18 STRANDED, 3 CONDUCTOR CABLE - WEST PENN #234 OR APPROVED EQUAL. N2 CABLE SHALL BE RUN ACCORDING TO NC-35 N2 NETWORK WIRING DIAGRAM AS SHOWN ON THIS DRAWING.

RESTORE EXPOSED FINISHES OF CUT OR PATCHED AREAS IN A MANNER THAT WILL ELIMINATE EVIDENCE OF PATCHING OR REFINISHING. UTILIZE ARCHITECTURALLY COMPATIBLE DEVICES FOR INSTALLATION IN FINISHED SPACE.



EXHAUST FAN EF-1 CONTROL SYSTEM LAYOUT



EXHAUST FAN EF-2 CONTROL SYSTEM LAYOUT

EF-1, EF-2, SF-T-1, AND SF-T-2 SEQUENCE OF OPERATIONS

(FOR INFORMATION ONLY - PROGRAMMING NOT IN CONTRACT)

EF-1 OPERATION: Exhaust Fan EF-1 shall be interlocked through software with dehumidifier AHU-TSB-3.

EF-2 OPERATION: Exhaust Fan EF-2 shall be interlocked through software with dehumidifier AHU-TSB-4. The speed of EF-2 shall be controlled through a variable frequency drive. When the particle beam is on, the DDC controller shall set the variable frequency drive to a speed calculated from the EF-2 fan curve to deliver 1000 CFM (adjustable). When the particle beam is off, the DDC controller shall set the variable frequency drive to a speed calculated from the EF-2 fan curve to deliver 3070 CFM (adjustable).

SF-T-1 OPERATION: Supply Fan SF-T-1 shall be interlocked through software with exhaust fan EF-1.

SF-T-2 OPERATION: Supply Fan SF-T-2 shall be interlocked through software with exhaust fan EF-1.

ITEMS SUPPLIED BY FERMILAB, INSTALLED BY SUBCONTRACTOR FOR 2 EXHAUST FANS		
LABEL	QUANTITY	DESCRIPTION
EF1-STAT	2	CURRENT SWITCH

EXHAUST FAN BILL OF MATERIALS

FC-T-1 SEQUENCE OF OPERATIONS

(FOR INFORMATION ONLY - PROGRAMMING NOT IN CONTRACT)

FAN OPERATION: The supply fan shall run continuously.

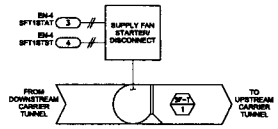
ZONE TEMPERATURE CONTROL: The zone temperature sensor shall control the heating and cooling as required to maintain the zone temperature setpoint of 68°F (adjustable). Upon a call for heating, the DDC controller shall energize the appropriate stages of electric reheat. Upon a call for cooling, the chilled water valve shall modulate open.

ZONE DEHUMIDIFICATION CONTROL: The DDC system shall calculate the zone dewpoint from the zone temperature and zone humidity sensors. Upon sensing a zone dewpoint of greater than 55°F (adjustable), the chilled water valve shall open fully. The electric reheat shall modulate to maintain the zone temperature setpoint, as earlier described.

FIRE ALARM SHUTDOWN: (Hardwired) Upon a shutdown signal from the fire alarm control panel, the fan coil unit shall shutdown. This condition will initiate a critical fire alarm on the DDC system.

ITEMS SUPPLIED BY FERMILAB, INSTALLED BY SUBCONTRACTOR FOR 2 SUPPLYT FANS		
LABEL	QUANTITY	DESCRIPTION
SFT1STAT	2	CURRENT SWITCH

SUPPLY FAN BILL OF MATERIALS

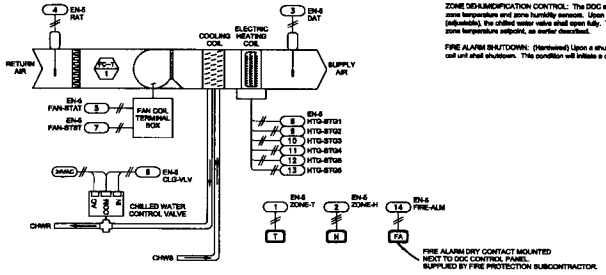


SUPPLY FAN SF-T-1 CONTROL SYSTEM LAYOUT

VAV-T-1, VAV-T-2, AND VAV-T-3, SEQUENCE OF OPERATIONS

(FOR INFORMATION ONLY - PROGRAMMING NOT IN CONTRACT)

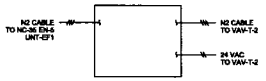
VAV OPERATION: VAV boxes shall be installed to control the airflow in the differenent duct branches for dehumidifier AHU-TSB-4. The VAV boxes shall be supplied with a Johnson Controls DDC controller, damper motor, and differential pressure sensor to sense airflow velocity. The DDC controller shall modulate the VAV damper to maintain the VAV box airflow setpoint (adjustable). Initial airflow setpoints shall be set to the airflow shown on drawings M-4 for dehumidifier AHU-TSB-4.



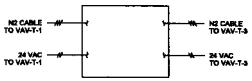
FAN COIL UNIT FC-T-1 CONTROL SYSTEM LAYOUT

ITEMS SUPPLIED BY FERMILAB, INSTALLED BY SUBCONTRACTOR FOR 1 FAN COIL UNITS		
LABEL	QUANTITY	DESCRIPTION
ZONE-T	1	ROOM TEMPERATURE SENSOR
ZONE-H	1	ROOM HUMIDITY SENSOR
DAT	1	DISCHARGE AIR DUCT SENSOR
RAT	1	RETURN AIR DUCT SENSOR
FAN-STAT	1	CURRENT SWITCH
CLG-VLV	1	VALVE AND ACTUATOR ASSEMBLY
EN-5	1	CONTROLLER ENCLOSURE

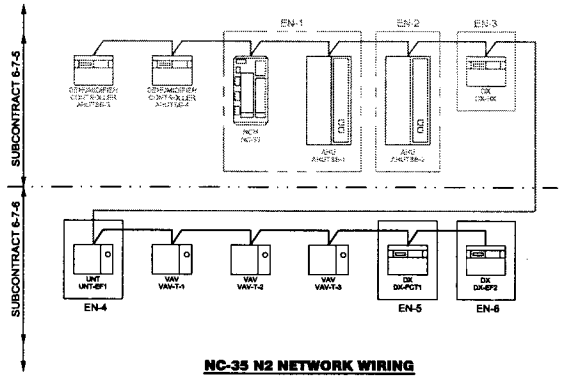
FAN COIL UNIT BILL OF MATERIALS



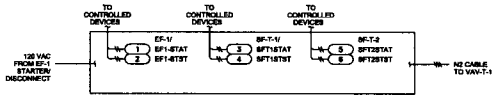
VAV-T-1 PANEL DETAIL



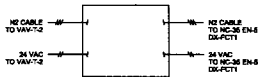
VAV-T-2 PANEL DETAIL



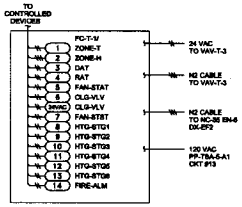
NC-35 N2 NETWORK WIRING



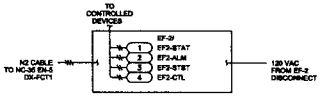
NC-35 EN-4 PANEL DETAIL



VAV-T-3 PANEL DETAIL



NC-35 EN-5 PANEL DETAIL



NC-35 EN-6 PANEL DETAIL

REV.	DATE	DESCRIPTION
2	10/14/02	CARRIER TUNNEL
1	8/15/02	CONFORMED SET

REVISIONS

	FERMILAB	DATE
FINAL REVIEW	J. SIEGS	01/15/02
CAS ACCEPTED	E. CRUMPLEY	01/15/02
FERM ACCEPTED	D. NEVIN	01/15/02
SUBMITTED	R. PLANKSET / D. BOGERT	01/15/02

SCALE:

PART OF PROJECT 6-7-8

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

TARGET HVAC CONTROLS

DRAWING NO. 6-7-6 M-13 REV. 2

1.5 (ACT), 2002