Fermilab

Particle Physics Division
Mechanical Department Engineering Note

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Project: NuMI / MINOS

Title: ODH Analysis for NuMI Below Ground Spaces

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Key Words: ODH Analysis,

Abstract Summary: Analysis of the effects of various quantities of inert gas used in the underground spaces of NuMI and MINOS. Result is that under all conditions, these spaces with the quantities of gas used or stored below ground, remain ODH classification 0.

Analysis considers:

- Inert Argon CO2 (80/20) for the Total Loss Monitor.
- Helium used for the target.
- Nitrogen used for the head spaces on the expansion tanks for the RAW systems in the mechanical support room under MI-65
- Inert gas used in the Muon and Hadron monitors in the muon alcove and absorber enclosure. Gas is either Helium or Argon (depending on the run conditions) per Sacha Kopp.

Applicable Codes: FESHM 5064

Discussion:

NuMI will have four systems located underground which will use inert gas. These systems include:
1) The nitrogen blanket used on the Target, Horn 1, Horn 2 and Decay pipe cooling RAW systems located in the target hall mechanical support room (THSR).
2) A helium gas pressure applied to the target in the target hall.
3) A total Loss Monitor which is fed gas from a bottle located underground in the electrical support room.
4) The gas system used at the downstream (MINOS) end of the project for the Muon Monitors and the Hadron Monitor. Both the Muon Monitors and the Hadron Monitor systems are fed gas from the same gas system. This system uses either Helium or Argon depending on the run conditions.

This analysis does not attempt to quantify an ODH analysis for any of the above ground service buildings (MI-60, MI-62). GN2 will be used in MI-62. GN2 will flow through MI-60. Additional ODH analysis will have to be addressed separately.

Ventilation details for the underground spaces are documented in FESS drawings for project 6-7-6 (NuMI Outfitting). See Drawings M-3, M-4 and M-5 attached.

<u>The Nitrogen Blanket for the RAW systems in the Target Hall Mechanical Support Room (THSR)</u>

This system will be fed GN2 from a Dewar located outside of MI-60. The lines have been run through MI-60 (pump room, north power supply room) down into the tunnel, to MI-62, with a branch line going down the NuMI stub, the stub extension, the RCP (round concrete pipe) carrier pipe, the drill and blast (D&B) portion of the carrier pipe, the pre-target, thru the labyrinth pipe chase (a non-habitable area), and into the target hall mechanical support room. The only place along this route where GN2 will be used in the THSR. Here, a small amount of GN2 (1 scfh) will be bled through each of four expansion tanks and vented into the room.

Three of the four expansion tanks are 100 gallon capacity, code stamped vessels. Each will be half filled with water and half filled with gas at less than 10 psig. The forth vessel is approximately 30 gallon capacity, also code stamped and also planned to operate half filled with water, half filled with gas at about 10 psig.

The Dewar has a MAWP of 250 psig but is currently labeled to operate the pressure between 30 and 50 psig. For NuMI needs, the Dewar does not need to operate above 100 psig, so a pressure of 100 psig is used to calculate the flow rate out of the copper tubing should it be severed in each area. Obviously, the flow rate out of the end of the severed tubing increases as the location of the sever gets closer to the gas source. The equation 3-20 from Crane Technical Paper 410 was used to calculate the flow rates.

Details on the MI-60 Dewar are not set. The responsibility for installing and commissioning this Dewar and performing the ODH analysis for MI-60 rests on the shoulders of Maurice Ball and the Accelerator Division Mechanical Department. As of the date that this engineering note has been written, the MI-60 Nitrogen Dewar is locked out. The Dewar does not appear to meet the current FESHM Dewar installation rules. Should the final Dewar installation not match the values assumed in this engineering note, this note will require a revision.

Initial operation of these systems will likely used compressed air in lieu of GN2 or will use one GN2 cylinder to provide a pressurized gas source. The analysis included for using a single GN2 or argon cylinder.

Target Helium

The target will be pressurized with helium from a gas bottle. The bottle will be located in the electrical support room next to the target hall. There helium is not planned to be purged through the target.

Total Loss Monitor

The total loss monitor will use Argon/ CO2 from a bottle in the electrical support room next to the target hall. The Ar/CO2 will be piped to the pre-target beam line and then all along the beam line, through the carrier tunnel, into the NuMI Stub, and to the inlet of the total loss monitor (TLM) at the upstream end of the NuMI stub. Then the TLM will carry the gas back down steam through four sections of TLM. The gas output will be routed back to the electrical support room next to the target hall where it will vent through a bubble. See the schematic on drawing 8875.117-MB-433163.

Muon and Hadron Monitors

The muon hadron monitors will be located in the muon alcoves (muon monitors) and in the absorber enclosure (hadron monitor). The gas will originate from a gas cylinder manifold near the bottom of the MINOS shaft. Gas will vent from each monitor and will be routed to the exhaust line (see FESS drawings for project 6-7-6 (NuMI Outfitting). Drawing M-5). This exhaust line will transport the gas to the suction of the exhaust fan located near the center of the decay pipe passage. Gas will either be Helium or Argon, depending on the run conditions.

General Notes Applicable to all Areas:

All ventilation rates listed are the ventilation rates of fresh, conditioned, make-up air. Mechanical HVAC drawings for these areas have been attached to this engineering note. Little air is re-circulated (refer to the drawings) and the re-circulated air is not considered in the ventilation rates.

All gas cylinders are planned to be 200 cubic feet. 230 cubic feet is used in the calculations in the spread sheets to account for cylinders filled to 110%.

ODH Calculations for the NuMI Underground Mechanical Support Room which uses GN2 from MI-60 for the RAW system expansion tanks head space. Considers each area that the GN2 line goes thru. Areas which intentionally bleed GN2 have a normal bleed rate. Otheres just have a leak based on a failure.

Complete rupture of the Nitrogen feed line into the NuMI Underground Mechanical Support Room:

Nitrogen comes from a dewar located near MI-60. 3/4 inch nominal size, type L copper lines bring the GN2 to this area

The calculated flow rate of gas out of this line if it were to be severed is:	95.5	cfm
Based on an outlet of 0 psig, and an inlet of :	100	psig
and a tubing length of:	1400	feet
Normal Ventillation Rate is :	440	cfm for this area
With the normal ventilation operating, the concentration of O2 would fall to :	0.1725515	% O2
However, the probability of having a brazed joint fail or of having one of the lines rupture is sufficiently low that the fatality rate would only get to:	9.34E-10	
Which results in an ODH classification of:	0	

Refer to the table below:

Elevation 626 feet

Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	70	1.00E-09	7.00E-08	95.5	0.1725515	4.67E-07	3.27E-14	0
valve (MOV)	rupture	2	1.00E-08	2.00E-08	80	0.1776923	1.94E-07	3.87E-15	0
valve (AOV)	rupture	2	1.00E-09	2.00E-09	80	0.1776923	1.94E-07	3.87E-16	0
brazed joint	leak	71	1.00E-09	7.10E-08	95.5	0.1725515	4.67E-07	3.31E-14	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	95.5	0.1725515	4.67E-07	4.67E-10	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	95.5	0.1725515	4.67E-07	4.67E-10	0
Total								9.34E-10	0

ODH Calculations for the NuMI Underground Mechanical Support Room - Helium for Target

Elevation 626 feet
Pressure 743.6 torr

Item		Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	in THSR	Sections	20	1.00E-09	2.00E-08	230	0.205863	1.55616E-09	3.11E-17	0
Pipes < 3"	in Target hall	Sections	20	1.00E-09	2.00E-08	230	0.209639	8.15177E-10	1.63E-17	0
valve (MOV)	in THSR	rupture	2	1.00E-08	2.00E-08	230	0.205863	1.55616E-09	3.11E-17	0
valve (MOV)	in Target hall	rupture	2	1.00E-08	2.00E-08	230	0.209639	8.15177E-10	1.63E-17	0
valve (AOV)	in THSR	rupture	2	1.00E-09	2.00E-09	230	0.205863	1.55616E-09	3.11E-18	0
valve (AOV)	in Target hall	rupture	2	1.00E-09	2.00E-09	230	0.209639	8.15177E-10	1.63E-18	0
brazed joint	in THSR	rupture	50	1.00E-09	5.00E-08	230	0.205863	1.55616E-09	7.78E-17	0
brazed joint	in Target hall	rupture	50	1.00E-09	5.00E-08	230	0.209639	8.15177E-10	4.08E-17	0
Total									1.77E-16	0

Complete rupture of the Helium feed line into the NuMI Underground Mechanical Support Room:

Helium from a 200 cubic foot gas cylinder supplies helium to the target. This gas isn't purged.
The maximum loss of helium is 230 cubic feet. This can occur in either the electrical room or the target hall

The volume of the room housing the helium cylinder is: 11445 cubic feet
The volume of the target hall is: 133650 cubic feet

Oxygen concentration assuming no ventilation and a sudden 200 cubic foot gas release in each volume is:
Target Hall Support room (THSR): 0.205863 fraction O2
Target Hall : 0.209639 fraction O2

In both areas, the O2 concentration does not fall below 18% considering an instantanous loss of the cylinder contents and no ventilation. No further analysis is required.

Complete rupture of the Nitrogen feed line into the NuMI Underground Pre-Target Area:

The volume of this tunnel is conservatively 20,800 cubic feet (13 feet wide by 10 feet tall by 160 feet long). Actual volume is much bigger.
Nitrogen comes from a dewar located near MI-60. 3/4 inch nominal size, type L copper lines bring the GN2 to this area

The calculated flow rate of gas out of this line if it were to be severed is:	111.9	cfm
Based on an outlet of 0 psig, and an inlet of :	100	psig
and a tubing length of:	1019	feet
Normal Ventillation Rate is :	900	cfm for this area
With the normal ventilation operating, the concentration of O2 would fall to :	0.1867719	% O2
However, the probability of having a brazed joint fail or of having one of the lines rupture is sufficiently low that the fatality rate would only get to:	8.18E-11	
Which results in an ODH classification of:	0	

Refer to the table below:

Elevation 626 feet
Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	70	1.00E-09	7.00E-08	111.9	0.1867719	4.09E-08	2.86E-15	0
brazed joint	leak	71	1.00E-09	7.10E-08	111.9	0.1867719	4.09E-08	2.90E-15	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	111.9	0.1867719	4.09E-08	4.09E-11	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	111.9	0.1867719	4.09E-08	4.09E-11	0
Total								8.18E-11	0

Complete rupture of the Nitrogen feed line in the Drill and Blast portion of the Carrier Tunnel.

The volume of this tunnel is conservatively 12000 cubic feet (10 feet wide by 6 feet tall by 200 feet long).
Nitrogen comes from a dewar located near MI-60. 3/4 inch nominal size, type L copper lines bring the GN2 to this area

The calculated flow rate of gas out of this line if it were to be severed is:	126.7	cfm
Based on an outlet of 0 psig, and an inlet of :	100	psig
and a tubing length of:	795	feet
Normal Ventillation Rate is :	1000	cfm for this area
With the normal ventilation operating, the concentration of O2 would fall to :	0.1863815	% O2
However, the probability of having a brazed joint fail or of having one of the lines rupture is sufficiently low that the fatality rate would only get to:	8.74E-11	
Which results in an ODH classification of:	0	

Refer to the table below:

Elevation 626 feet
Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	70	1.00E-09	7.00E-08	126.7	0.1863815	4.37E-08	3.06E-15	0
brazed joint	leak	71	1.00E-09	7.10E-08	126.7	0.1863815	4.37E-08	3.10E-15	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	126.7	0.1863815	4.37E-08	4.37E-11	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	126.7	0.1863815	4.37E-08	4.37E-11	0
Total								8.74E-11	0

Complete rupture of the Nitrogen feed line in the Round Concrete Pre-Cast Lined portion of the Carrier Tunnel.

The volume of this tunnel is conservatively 6107 cubic feet (6 feet diameter by 216 feet long).
Nitrogen comes from a dewar located near MI-60. 3/4 inch nominal size, type L copper lines bring the GN2 to this area

The calculated flow rate of gas out of this line if it were to be severed is:	151.7	cfm
Based on an outlet of 0 psig, and an inlet of :	100	psig
and a tubing length of:	555	feet
Normal Ventillation Rate is :	1000	cfm for this area
With the normal ventilation operating, the concentration of O2 would fall to :	0.1823446	% O2
However, the probability of having a brazed joint fail or of having one of the lines rupture is sufficiently low that the fatality rate would only get to:	1.75E-10	
Which results in an ODH classification of:	0	

Refer to the table below:
Elevation 626 feet
Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	70	1.00E-09	7.00E-08	151.7	0.1823446	8.73E-08	6.11E-15	0
brazed joint	leak	71	1.00E-09	7.10E-08	151.7	0.1823446	8.73E-08	6.20E-15	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	151.7	0.1823446	8.73E-08	8.73E-11	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	151.7	0.1823446	8.73E-08	8.73E-11	0
Total								1.75E-10	0

Complete rupture of the Nitrogen feed line in the Numi Stub and Stub Extension

The volume of this enclosure is conservatively 20000 cubic feet (10 feet wide, 10 feet tall by 200 feet long). Actual volume larger due to higher ceilings.
Nitrogen comes from a dewar located near MI-60. 3/4 inch nominal size, type L copper lines bring the GN2 to this area

The calculated flow rate of gas out of this line if it were to be severed is:	188.3	cfm
Based on an outlet of 0 psig, and an inlet of :	100	psig
and a tubing length of:	360	feet
Normal Ventillation Rate is :	1000	cfm for this area
With the normal ventilation operating, the concentration of O2 would fall to :	0.176721	% O2
However, the probability of having a brazed joint fail or of having one of the lines rupture is sufficiently low that the fatality rate would only get to:	4.57E-10	
Which results in an ODH classification of:	0	

Refer to the table below:
Elevation 626 feet
Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	70	1.00E-09	7.00E-08	188.3	0.176721	2.29E-07	1.60E-14	0
brazed joint	leak	71	1.00E-09	7.10E-08	188.3	0.176721	2.29E-07	1.62E-14	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	188.3	0.176721	2.29E-07	2.29E-10	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	188.3	0.176721	2.29E-07	2.29E-10	0
Total								4.57E-10	0

Concentration of O2 in the Mechanical Support Room as a function of time for normal ventilation and loss of ventilation conditions with the 'Normal' GN2 bleed rate into this space:

This area is ventilated by the main air handling equipment located in the MI-65 service building. The MI-65 equipment moves 440 cfm through this room. There is also a fan located at EAV-2 which draws air from the target hall and upstream spaces. The HVAC drawings indicate that EAV-2 should provide 26 cfm moving thru the mechanical support room. The volume is based on a room 12' tall, 35 feet long and 21.5 feet wide. There are four expansion tanks, each will get a little N2 bled thru it to remove any hydrogen. Bleed rate will be about 1 standard cubic feet per hour (scfh). This is 1/60 scfm. Therefore, bleed into the room will be 4*1/60 = 0.06667 cfm.

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

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room	Normal	Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cfm
440	0.066667	9030

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

Concentration, O2 % at (time = 10 days) = 20.9968

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

* O2 as a f(t) for the normal case of NuMI Mechanical Support Room

t, min	t, hrs	t, days	C, %
0	0	0	21.00
30	0.5	0.02	21.00
60	1	0.04	21.00
90	1.5	0.06	21.00
120	2	0.08	21.00
150	2.5	0.10	21.00
180	3	0.13	21.00
210	3.5	0.15	21.00
240	4	0.17	21.00
14400	240	10.00	21.00

Complete Loss of Ventilation:

Room	Normal	Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cfm
0	0.066667	9030

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

Concentration, O2 % at (time = 10 days) = 18.8820

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

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

t, min	t, hrs	t, days	C, %
0	0	0	21.0000
30	0.5	0.02	20.9953
60	1	0.04	20.9907
90	1.5	0.06	20.9861
120	2	0.08	20.9814
150	2.5	0.10	20.9768
180	3	0.13	20.9721
210	3.5	0.15	20.9675
240	4	0.17	20.9628
14400	240	10.00	18.8820

Partial Loss of Ventilation:

Room	Normal	Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cfm
26	0.066667	9030

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

Concentration, O2 % at (time = 10 days) = 20.9463

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

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

t, min	t, hrs	t, days	C, %
0	0	0	21.0000
30	0.5	0.02	20.9955
60	1	0.04	20.9915
90	1.5	0.06	20.9877
120	2	0.08	20.9843
150	2.5	0.10	20.9811
180	3	0.13	20.9782
210	3.5	0.15	20.9756
240	4	0.17	20.9732
14400	240	10.00	20.9463

ODH Calculations for the NuMI Underground Mechanical Support Room - GN2 gas Cylinder used for initial commissioning (gas used in the four expansion tanks)

Elevation	626 feet									
Pressure	743.6 torr									
Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class	
Pipes < 3" in THSR	Sections	20	1.00E-09	2.00E-08	230	0.204784	3162278	6.32E-02		0
Pipes < 3" in Target h	Sections	20	1.00E-09	2.00E-08	230	0.204784	3162278	6.32E-02		0
valve (MO\ in THSR	rupture	2	1.00E-08	2.00E-08	230	0.204784	3162278	6.32E-02		0
valve (MO\ in Target h	rupture	2	1.00E-08	2.00E-08	230	0.204784	3162278	6.32E-02		0
valve (AO\ in THSR	rupture	2	1.00E-09	2.00E-09	230	0.204784	3162278	6.32E-03		0
valve (AO\ in Target h	rupture	2	1.00E-09	2.00E-09	230	0.204784	3162278	6.32E-03		0
brazed join in THSR	rupture	50	1.00E-09	5.00E-08	230	0.204784	3162278	1.58E-01		0
brazed join in Target h	rupture	50	1.00E-09	5.00E-08	230	0.204784	3162278	1.58E-01		0
Total								4.24E-01		0

Complete rupture of the GN2 from a cylinder and the expansion tanks into the NuMI Underground Mechanical Support Room:

GN2 from a 200 cubic foot (230 used in the calculation) gas cylinder supplies GN2 to the water expansion tanks.
The maximum loss of helium is 230 cubic feet. This can occur in the mechanical room

The volume of the expansion tanks (3 @ 100 gallons + 1 at 30 gallons) half full	165	gallons
The volume of the expansion tanks (3 @ 100 gallons + 1 at 30 gallons) half full	22.058824	cubic feet
Capacity of the expansion tanks half filled with gas at 15 psig	44.117647	scf
The volume of the room housing the gas cylinder is:	9030	cubic feet

Oxygen concentration assuming no ventilation and a sudden 200 cubic foot gas release in the room is:
Target Hall Support room (THSR): 0.204784 fraction O2

Oxygen concentration assuming no ventilation and a sudden 275 cubic foot (230 + 45 cubic feet) gas release in the room is:
Target Hall Support room (THSR): 0.203794 fraction O2
Note, this analysis is applicable if the gas is changed from GN2 to argon.
In both areas, the O2 concentration does not fall below 18% considering an instantanous loss of the cylinder contents and no ventilation. No further analysis is required.

ODH Calculations for the NuMI Muon Alcoves Room with the inert gas mixture used in the muon detectors and the hadron monitor:

Complete Loss of Gas Bottle Contents at the Gas Rack below ground at MINOS Shaft bottom:

Muon Monitor and the Hadron gas system will use eight (8) two hundred (200) cubic foot bottles of inert gas connected to a manifold.
This bottle manifold will be in the underground near the MINOS shaft (not in the fire escape egress passage).
The volume in the area of the MINOS shaft is not less than : 69272.12 cubit feet
based on a tunnel cross section of 21 feet diameter extending 100 feet towards MINOS and 100 feet up the shaft
Should this manifold suddenly loose 100% of all eight bottle inert contents into this space, the oxygen concentration (assuming no ventilation) will drop to:

Concentration, O2 %= 20.52591 — This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Complete Loss of Gas Bottle Contents at the Gas Rack below ground in a Muon Alcove:

Muon Monitor and the Hadron gas system will use eight (8) two hundred (200) cubic foot bottles of inert gas connected to a manifold.
This bottle manifold will be in the underground near the MINOS shaft (not in the fire escape egress passage) and piped to the alcoves.
The volume in the muon alcove is not less than : 3016 cubic feet
based on a space 9'-10" deep, 12 feet tall and 12 feet across and a hallway 8' wide, by 8' tall by 25 feet long
Should this manifold suddenly loose 100% of all eight bottle inert contents into this space, the oxygen concentration (assuming no ventilation) will drop to:

Concentration, O2 %= 13.72097 — This would be an ODH condition since the oxygen concentration falls below 18%
One needs to consider the probability of the valves failing and causing the entire contents of the gas rack to dump into one muon alcove.

ODH Calculations for the NuMI Muon Alcoves Room with the inert gas mixture used in the muon detectors and the hadron monitor considering the probability of a failure of each component. Assumes the entire contents of the gas rack discharge into one Muon Alcove in 1 minute time:

Elevation 430 feet
Pressure 748.7 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	200	1.00E-09	2.00E-07	1840	0.04832636	1	2.00E-07	0
valve (MOV)	rupture	2	1.00E-08	2.00E-08	1840	0.04832636	1	2.00E-08	0
valve (AOV)	rupture	2	1.00E-09	2.00E-09	1840	0.04832636	1	2.00E-09	0
brazed joint	leak	10	1.00E-09	1.00E-08	1840	0.04832636	1	1.00E-08	0
partial ventilation	fail to run	1	1.00E-03	1.00E-03	0.03532	0.209986515	5.99233E-10	5.99E-13	0
complete ventilation	fail to run	1	1.00E-03	1.00E-03	0.03532	0.209986515	5.99233E-10	5.99E-13	0
Total								2.32E-07	0

Conclusion: The ODH classification remains 0 because of the probability of the failures remains sufficiently low.

Complete Loss of Gas Bottle Contents at the Gas Rack below ground in the Absorber Enclosure:

Muon Monitor and the Hadron gas system will use eight (8) two hundred (200) cubic foot bottles of inert gas connected to a manifold.
This bottle manifold will be in the underground near the MINOS shaft (not in the fire escape egress passage) and piped to the alcoves.
The volume in the absorber enclosure is not less than : 15820 cubic feet
based on a space 40 feet long, 20 feet hgh and 27 feet wide minus the 17' by 17' by 20' absorber volume. This includes the first muon counter location.
Should this manifold suddenly loose 100% of all eight bottle inert contents into this space, the oxygen concentration (assuming no ventilation) will drop to:

Concentration, O2 %= 19.07118

This would not be an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Concentration of O2 in the Muon Alcoves as a function of time for normal ventilation and loss of ventilation conditions:

There are two ventilation fans in this area. One fan exchanges air with the absorber access tunnel at 495 cfm. The other fan is the exhaust fan which draws air out of each alcove (and the vacuum pump exhaust) at a rate of approximately 55 cfm and transports this air to the suction of EAV-3 near the middle of the decay pipe. Each of these fans provide air exchange for the alcoves. One case considers the loss of the both fans while the other considers the loss of the large fan. Muon Alcove Volume is approximately 9'-10 in z, 12'-0 tall and 12'-0 wide. The hallway entry is about 8'-0 wide, 8'-0 tall and about 25'-0 long. The hallway volume is ignored below.

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

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room	Normal	Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cf
550	0.03532	3016

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

Complete Loss of Ventilation:

Room		Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cf
0	0.03532	3016

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

Partial Loss of Ventilation:

Room	Normal	Room
Vent rate	Spill Rate	Volume
Q, cfm	R, cfm	V, cf
55	0.03532	3016

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

Per Sacha Kopp, the anticipated gas usage thru the detector is.60 liters per hour which equates to 0.03532 cfm

Concentration, O2 % at (time = 10 days) = 20.9987

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

Concentration, O2 % at (time = 10 days) = 17.7411

This does cause an ODH condition after two days of ventilation loss since the oxygen concentration falls below 18%
However, because the probability of both fans failing is low (see the table below), the ODH class remains at 0

Concentration, O2 % at (time = 10 days) = 20.9865

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

* O2 as a f(t) for the normal case of NuMI Muon Alcoves

t, min	t, hrs	t, days	C, %
0	0	0	21.0000
30	0.5	0.02	20.9987
60	1	0.04	20.9987
90	1.5	0.06	20.9987
120	2	0.08	20.9987
150	2.5	0.10	20.9987
180	3	0.13	20.9987
210	3.5	0.15	20.9987
240	4	0.17	20.9987
14400	240	10.00	20.9987

* O2 as a f(t) for the worst case ventilation loss of NuMI Muon Alcoves

t, min	t, hrs	t, days	C, %
0	0	0	21.0000
30	0.5	0.02	20.9926
60	1	0.04	20.9852
90	1.5	0.06	20.9779
120	2	0.08	20.9705
150	2.5	0.10	20.9631
180	3	0.13	20.9558
210	3.5	0.15	20.9484
240	4	0.17	20.9411
14400	240	10.00	17.7411

* O2 as a f(t) for another case of ventilation loss for the NuMI Muon Alcoves

t, min	t, hrs	t, days	C, %
0	0	0	21.0000
30	0.5	0.02	20.9943
60	1	0.04	20.9910
90	1.5	0.06	20.9891
120	2	0.08	20.9880
150	2.5	0.10	20.9874
180	3	0.13	20.9870
210	3.5	0.15	20.9868
240	4	0.17	20.9867
14400	240	10.00	20.9865

ODH Calculations for the NuMI Muon Alcoves Room with the inert gas mixture used in the muon detectors and the hadron monitor considering the probability of a failure of each component. Assumes steady leak rate and a fan failure:

Elevation 430 feet
Pressure 748.7 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Steady Vent		1	1.00E+00	1.00E+00	0.03532	0.209986515	5.99233E-10	5.99E-10	0
partial ventilation	fail to run	1	1.00E-03	1.00E-03	0.03532	0.209865228	6.11895E-10	6.12E-13	0
complete ventilation	fail to run	1	1.00E-03	1.00E-03	0.03532	0.177411328	1.64669E-07	1.65E-10	0
Total								7.65E-10	0

Conclusion: The ODH classification remains 0 because of the probability of the failures remains sufficiently low.

ODH Calculations for the NuMI Electrical Support Room with the 80-20 Argon and CO2 mixture used in the Total loss monitor (TLM):

Elevation 626 feet
Pressure 743.6 torr

Item	Type	Number	Failure Rate	Group Failure Rate	Leak Rate (SCFM)	fO2 Fraction O2	Fatality Factor	Fatality Rate	ODH Class
Pipes < 3"	Sections	20	1.00E-09	2.00E-08	200	0.144375	5.81E-05	1.16E-12	0
valve (MOV)	rupture	2	1.00E-08	2.00E-08	200	0.144375	5.81E-05	1.16E-12	0
valve (AOV)	rupture	2	1.00E-09	2.00E-09	200	0.144375	5.81E-05	1.16E-13	0
brazed joint	leak	100	1.00E-09	1.00E-07	200	0.144375	5.81E-05	5.81E-12	0
partial ventillation	fail to run	1	1.00E-03	1.00E-03	0.002111	0.209999	7.66E-10	7.66E-13	0
complete ventillation	fail to run	1	1.00E-03	1.00E-03	0.002111	0.209999	7.66E-10	7.66E-13	0
Total								9.79E-12	0

Complete Loss of Gas Bottle Contents at the Gas Rack below ground in the Electrical Support Room (location of gas bottle rack and the bubbler):

Loss Monitor (TLM) gas system will use one (1) two hundred (200) cubic foot bottle of Argon (80%) and C02 (20%) (230 cubic feet used below)
This bottle will be in the electrical support room underground. The volume of this area is 11,445 cubic feet.
Should this bottle suddenly loose 100% of its inert contents into this room, the oxygen concentration (assuming no ventillation) will drop to:

Concentration, O2 %= 20.5863

This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Complete Loss of Gas Bottle Contents in the Pretarget Tunnel.

Loss Monitor (TLM) gas system will use one (1) two hundred (200) cubic foot bottle of Argon (80%) and C02 (20%) (230 cubic feet used below)
The volume of this tunnel is conservatively 20,800 cubic feet (13 feet wide by 10 feet tall by 160 feet long). Actual volume is much bigger.
Should this bottle suddenly loose 100% of its inert contents into this room, the oxygen concentration (assuming no ventillation) will drop to:

Concentration, O2 %= 20.77033

This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Complete Loss of Gas Bottle Contents in the Drill and Blast portion of the Carrier Tunnel.

Loss Monitor (TLM) gas system will use one (1) two hundred (200) cubic foot bottle of Argon (80%) and C02 (20%) (230 cubic feet used below)
The volume of this tunnel is conservatively 12000 cubic feet (10 feet wide by 6 feet tall by 200 feet long).
Should this bottle suddenly loose 100% of its inert contents into this room, the oxygen concentration (assuming no ventillation) will drop to:

Concentration, O2 %= 20.60507

This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Complete Loss of Gas Bottle Contents in the Round Concrete Pre-Cast Lined portion of the Carrier Tunnel.

Loss Monitor (TLM) gas system will use one (1) two hundred (200) cubic foot bottle of Argon (80%) and C02 (20%) (230 cubic feet used below)
The volume of this tunnel is conservatively 6107 cubic feet (6 feet diameter by 216 feet long). .
Should this bottle suddenly loose 100% of its inert contents into this room, the oxygen concentration (assuming no ventillation) will drop to:

Concentration, O2 %= 20.23781

This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Complete Loss of Gas Bottle Contents in the Numi Stub and Stub Extension

Loss Monitor (TLM) gas system will use one (1) two hundred (200) cubic foot bottle of Argon (80%) and C02 (20%) (230 cubic feet used below)
The volume of this enclosure is conservatively 20000 cubic feet (10 feet wide, 10 feet tall by 200 feet long). Actual volume larger due to higher ceilings.
Should this bottle suddenly loose 100% of its inert contents into this room, the oxygen concentration (assuming no ventillation) will drop to:

Concentration, O2 %= 20.76125

This does not cause an ODH condition since the oxygen concentration remains above 18%
One does not need to go any further and consider the probability if this failure occuring since even if the bottle was breached, the oxygen concentration stays above 18%

Concentration of O2 in the NuMI Electrical Support Room as a function of time for normal ventilation and loss of ventilation conditions:

This area is ventilated by the main air handling equipment located in the MI-65 service building. The MI-65 equipment moves 440 cfm through this room. There is also a fan located at EAV-2 which draws air from the target hall and upstream spaces. The HVAC drawings indicate that EAV-2 should provide 26 cfm moving thru the electrical support room. This area is also ventilated by the penetration strip line fan, which has a capacity larger than 26 cfm.

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

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
440	0.002111	11445

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

Per Dan Schoo, the anticipated gas usage thru the detector is 86 liters per day which equates to 0.00211 cfm

Concentration, O2 % at (time = 10 days) = 20.9999

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

* O2 as a f(t) for the normal case of NuMI electrical Support Room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9999
90	1.5	0.06	20.9999
120	2	0.08	20.9999
14400	240	10.00	20.9999

Complete Loss of Ventilation:

Room Vent rate Q, cfm	Spill Rate R, cfm	Room Volume V, cf
0	0.002111	11445

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

Concentration, O2 % at (time = 10 days) = 20.9443

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

* O2 as a f(t) for the worst case ventilation loss of NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9998
90	1.5	0.06	20.9997
120	2	0.08	20.9995
14400	240	10.00	20.9443

Partial Loss of Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
26	0.002111	11445

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

Concentration, O2 % at (time = 10 days) = 20.9983

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

* O2 as a f(t) for another case of ventilation loss for the NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9998
90	1.5	0.06	20.9997
120	2	0.08	20.9996
14400	240	10.00	20.9983

Concentration of O2 in the NuMI Pre-Target Tunnel as a function of time for normal ventilation and loss of ventilation conditions:

This area is ventilated by the main air handling equipment located in the MI-65 service building. The MI-65 equipment moves about 900 cfm through this tunnel. There is also a fan located at EAV-1 which draws air out of this tunnel and exhausts at a rate of 900 cfm. The volume of this tunnel is conservatively 20,800 cubic feet (13 feet wide by 10 feet tall by 160 feet long). Actual volume is much bigger.

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

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
900	0.002111	20800

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

Per Dan Schoo, the anticipated gas usage thru the detector is 86 liters per day which equates to 0.00211 cfm

Concentration, O2 % at (time = 10 days) = 21.0000

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

* O2 as a f(t) for the normal case of NuMI electrical Support Room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	21.0000
60	1	0.04	21.0000
90	1.5	0.06	21.0000
120	2	0.08	21.0000
14400	240	10.00	21.0000

Complete Loss of Ventilation:

Room Vent rate Q, cfm	Spill Rate R, cfm	Room Volume V, cf
0	0.002111	20800

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

Concentration, O2 % at (time = 10 days) = 20.9693

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

* O2 as a f(t) for the worst case ventilation loss of NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9999
90	1.5	0.06	20.9998
120	2	0.08	20.9997
14400	240	10.00	20.9693

Partial Loss of Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
26	0.002111	20800

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

Concentration, O2 % at (time = 10 days) = 20.9983

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

* O2 as a f(t) for another case of ventilation loss for the NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9999
90	1.5	0.06	20.9998
120	2	0.08	20.9998
14400	240	10.00	20.9983

Concentration of O2 in the NuMI RCP Carrier Tunnel as a function of time for normal ventilation and loss of ventilation conditions:

This area is ventilated by two 1000 cfm fans. One fan pressurizes the area, the other draws air out of the area and into the pre-target tunnel. The volume of this space is about 12000 cubic feet. This assumes that the TLM bleeds 86 liters per day into this volume as a result of a pipe or tube failure and that there is a problem with the ventilation.

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

VERY (!) Simple O2 concentration Calculations

Normal Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
1000	0.002111	12000

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

Per Dan Schoo, the anticipated gas usage thru the detector is 86 liters per day which equates to 0.00211 cfm

Concentration, O2 % at (time = 10 days) = 21.0000

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

* O2 as a f(t) for the normal case of NuMI electrical Support Room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	21.0000
60	1	0.04	21.0000
90	1.5	0.06	21.0000
120	2	0.08	21.0000
14400	240	10.00	21.0000

Complete Loss of Ventilation:

Room Vent rate Q, cfm	Spill Rate R, cfm	Room Volume V, cf
0	0.002111	12000

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

Concentration, O2 % at (time = 10 days) = 20.9469

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

* O2 as a f(t) for the worst case ventilation loss of NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9998
90	1.5	0.06	20.9997
120	2	0.08	20.9996
14400	240	10.00	20.9469

Partial Loss of Ventilation:

Room Vent rate Q, cfm	Normal Leak Rate R, cfm	Room Volume V, cf
500	0.002111	12000

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

Concentration, O2 % at (time = 10 days) = 20.9999

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

* O2 as a f(t) for another case of ventilation loss for the NuMI electrical support room

t, min	t, hrs	t, days	O2 %
0	0	0	21.0000
30	0.5	0.02	20.9999
60	1	0.04	20.9999
90	1.5	0.06	20.9999
120	2	0.08	20.9999
14400	240	10.00	20.9999

Measured Distances in the MI Enclosure

Downstream from Q608 Quad	Reference Point	Upstream from Q624 Quad
-0.50	MI-60 Equipment Gallery RF19 Penetration	770.75
0.00	Q608 Center	770.25
0.50	MI-60 Equipment Gallery RF18 Penetration	769.75
50.00	Downstream Wall of Q609 Alcove	720.25
58.00	Q609 Center	712.25
77.75	Barrier Gate	692.50
99.92	Q610 Center	670.33
142.67	Q611 Center	627.58
185.50	Q612 Center	584.75
188.25	Exit Door Center Line	582.00
227.33	Q613 Center	542.92
244.00	Dual LCW Headers From MI-62 Transition Over Aisle	526.25
264.42	Edge of Wall Dividing A150 Line and Main Injector	505.83
285.00	Q614 Center	485.25
343.00	Q615 Center	427.25
359.17	Edge of Wall Dividing NuMI Stub and Main Injector	411.08
372.58	Enclosure Takes a Step Change in Width	397.67
385.17	Q616 Center	385.08
400.33	Level of Dual 18 Inch Tray Moves 10 Feet Toward S	369.92
427.92	Q617 Center	342.33
432.83	Enclosure Takes a Step Change in Width	337.42
436.67	Center Line of Passage to NuMI Stub Access	333.58
470.75	Q618 Centerline	299.50
504.92	Center Line of Penetrations to NuMI Stub	265.33
512.75	Q619 Center	257.50
513.50	Center Line of Exhaust Pipe from NuMI Stub	256.75
570.50	Q620 Center	199.75
583.33	End of 2nd Level of Dual 18 Inch Cable Tray	186.92
627.50	Q621 Center	142.75
685.42	Q622 Center	84.83
727.58	Q623 Center	42.67
744.83	MI-62 Controls/Kicker Room K1 Penetration	25.42
758.17	MI-62 Controls/Kicker Room K12 Penetration	12.08
762.42	Upstream Wall of MI-62 Alcove	7.83
763.25	MI-62 Power Supply Room Penetrations 1 and 11	7.00
767.33	Ceiling LCW Penetrations	2.92
770.25	Q624 Center	0.00
771.33	MI-62 Power Supply Room Penetrations 10 and 20	-1.08
778.33	Downstream Wall of MI-62 Alcove	-8.08

@ Q108

line	location	typ_code	distance	x	y	z	brng	pitch
	[ft]	[ft]	[ft]	[ft]	[deg]	[deg]	[deg]	
0	S1_BML	marker	-56.88634	101383.293	97215.3773	715.72409	148.73096	0.10571
1	LAM60	MI_LAM	-56.88634	101383.293	97215.3773	715.72409	148.73096	0.10571
2	LAMEND	DRIFT	-47.7	101375.48	97220.2106	715.74102	148.69343	0.21142
3	QSPOOL	drift	-46.94423	101374.835	97220.6033	715.74381	148.69343	0.21142
4	QENDU	drift	-46.52756	101374.479	97220.8198	715.74535	148.69343	0.21142
5	HQ608	3Q84/2	-46.40256	101374.372	97220.8848	715.74581	148.72552	0.22202
6	HQ608	3Q84/2	-42.90257	101371.38	97222.7018	715.7593	148.78998	0.24866
7	QENDD	drift	-39.40258	101368.387	97224.5154	715.77442	148.82235	0.26471
8	BPM	MI_BPM	-39.21006	101368.222	97224.6151	715.77531	148.82235	0.26471
9	D3IN	drift	-38.54339	101367.652	97224.9602	715.77839	148.82235	0.26471
10	LAMEND	DRIFT	-38.29339	101367.438	97225.0896	715.77954	148.82235	0.26471
11	LAM61A	MI_LAM	-37.53762	101366.791	97225.4809	715.78302	148.81805	0.47957
12	LAMEND	DRIFT	-28.35129	101358.932	97230.2372	715.85992	148.81376	0.69442
13	LSPOOL	drift	-27.59552	101358.286	97230.6285	715.86907	148.81376	0.69442
14	LAMEND	DRIFT	-27.09552	101357.858	97230.8874	715.87514	148.81376	0.69442
15	LAM61B	MI_LAM	-26.33974	101357.211	97231.2788	715.8843	148.81376	0.90957
16	LAMEND	DRIFT	-17.15341	101349.353	97236.0357	716.03016	148.81376	1.12472
17	VALVE	VALVE	-16.3976	101348.706	97236.4271	716.04502	148.81376	1.12472
18	LCSPOO	drift	-15.89761	101348.278	97236.6859	716.05483	148.81376	1.12472
19	CMGEND	DRIFT	-15.42198	101347.872	97236.9322	716.06418	148.81376	1.12472
20	V100	MI_CMG	-14.75532	101347.301	97237.2773	716.07724	148.81376	1.36536
21	CMGEND	DRIFT	-3.75531	101337.894	97242.9718	716.33935	148.81376	1.606
22	NOVALV	drift	-3.08864	101337.324	97243.3168	716.35805	148.81376	1.606
23	Q12_UP	DRIFT	-2.58864	101336.896	97243.5756	716.37206	148.81376	1.606
24	HQD101	3Q120/2	-2.01571	101336.406	97243.8722	716.3881	148.81376	1.606
25	HQD101	3Q120/2	2.98428	101332.13	97246.4603	716.52826	148.81376	1.606
26	Q101DN	drift	7.98427	101327.855	97249.0484	716.66838	148.81376	1.606
27	IP101A	ionpump	8.8905	101327.08	97249.5175	716.69378	148.81376	1.606
28	P101SE	drift	9.3905	101326.652	97249.7763	716.70779	148.81376	1.606
29	IP101B	ionpump	15.6481	101321.301	97253.0153	716.88318	148.81376	1.606
30	V101UP	drift	16.1481	101320.873	97253.2741	716.89719	148.81376	1.606
31	VP101	BPM	16.78766	101320.326	97253.6052	716.9151	148.81376	1.606
32	BPM_DN	DRIFT	17.321	101319.87	97253.8813	716.93006	148.81376	1.606
33	BPM_UP	DRIFT	17.42933	101319.778	97253.9374	716.93308	148.81376	1.606
34	HP101	BPM	17.70433	101319.542	97254.0797	716.94079	148.81376	1.606
35	H101DN	drift	18.23766	101319.086	97254.3558	716.95575	148.81376	1.606
36	PM101	MUWIRE	19.22982	101318.238	97254.8693	716.98357	148.81376	1.606
37	DUP4	drift	20.04648	101317.539	97255.292	717.00644	148.81376	1.606
38	IP101C	ionpump	22.53299	101315.413	97256.5791	717.07612	148.81376	1.606
39	RWMUPS	drift	23.03299	101314.986	97256.8379	717.09013	148.81376	1.606
40	RWCM01	REWAMON	23.50172	101314.585	97257.0805	717.10329	148.81376	1.606
41	RWMDNS	drift	24.09549	101314.077	97257.3879	717.11992	148.81376	1.606
42	TOR1UP	DRIFT	24.35933	101313.851	97257.5245	717.12731	148.81376	1.606
43	TOR101	TOROID	24.57042	101313.671	97257.6337	717.13324	148.81376	1.606
44	TOR1DN	DRIFT	25.28919	101313.056	97258.0058	717.15339	148.81376	1.606
45	MIC2UP	DRIFT	25.35169	101313.003	97258.0381	717.15513	148.81376	1.606
46	HT102	MIHC	25.69234	101312.711	97258.2144	717.16467	148.81376	1.606

47	MICR_D	DRIFT	26.69234	101311.856	97258.7321	717.19269	148.81376	1.606
48	EPB_UP	DRIFT	26.99443	101311.598	97258.8884	717.20116	148.81376	1.606
49	HV01_1	EPB	27.5465	101311.126	97259.1742	717.21664	149.14292	1.606
50	EPB_DN	DRIFT	37.54655	101302.545	97264.3011	717.49689	149.47208	1.606
51	EPB_UP	DRIFT	37.99445	101302.159	97264.5286	717.50946	149.47208	1.606
52	HV01_2	EPB	38.54654	101301.684	97264.8089	717.52494	149.80067	1.58451
53	EPB_DN	DRIFT	48.54656	101293.044	97269.8371	717.80142	150.12927	1.56303
54	Q12_UP	DRIFT	48.99449	101292.656	97270.0601	717.81362	150.12927	1.56303
55	HQF102	3Q120/2	49.56742	101292.159	97270.3453	717.82927	150.12927	1.56303
56	HQF102	3Q120/2	54.56741	101287.825	97272.8347	717.96562	150.12927	1.56303
57	Q12_DN	DRIFT	59.5674	101283.491	97275.324	718.10198	150.12927	1.56303
58	BPM_UP	DRIFT	59.99447	101283.121	97275.5366	718.11362	150.12927	1.56303
59	HP102	BPM	60.26947	101282.883	97275.6735	718.12114	150.12927	1.56303
60	BPM_DN	DRIFT	60.8028	101282.42	97275.939	718.13567	150.12927	1.56303
61	PUMP	PUMP	60.91113	101282.326	97275.993	718.13862	150.12927	1.56303
62	EPB_UP	DRIFT	61.24446	101282.037	97276.1589	718.14771	150.12927	1.56303
63	HV01_3	EPB	61.79656	101281.559	97276.4338	718.16277	150.42921	1.4281
64	EPB_DN	DRIFT	71.79658	101272.864	97281.3672	718.41195	150.72915	1.29317
65	EPB_UP	DRIFT	72.24451	101272.473	97281.5862	718.42205	150.72915	1.29317
66	HV01_4	EPB	72.79657	101271.992	97281.856	718.43452	150.97008	1.06857
67	EPB_DN	DRIFT	82.79662	101263.25	97286.7078	718.62097	151.21101	0.84397
68	EPB_UP	DRIFT	83.24452	101262.857	97286.9235	718.62757	151.21101	0.84397
69	HV01_5	EPB	83.79662	101262.374	97287.1894	718.6357	151.45996	0.62882
70	EPB_DN	DRIFT	93.79666	101253.589	97291.9668	718.74548	151.70891	0.41368
71	MICR_U	DRIFT	94.24456	101253.195	97292.1791	718.74869	151.70891	0.41368
72	VT103	MIHC-R	94.73416	101252.764	97292.4111	718.75224	151.70891	0.41368
73	MICR_D	DRIFT	95.73416	101251.883	97292.8851	718.75945	151.70891	0.41368
74	Q12_UP	DRIFT	96.03623	101251.617	97293.0282	718.76165	151.70891	0.41368
75	HQD103	3Q120/2	96.60916	101251.113	97293.2998	718.76579	151.70891	0.41368
76	HQD103	3Q120/2	101.60915	101246.71	97295.6695	718.80188	151.70891	0.41368
77	Q12_DN	DRIFT	106.60914	101242.308	97298.0392	718.838	151.70891	0.41368
78	BPM_UP	DRIFT	107.0362	101241.931	97298.2416	718.84108	151.70891	0.41368
79	VP103	BPM	107.3112	101241.689	97298.3719	718.84305	151.70891	0.41368
80	BPM_DN	DRIFT	107.84453	101241.22	97298.6247	718.84692	151.70891	0.41368
81	PUMP	PUMP	107.95287	101241.124	97298.676	718.84768	151.70891	0.41368
82	EPB_UP	DRIFT	108.2862	101240.831	97298.834	718.8501	151.70891	0.41368
83	HV01_6	EPB	108.8383	101240.345	97299.0956	718.85407	151.95786	0.19853
84	EPB_DN	DRIFT	118.83831	101231.519	97303.7968	718.88875	152.20681	-0.01662
85	DRC0	drift	119.28624	101231.122	97304.0057	718.88862	152.20681	-0.01662
86	DRMTDX	drift	121.70743	101228.981	97305.1346	718.88793	152.20681	-0.01662
87	BPM_UP	DRIFT	132.30456	101219.606	97310.0759	718.88488	152.20681	-0.01662
88	HP104	BPM	132.57956	101219.363	97310.2041	718.88478	152.20681	-0.01662
89	BPM_DN	DRIFT	133.11289	101218.891	97310.4528	718.88462	152.20681	-0.01662
90	Q12_UP	DRIFT	133.22122	101218.795	97310.5033	718.88459	152.20681	-0.01662
91	HQF104	3Q60/2	133.79415	101218.288	97310.7704	718.88442	152.20681	-0.01662
92	HQF104	3Q60/2	136.29415	101216.077	97311.9361	718.8837	152.20681	-0.01662
93	Q12_DN	DRIFT	138.79414	101213.865	97313.1018	718.88298	152.20681	-0.01662
94	DR104D	drift	139.22121	101213.487	97313.301	718.88288	152.20681	-0.01662
95	SYTR_U	DRIFT	140.91911	101211.985	97314.0927	718.88239	152.20681	-0.01662

96	H104	SYTRIM	141.56494	101211.414	97314.3938	718.88219	152.20681	-0.01662
97	SYTR_D	DRIFT	144.48163	101208.834	97315.7538	718.88134	152.20681	-0.01662
98	BPM_UP	DRIFT	144.93997	101208.428	97315.9675	718.88121	152.20681	-0.01662
99	HP105	BPM	145.21497	101208.185	97316.0957	718.88114	152.20681	-0.01662
100	BPM_DN	DRIFT	145.7483	101207.713	97316.3444	718.88098	152.20681	-0.01662
101	SFOUR_	adapter	145.85663	101207.617	97316.3949	718.88094	152.20681	-0.01662
102	PM105	MUWIRE	146.00246	101207.488	97316.4629	718.88091	152.20681	-0.01662
103	SFOUR_	adapter	147.33579	101206.309	97317.0846	718.88052	152.20681	-0.01662
104	Q12_UP	DRIFT	147.48163	101206.18	97317.1526	718.88048	152.20681	-0.01662
105	HQF105	3Q120/2	148.05453	101205.673	97317.4198	718.88032	152.20681	-0.01662
106	HQF105	3Q120/2	153.05452	101201.25	97319.7512	718.87888	152.20681	-0.01662
107	Q12_DN	DRIFT	158.05451	101196.827	97322.0826	718.87743	152.20681	-0.01662
108	MICR_U	DRIFT	158.48161	101196.449	97322.2817	718.8773	152.20681	-0.01662
109	HT105	MIHC	158.97117	101196.016	97322.51	718.87717	152.20681	-0.01662
110	MICR_D	DRIFT	159.97117	101195.131	97322.9763	718.87688	152.20681	-0.01662
111	DRMTU1	drift	160.27327	101194.864	97323.1171	718.87681	152.20681	-0.01662
112	DRMTD	drift	182.05597	101175.594	97333.274	718.87051	152.20681	-0.01662
113	BPM_UP	DRIFT	203.1114	101156.968	97343.0917	718.86444	152.20681	-0.01662
114	VP106	BPM	203.3864	101156.724	97343.22	718.86434	152.20681	-0.01662
115	BPM_DN	DRIFT	203.91974	101156.253	97343.4687	718.86421	152.20681	-0.01662
116	Q12_UP	DRIFT	204.02807	101156.157	97343.5192	718.86418	152.20681	-0.01662
117	HQD106	3Q120/2	204.60097	101155.65	97343.7863	718.86402	152.20681	-0.01662
118	HQD106	3Q120/2	209.60096	101151.227	97346.1177	718.86257	152.20681	-0.01662
119	Q12_DN	DRIFT	214.60098	101146.804	97348.4491	718.86113	152.20681	-0.01662
120	MICR_U	DRIFT	215.02805	101146.426	97348.6483	718.861	152.20681	-0.01662
121	VT106	MIHC-R	215.51761	101145.993	97348.8765	718.86087	152.20681	-0.01662
122	MICR_D	DRIFT	216.51761	101145.108	97349.3428	718.86057	152.20681	-0.01662
123	DRMTU	drift	216.81971	101144.841	97349.4837	718.86047	152.20681	-0.01662
124	DRMTD1	drift	237.27098	101126.749	97359.0197	718.8546	152.20681	-0.01662
125	BPM_UP	DRIFT	258.03479	101108.38	97368.7015	718.8486	152.20681	-0.01662
126	HP107	BPM	258.30979	101108.137	97368.8297	718.84853	152.20681	-0.01662
127	BPM_DN	DRIFT	258.84312	101107.665	97369.0784	718.84837	152.20681	-0.01662
128	SFOUR_	adapter	258.95145	101107.57	97369.1289	718.84833	152.20681	-0.01662
129	PM107	MUWIRE	259.09728	101107.441	97369.1969	718.8483	152.20681	-0.01662
130	SFOUR_	adapter	260.43061	101106.261	97369.8186	718.84791	152.20681	-0.01662
131	Q12_UP	DRIFT	260.57645	101106.132	97369.8866	718.84787	152.20681	-0.01662
132	HQF107	3Q120/2	261.14935	101105.625	97370.1538	718.84771	152.20681	-0.01662
133	HQF107	3Q120/2	266.14934	101101.202	97372.4851	718.84627	152.20681	-0.01662
134	Q12_DN	DRIFT	271.14933	101096.779	97374.8165	718.84482	152.20681	-0.01662
135	MICR_U	DRIFT	271.57643	101096.401	97375.0157	718.84469	152.20681	-0.01662
136	HT107	MIHC	272.06599	101095.968	97375.244	718.84456	152.20681	-0.01662
137	MICR_D	DRIFT	273.06599	101095.083	97375.7102	718.84426	152.20681	-0.01662
138	DRMTU2	drift	273.36809	101094.816	97375.8511	718.84417	152.20681	-0.01662
139	DRMTDM	drift	294.35066	101076.254	97385.6349	718.83813	152.20681	-0.01662
140	MICR_U	DRIFT	312.87441	101059.867	97394.2721	718.83278	152.20681	-0.01662
141	VT108	MIHC-R	313.36401	101059.434	97394.5004	718.83262	152.20681	-0.01662
142	MICR_D	DRIFT	314.364	101058.55	97394.9667	718.83235	152.20681	-0.01662
143	BPM_UP	DRIFT	314.66607	101058.282	97395.1076	718.83226	152.20681	-0.01662
144	VP108	BPM	314.94107	101058.039	97395.2358	718.83219	152.20681	-0.01662

145	BPM_DN	DRIFT	315.4744	101057.567	97395.4845	718.83203	152.20681	-0.01662
146	SFOUR_	adapter	315.58273	101057.471	97395.535	718.83199	152.20681	-0.01662
147	PM108	MUWIRE	315.72857	101057.342	97395.603	718.83196	152.20681	-0.01662
148	SFOUR_	adapter	317.0619	101056.163	97396.2247	718.83157	152.20681	-0.01662
149	Q12_UP	DRIFT	317.20773	101056.034	97396.2927	718.83153	152.20681	-0.01662
150	HQD108	3Q120/2	317.78066	101055.527	97396.5598	718.83137	152.20681	-0.01662
151	HQD108	3Q120/2	322.78065	101051.104	97398.8912	718.82993	152.20681	-0.01662
152	Q12_DN	DRIFT	327.78064	101046.681	97401.2227	718.82848	152.20681	-0.01662
153	SMIDGE	drift	328.20771	101046.303	97401.4218	718.82835	152.20681	-0.01662
154	FOUR_6	adapter	329.34951	101045.293	97401.9542	718.82802	152.20681	-0.01662
155	B2_UPS	DRIFT	329.51617	101045.145	97402.0319	718.82796	152.20681	-0.01662
156	V108_1	B2	330.13074	101044.602	97402.3185	718.82779	152.20681	-0.76089
157	B2_DNS	DRIFT	350.04792	101026.984	97411.6044	718.56326	152.20681	-1.50516
158	B2_UPS	DRIFT	350.60002	101026.496	97411.8617	718.54876	152.20681	-1.50516
159	V108_2	B2	351.21459	101025.953	97412.1482	718.53262	152.20681	-2.24972
160	B2_DNS	DRIFT	371.13177	101008.347	97421.4278	717.75073	152.20681	-2.99428
161	FOUR_6	adapter	371.68387	101007.859	97421.6849	717.72189	152.20681	-2.99428
162	MICR_U	DRIFT	371.85054	101007.712	97421.7624	717.71316	152.20681	-2.99428
163	HT109	MIHC	372.3401	101007.28	97421.9904	717.68761	152.20681	-2.99428
164	MICR_D	DRIFT	373.3401	101006.396	97422.4561	717.63538	152.20681	-2.99428
165	Q12_UP	DRIFT	373.6422	101006.129	97422.5967	717.61959	152.20681	-2.99428
166	HQF109	3Q120/2	374.2151	101005.623	97422.8635	717.58964	152.20681	-2.99428
167	HQF109	3Q120/2	379.21509	101001.206	97425.1917	717.32845	152.20681	-2.99428
168	Q12_DN	DRIFT	384.21508	100996.789	97427.5199	717.06727	152.20681	-2.99428
169	H109UP	drift	384.64218	100996.412	97427.7188	717.04496	152.20681	-2.99428
170	HP109	BPM	385.04375	100996.057	97427.9058	717.02399	152.20681	-2.99428
171	FOUR_6	adapter	385.57708	100995.586	97428.1541	716.99611	152.20681	-2.99428
172	V183UP	drift	385.74375	100995.439	97428.2318	716.98741	152.20681	-2.99428
173	V108_3	B2	386.34007	100994.912	97428.5094	716.95628	152.20681	-3.73884
174	B2_DNS	DRIFT	406.25729	100977.33	97437.7764	715.65753	152.20681	-4.48339
175	B2_UPS	DRIFT	406.80936	100976.843	97438.033	715.61435	152.20681	-4.48339
176	V108_4	B2	407.42392	100976.301	97438.3187	715.56632	152.20681	-5.22795
177	B2_DNS	DRIFT	427.34114	100958.756	97447.5669	713.75159	152.20681	-5.97251
178	FOUR_6	adapter	427.89321	100958.27	97447.8229	713.69414	152.20681	-5.97251
179	MICR_U	DRIFT	428.05987	100958.123	97447.9002	713.67682	152.20681	-5.97251
180	VT110	MIHC-R	428.54947	100957.693	97448.1272	713.62587	152.20681	-5.97251
181	MICR_D	DRIFT	429.54947	100956.813	97448.591	713.52183	152.20681	-5.97251
182	Q60_UP	DRIFT	429.85154	100956.547	97448.7311	713.4904	152.20681	-5.97251
183	HQD110	3Q60/2	430.30987	100956.144	97448.9436	713.4427	152.20681	-5.97251
184	HQD110	3Q60/2	432.80986	100953.944	97450.103	713.1826	152.20681	-5.97251
185	Q60_DN	DRIFT	435.30986	100951.744	97451.2624	712.92246	152.20681	-5.97251
186	V110UP	drift	435.85152	100951.268	97451.5136	712.86609	152.20681	-5.97251
187	VP110	BPM	436.17961	100950.979	97451.6657	712.83197	152.20681	-5.97251
188	V110DN	drift	436.71294	100950.51	97451.913	712.77646	152.20681	-5.97251
189	FOUR_6	adapter	436.76819	100950.461	97451.9387	712.77072	152.20681	-5.97251
190	B2_UPS	DRIFT	436.93485	100950.315	97452.016	712.7534	152.20681	-5.97251
191	V108_5	B2	437.54945	100949.774	97452.301	712.68945	152.20681	-6.71678
192	B2_DNS	DRIFT	457.46664	100932.276	97461.524	710.35996	152.20681	-7.46106
193	B2_UPS	DRIFT	458.0187	100931.792	97461.7792	710.28828	152.20681	-7.46106

194	V108_6	B2	458.6333	100931.253	97462.0633	710.20849	152.20681	-8.20562
195	B2_DNS	DRIFT	478.55049	100913.814	97471.255	707.36584	152.20681	-8.95017
196	FOUR_6	adapter	479.10255	100913.332	97471.5093	707.27995	152.20681	-8.95017
197	DV1T0	drift	479.26922	100913.186	97471.5861	707.254	152.20681	-8.95017
198	P111UP	drift	479.43756	100913.039	97471.6636	707.22782	152.20681	-8.95017
199	CT111T	CALTGT	479.7246	100912.788	97471.7958	707.18317	152.20681	-8.95017
200	P111DN	drift	481.05793	100911.623	97472.4099	706.97572	152.20681	-8.95017
201	DV2T0A	drift	481.06255	100911.619	97472.4121	706.975	152.20681	-8.95017
202	STUB_E	POINT	482.25412	100910.578	97472.9609	706.78963	152.20681	-8.95017
203	DV2T0B	drift	482.25412	100910.578	97472.9609	706.78963	152.20681	-8.95017
204	MICR_U	DRIFT	484.94988	100908.222	97474.2026	706.37024	152.20681	-8.95017
205	VT111	MIH-OR	485.43945	100907.794	97474.4281	706.29406	152.20681	-8.95017
206	MICR_D	DRIFT	486.43945	100906.92	97474.8887	706.13848	152.20681	-8.95017
207	Q12_UP	DRIFT	486.74155	100906.656	97475.0279	706.0915	152.20681	-8.95017
208	HQD111	3Q120/2	487.31445	100906.155	97475.2917	706.00236	152.20681	-8.95017
209	HQD111	3Q120/2	492.31444	100901.786	97477.5947	705.22451	152.20681	-8.95017
210	Q12_DN	DRIFT	497.31443	100897.417	97479.8978	704.44662	152.20681	-8.95017
211	V111UP	drift	497.74152	100897.044	97480.0945	704.38019	152.20681	-8.95017
212	VP111	BPM	498.15822	100896.68	97480.2864	704.31536	152.20681	-8.95017
213	DV2TA	drift	498.69156	100896.213	97480.5321	704.23238	152.20681	-8.95017
214	MICR_U	DRIFT	499.64241	100895.382	97480.97	704.08445	152.20681	-8.95017
215	HT112	MIHC-O	500.132	100894.955	97481.1956	704.00827	152.20681	-8.95017
216	MICR_D	DRIFT	501.132	100894.081	97481.6562	703.85269	152.20681	-8.95017
217	Q12_UP	DRIFT	501.43407	100893.817	97481.7953	703.80571	152.20681	-8.95017
218	HQF112	3Q120/2	502.007	100893.316	97482.0592	703.71657	152.20681	-8.95017
219	HQF112	3Q120/2	507.00699	100888.947	97484.3622	702.93869	152.20681	-8.95017
220	Q12_DN	DRIFT	512.00698	100884.578	97486.6652	702.16083	152.20681	-8.95017
221	H112UP	drift	512.43405	100884.204	97486.8619	702.0944	152.20681	-8.95017
222	HP112	BPM	512.87732	100883.817	97487.0661	702.02543	152.20681	-8.95017
223	PM112U	drift	513.41069	100883.351	97487.3118	701.94243	152.20681	-8.95017
224	PM112	MUWIRE	513.53362	100883.243	97487.3684	701.9233	152.20681	-8.95017
225	C_P_MK	POINT	514.51351	100882.387	97487.8197	701.77087	152.20681	-8.95017
226	PM112B	MUWIRE	514.51351	100882.387	97487.8197	701.77087	152.20681	-8.95017
227	PM112D	drift	514.86695	100882.078	97487.9825	701.71589	152.20681	-8.95017
228	DHALFX	drift	514.97574	100881.983	97488.0326	701.69896	152.20681	-8.95017
229	DHALFX	drift	524.51739	100873.645	97492.4275	700.21451	152.20681	-8.95017
230	DHALFX	drift	535.64237	100863.923	97497.5517	698.48374	152.20681	-8.95017
231	DHALFX	drift	546.76734	100854.202	97502.6759	696.75297	152.20681	-8.95017
232	DHALFX	drift	557.89232	100844.48	97507.8002	695.0222	152.20681	-8.95017
233	DHALFX	drift	569.0173	100834.758	97512.9244	693.29143	152.20681	-8.95017
234	DHALFX	drift	580.14228	100825.036	97518.0486	691.56066	152.20681	-8.95017
235	DHALFX	drift	591.26726	100815.315	97523.1728	689.82989	152.20681	-8.95017
236	DHALFX	drift	602.39223	100805.593	97528.297	688.09912	152.20681	-8.95017
237	DHALFX	drift	613.51721	100795.871	97533.4212	686.36835	152.20681	-8.95017
238	DHALFX	drift	624.64219	100786.15	97538.5454	684.63757	152.20681	-8.95017
239	DHALFX	drift	635.76717	100776.428	97543.6696	682.9068	152.20681	-8.95017
240	DHALFX	drift	646.89214	100766.706	97548.7938	681.17603	152.20681	-8.95017
241	DHALFX	drift	658.01712	100756.984	97553.918	679.44526	152.20681	-8.95017
242	DHALFX	drift	669.1421	100747.263	97559.0422	677.71449	152.20681	-8.95017

RCP START

243	DHALFX	drift	680.26708	100737.541	97564.1664	675.98372	152.20681	-8.95017
244	DHALFX	drift	691.39206	100727.819	97569.2906	674.25295	152.20681	-8.95017
245	DHALFX	drift	702.51703	100718.097	97574.4148	672.52218	152.20681	-8.95017
246	DHALFX	drift	713.64201	100708.376	97579.539	670.79141	152.20681	-8.95017
247	DHALFX	drift	724.76699	100698.654	97584.6632	669.06064	152.20681	-8.95017
248	BPM_UP	DRIFT	736.01693	100688.823	97589.845	667.31041	152.20681	-8.95017
249	VP113	BPM	736.29193	100688.583	97589.9717	667.26763	152.20681	-8.95017
250	BPM_DN	DRIFT	736.82527	100688.117	97590.2173	667.18466	152.20681	-8.95017
251	Q12_UP	DRIFT	736.9336	100688.022	97590.2672	667.16779	152.20681	-8.95017
252	HQD113	3Q120/2	737.50653	100687.521	97590.5311	667.07869	152.20681	-8.95017
253	HQD113	3Q120/2	742.50652	100683.152	97592.8341	666.3008	152.20681	-8.95017
254	Q12_DN	DRIFT	747.50651	100678.783	97595.1371	665.52291	152.20681	-8.95017
255	MICR_U	DRIFT	747.93358	100678.409	97595.3338	665.45648	152.20681	-8.95017
256	VT114	MIH-OR	748.42318	100677.982	97595.5593	665.3803	152.20681	-8.95017
257	MICR_D	DRIFT	749.42317	100677.108	97596.0199	665.22475	152.20681	-8.95017
258	DV2T13	drift	749.72524	100676.844	97596.1591	665.17774	152.20681	-8.95017
259	MICR_U	DRIFT	749.83495	100676.748	97596.2096	665.16068	152.20681	-8.95017
260	HT114	MIHC-O	750.32452	100676.32	97596.4351	665.0845	152.20681	-8.95017
261	MICR_D	DRIFT	751.32451	100675.446	97596.8957	664.92892	152.20681	-8.95017
262	Q12_UP	DRIFT	751.62661	100675.182	97597.0349	664.88194	152.20681	-8.95017
263	HQF114	3Q120/2	752.19951	100674.682	97597.2987	664.7928	152.20681	-8.95017
264	HQF114	3Q120/2	757.1995	100670.312	97599.6018	664.01494	152.20681	-8.95017
265	Q12_DN	DRIFT	762.19949	100665.943	97601.9048	663.23706	152.20681	-8.95017
266	BPM_UP	DRIFT	762.62659	100665.57	97602.1015	663.17062	152.20681	-8.95017
267	HP114	BPM	762.90159	100665.329	97602.2282	663.12784	152.20681	-8.95017
268	BPM_DN	DRIFT	763.43492	100664.863	97602.4738	663.04487	152.20681	-8.95017
269	SFOUR_	adapter	763.54326	100664.769	97602.5237	663.028	152.20681	-8.95017
270	PM114	MUWIRE	763.68909	100664.641	97602.5909	663.0053	152.20681	-8.95017
271	V14_UP	drift	765.02242	100663.476	97603.205	662.79789	152.20681	-8.95017
272	IP114A	ionpump	765.54571	100663.019	97603.446	662.71646	152.20681	-8.95017
273	P114SE	drift	766.04571	100662.582	97603.6764	662.63867	152.20681	-8.95017
274	IP114B	ionpump	780.52485	100649.929	97610.3455	660.38608	152.20681	-8.95017
275	P114SE	drift	781.02485	100649.492	97610.5758	660.30829	152.20681	-8.95017
276	IP114C	ionpump	795.50402	100636.839	97617.245	658.0557	152.20681	-8.95017
277	P114SE	drift	796.00402	100636.402	97617.4753	657.97792	152.20681	-8.95017
278	IP114D	ionpump	810.48319	100623.75	97624.1444	655.7253	152.20681	-8.95017
279	....	drift	810.98319	100623.313	97624.3747	655.64751	152.20681	-8.95017
280	BPM_UP	DRIFT	811.50648	100622.855	97624.6157	655.56611	152.20681	-8.95017
281	HP115	BPM	811.78148	100622.615	97624.7424	655.52333	152.20681	-8.95017
282	BPM_DN	DRIFT	812.31481	100622.149	97624.9881	655.44036	152.20681	-8.95017
283	SFOUR_	adapter	812.42315	100622.054	97625.038	655.42349	152.20681	-8.95017
284	PM115	MUWIRE	812.56898	100621.927	97625.1051	655.40082	152.20681	-8.95017
285	SFOUR_	adapter	813.90231	100620.762	97625.7193	655.19337	152.20681	-8.95017
286	Q60_UP	DRIFT	814.04814	100620.634	97625.7864	655.1707	152.20681	-8.95017
287	HQF115	3Q60/2	814.50647	100620.234	97625.9976	655.09938	152.20681	-8.95017
288	HQF115	3Q60/2	817.00647	100618.049	97627.1491	654.71044	152.20681	-8.95017
289	Q60_DN	DRIFT	819.50646	100615.864	97628.3006	654.32149	152.20681	-8.95017
290	MICR_U	DRIFT	820.04813	100615.391	97628.5501	654.23724	152.20681	-8.95017
291	HT115	MIHC	820.5377	100614.963	97628.7756	654.16106	152.20681	-8.95017

D&B CT START

292	MICR_D	DRIFT	821.53769	100614.089	97629.2362	654.00548	152.20681	-8.95017
293	V15_UP	drift	821.83979	100613.825	97629.3753	653.9585	152.20681	-8.95017
294	IP115A	ionpump	822.10666	100613.592	97629.4982	653.91697	152.20681	-8.95017
295	P115SE	drift	822.60666	100613.155	97629.7285	653.83921	152.20681	-8.95017
296	MVA15A	valve	839.78917	100598.14	97637.6429	651.16602	152.20681	-8.95017
297	MVA15B	valve	840.28917	100597.703	97637.8732	651.08823	152.20681	-8.95017
298	PG115	gauge	840.78916	100597.266	97638.1034	651.01044	152.20681	-8.95017
299	IP115B	ionpump	841.28916	100596.829	97638.3338	650.93265	152.20681	-8.95017
300	V15_DN	drift	841.78916	100596.392	97638.564	650.85487	152.20681	-8.95017
301	BPM_UP	DRIFT	842.05603	100596.159	97638.687	650.81336	152.20681	-8.95017
302	VP116	BPM	842.33103	100595.919	97638.8137	650.77058	152.20681	-8.95017
303	BPM_DN	DRIFT	842.86436	100595.453	97639.0593	650.68761	152.20681	-8.95017
304	Q12_UP	DRIFT	842.97269	100595.358	97639.1092	650.67075	152.20681	-8.95017
305	HQD116	3Q120/2	843.54559	100594.857	97639.3731	650.58161	152.20681	-8.95017
306	HQD116	3Q120/2	848.54558	100590.488	97641.6761	649.80375	152.20681	-8.95017
307	Q12_DN	DRIFT	853.54557	100586.119	97643.9791	649.02587	152.20681	-8.95017
308	MICR_U	DRIFT	853.97267	100585.746	97644.1758	648.95943	152.20681	-8.95017
309	VT116	MIHC-R	854.46223	100585.318	97644.4013	648.88325	152.20681	-8.95017
310	MICR_D	DRIFT	855.46223	100584.444	97644.8619	648.72767	152.20681	-8.95017
311	V16_UP	drift	855.76433	100584.18	97645.0011	648.68069	152.20681	-8.95017
312	IP116A	ionpump	856.04655	100583.933	97645.1311	648.63676	152.20681	-8.95017
313	P116SE	drift	856.54655	100583.496	97645.3614	648.55897	152.20681	-8.95017
314	IP116B	ionpump	872.04655	100569.951	97652.5007	646.14756	152.20681	-8.95017
315	P116SE	drift	872.54655	100569.515	97652.731	646.06977	152.20681	-8.95017
316	IP116C	ionpump	888.04655	100555.97	97659.8704	643.65836	152.20681	-8.95017
317	P116SE	drift	888.54655	100555.533	97660.1007	643.58057	152.20681	-8.95017
318	IP116D	ionpump	904.04655	100541.988	97667.24	641.16916	152.20681	-8.95017
319	P116SE	drift	904.54655	100541.551	97667.4704	641.09137	152.20681	-8.95017
320	IP116E	ionpump	920.04655	100528.006	97674.6097	638.67996	152.20681	-8.95017
321	V16_DN	drift	920.54655	100527.569	97674.84	638.60217	152.20681	-8.95017
322	BPM_UP	DRIFT	920.82877	100527.322	97674.97	638.55827	152.20681	-8.95017
323	HP117	BPM	921.10377	100527.082	97675.0966	638.51549	152.20681	-8.95017
324	BPM_DN	DRIFT	921.6371	100526.616	97675.3423	638.43252	152.20681	-8.95017
325	SFOUR_	adapter	921.74543	100526.521	97675.3922	638.41565	152.20681	-8.95017
326	PM117	MUWIRE	921.89127	100526.394	97675.4594	638.39295	152.20681	-8.95017
327	SFOUR_	adapter	923.2246	100525.229	97676.0735	638.18553	152.20681	-8.95017
328	Q12_UP	DRIFT	923.37043	100525.101	97676.1407	638.16283	152.20681	-8.95017
329	HQF117	3Q120/2	923.94336	100524.601	97676.4046	638.07372	152.20681	-8.95017
330	HQF117	3Q120/2	928.94335	100520.231	97678.7076	637.29584	152.20681	-8.95017
331	Q12_DN	DRIFT	933.94334	100515.862	97681.0106	636.51795	152.20681	-8.95017
332	MICR_U	DRIFT	934.37041	100515.489	97681.2073	636.45152	152.20681	-8.95017
333	HT117	MIHC	934.86001	100515.061	97681.4328	636.37533	152.20681	-8.95017
334	MICR_D	DRIFT	935.86	100514.187	97681.8934	636.21979	152.20681	-8.95017
335	D2MMI	drift	936.16207	100513.923	97682.0326	636.17278	152.20681	-8.95017
336	SYTR_U	DRIFT	937.95846	100512.353	97682.86	635.89331	152.20681	-8.95017
337	H117	SYTRIM	938.60429	100511.789	97683.1575	635.79282	152.19507	-8.95017
338	SYTR_D	DRIFT	941.52095	100509.24	97684.5014	635.33908	152.18332	-8.95017
339	V17_UP	drift	941.97928	100508.84	97684.7127	635.26776	152.18332	-8.95017
340	IP117	ionpump	942.23233	100508.619	97684.8293	635.22839	152.18332	-8.95017

341	P117SE	drift	942.73233	100508.182	97685.0598	635.1506	152.18332	-8.95017
342	V17_DN	drift	943.30566	100507.681	97685.3241	635.06143	152.18332	-8.95017
343	BPM_UP	DRIFT	943.55868	100507.46	97685.4407	635.02206	152.18332	-8.95017
344	VP118	BPM	943.83368	100507.22	97685.5675	634.97927	152.18332	-8.95017
345	BPM_DN	DRIFT	944.36701	100506.754	97685.8133	634.8963	152.18332	-8.95017
346	Q12_UP	DRIFT	944.47537	100506.659	97685.8633	634.87944	152.18332	-8.95017
347	HQD118	3Q120/2	945.04827	100506.159	97686.1274	634.7903	152.18332	-8.95017
348	HQD118	3Q120/2	950.04826	100501.79	97688.4322	634.01245	152.18332	-8.95017
349	Q12_DN	DRIFT	955.04825	100497.422	97690.737	633.23456	152.18332	-8.95017
350	MICR_U	DRIFT	955.47535	100497.049	97690.9339	633.16812	152.18332	-8.95017
351	VT118	MIHC-R	955.96492	100496.621	97691.1595	633.09194	152.18332	-8.95017
352	MICR_D	DRIFT	956.96492	100495.747	97691.6205	632.93637	152.18332	-8.95017
353	SFOUR_	adapter	957.26702	100495.483	97691.7597	632.88938	152.18332	-8.95017
354	CT118T	CALTGT	957.41285	100495.356	97691.827	632.86668	152.18332	-8.95017
355	V18_UP	drift	958.74618	100494.191	97692.4416	632.65927	152.18332	-8.95017
356	IP118A	ionpump	959.03909	100493.935	97692.5766	632.6137	152.18332	-8.95017
357	P118SE	drift	959.53909	100493.498	97692.8071	632.53591	152.18332	-8.95017
358	IP118B	ionpump	975.04241	100479.954	97699.9536	630.12397	152.18332	-8.95017
359	V18_DN	drift	975.54241	100479.517	97700.184	630.04618	152.18332	-8.95017
360	FOUR_6	adapter	975.83532	100479.261	97700.3191	630.00061	152.18332	-8.95017
361	B2_UPS	DRIFT	976.00198	100479.115	97700.3959	629.97466	152.18332	-8.95017
362	V118_1	B2	976.61658	100478.578	97700.6792	629.87906	152.18332	-8.24945
363	B2_DNS	DRIFT	996.5337	100461.145	97709.877	627.02142	152.18332	-7.54872
364	B2_UPS	DRIFT	997.0858	100460.661	97710.1324	626.94888	152.18332	-7.54872
365	V118_2	B2	997.70037	100460.122	97710.4167	626.86814	152.18332	-6.84771
366	B2_DNS	DRIFT	1017.61749	100442.633	97719.6444	624.4935	152.18332	-6.14669
367	FOUR_6	adapter	1018.16958	100442.147	97719.9006	624.43438	152.18332	-6.14669
368	MICR_U	DRIFT	1018.33625	100442.001	97719.9779	624.41653	152.18332	-6.14669
369	HT119	MIHC	1018.82582	100441.57	97720.2051	624.36411	152.18332	-6.14669
370	MICR_D	DRIFT	1019.82581	100440.691	97720.669	624.25702	152.18332	-6.14669
371	Q60_UP	DRIFT	1020.12791	100440.425	97720.8092	624.22467	152.18332	-6.14669
372	HQF119	3Q60/2	1020.58625	100440.022	97721.0218	624.17559	152.18332	-6.14669
373	HQF119	3Q60/2	1023.08624	100437.824	97722.1817	623.90791	152.18332	-6.14669
374	Q60_DN	DRIFT	1025.58624	100435.626	97723.3416	623.64022	152.18332	-6.14669
375	BPM_UP	DRIFT	1026.1279	100435.149	97723.5929	623.58222	152.18332	-6.14669
376	HP119	BPM	1026.4029	100434.907	97723.7205	623.55279	152.18332	-6.14669
377	BPM_DN	DRIFT	1026.93623	100434.438	97723.968	623.49567	152.18332	-6.14669
378	FOUR_6	adapter	1027.04457	100434.343	97724.0182	623.48405	152.18332	-6.14669
379	B2_UPS	DRIFT	1027.21123	100434.197	97724.0956	623.46621	152.18332	-6.14669
380	V118_3	B2	1027.8258	100433.656	97724.3807	623.40043	152.18332	-5.44596
381	B2_DNS	DRIFT	1047.74292	100416.121	97733.6328	621.51017	152.18332	-4.74524
382	B2_UPS	DRIFT	1048.29502	100415.634	97733.8895	621.46451	152.18332	-4.74524
383	V118_4	B2	1048.90958	100415.092	97734.1753	621.41365	152.18332	-4.04422
384	B2_DNS	DRIFT	1068.82673	100397.521	97743.4462	620.009	152.18332	-3.34321
385	FOUR_6	adapter	1069.3788	100397.033	97743.7033	619.97678	152.18332	-3.34321
386	Q12_UP	DRIFT	1069.54547	100396.886	97743.781	619.96707	152.18332	-3.34321
387	HQD120	3Q120/2	1070.1184	100396.38	97744.0479	619.93364	152.18332	-3.34321
388	HQD120	3Q120/2	1075.11839	100391.966	97746.3771	619.64203	152.18332	-3.34321
389	Q12_DN	DRIFT	1080.11838	100387.551	97748.7064	619.35043	152.18332	-3.34321

PRE-TARGET START

390	DRV3TB	drift	1080.54544	100387.174	97748.9053	619.32553	152.18332	-3.34321
391	Q12_UP	DRIFT	1080.95532	100386.812	97749.0963	619.30162	152.18332	-3.34321
392	HQF121	3Q120/2	1081.52822	100386.306	97749.3631	619.26822	152.18332	-3.34321
393	HQF121	3Q120/2	1086.52821	100381.892	97751.6924	618.97662	152.18332	-3.34321
394	Q12_DN	DRIFT	1091.5282	100377.477	97754.0217	618.68498	152.18332	-3.34321
395	MICR_U	DRIFT	1091.9553	100377.1	97754.2206	618.66008	152.18332	-3.34321
396	HT121	MIHC	1092.44486	100376.668	97754.4487	618.63154	152.18332	-3.34321
397	MICR_D	DRIFT	1093.44486	100375.785	97754.9145	618.57321	152.18332	-3.34321
398	MICR_U	DRIFT	1093.74696	100375.518	97755.0552	618.55559	152.18332	-3.34321
399	VT121	MIHC-R	1094.23653	100375.086	97755.2833	618.52704	152.18332	-3.34321
400	MICR_D	DRIFT	1095.23652	100374.203	97755.7492	618.46871	152.18332	-3.34321
401	BPM_UP	DRIFT	1095.53862	100373.936	97755.8899	618.45109	152.18332	-3.34321
402	HP121	SMABPM	1095.81362	100373.693	97756.018	618.43505	152.18332	-3.34321
403	BPM_DN	DRIFT	1096.34695	100373.222	97756.2665	618.40395	152.18332	-3.34321
404	BPM_UP	DRIFT	1096.45529	100373.127	97756.3169	618.39765	152.18332	-3.34321
405	VP121	SMABPM	1096.73029	100372.884	97756.445	618.3816	152.18332	-3.34321
406	BPM_DN	DRIFT	1097.26362	100372.413	97756.6935	618.3505	152.18332	-3.34321
407	SFOUR_	adapter	1097.37195	100372.317	97756.744	618.34417	152.18332	-3.34321
408	PM121	TARGMW	1097.51779	100372.188	97756.8119	618.33567	152.18332	-3.34321
409	V21_UP	drift	1098.85112	100371.011	97757.433	618.25792	152.18332	-3.34321
410	IP121A	ionpump	1099.14639	100370.751	97757.5706	618.24069	152.18332	-3.34321
411	PG121	gauge	1099.64639	100370.309	97757.8035	618.21153	152.18332	-3.34321
412	MAVL21	valve	1100.14639	100369.868	97758.0364	618.18236	152.18332	-3.34321
413	P121SE	drift	1100.64639	100369.426	97758.2694	618.15319	152.18332	-3.34321
414	IP121B	ionpump	1116.48212	100355.444	97765.6465	617.22964	152.18332	-3.34321
415	P121SE	drift	1116.98212	100355.003	97765.8794	617.20047	152.18332	-3.34321
416	IP121C	ionpump	1132.81788	100341.021	97773.2565	616.27692	152.18332	-3.34321
417	V21_DN	drift	1133.31788	100340.579	97773.4894	616.24775	152.18332	-3.34321
418	TOR_UP	DRIFT	1133.61315	100340.318	97773.627	616.23053	152.18332	-3.34321
419	TORTGT	TOROID	1133.94649	100340.024	97773.7822	616.21107	152.18332	-3.34321
420	TOR_DN	DRIFT	1134.23815	100339.767	97773.9181	616.19408	152.18332	-3.34321
421	BPM_UP	DRIFT	1134.61315	100339.435	97774.0928	616.17219	152.18332	-3.34321
422	HPTGT	SMABPM	1134.88815	100339.193	97774.2209	616.15615	152.18332	-3.34321
423	BPM_DN	DRIFT	1135.42148	100338.722	97774.4694	616.12505	152.18332	-3.34321
424	BPM_UP	DRIFT	1135.52982	100338.626	97774.5198	616.11875	152.18332	-3.34321
425	VPTGT	SMABPM	1135.80481	100338.383	97774.6479	616.1027	152.18332	-3.34321
426	BPM_DN	DRIFT	1136.33815	100337.912	97774.8964	616.0716	152.18332	-3.34321
427	PMTGT	TARGMW	1136.44648	100337.817	97774.9469	616.06527	152.18332	-3.34321
428	OT_UPS	drift	1137.77981	100336.64	97775.568	615.98751	152.18332	-3.34321
429	OTRTGT	otrmon	1138.23814	100336.235	97775.7815	615.96078	152.18332	-3.34321
430	OT_DNS	drift	1139.86314	100334.8	97776.5385	615.86603	152.18332	-3.34321
431	OUCADR	drift	1140.20828	100334.495	97776.6993	615.84588	152.18332	-3.34321
432	SH_WAL	drift	1141.20828	100333.612	97777.1651	615.78755	152.18332	-3.34321
433	M_TACA	POINT	1147.20827	100328.315	97779.9603	615.43765	152.18332	-3.34321
434	INCADR	drift	1147.20827	100328.315	97779.9603	615.43765	152.18332	-3.34321
435	BAFL2P	BAFFLE	1160.89253	100316.232	97786.3351	614.63955	152.18332	-3.34321
436	TA_OFF	drift	1165.81378	100311.887	97788.6276	614.35251	152.18332	-3.34321
437	TA_UPS	drift	1167.25383	100310.616	97789.2985	614.26852	152.18332	-3.34321
438	HALTA1	TAR/2	1168.04451	100309.918	97789.6668	614.22243	152.18332	-3.34321

BRANCH
OF N2
LINE
TO THSR
MECHANICAL

439	MCZERO	point	1169.19281	100308.904	97790.2018	614.15546	152.18332	-3.34321
440	ACTRN1	horn1	1169.29123	100308.817	97790.2476	614.14972	152.18332	-3.34321
441	HALTA2	TAR/2	1169.60914	100308.536	97790.3957	614.13119	152.18332	-3.34321
442	ENDFIN	fin	1171.17377	100307.155	97791.1246	614.03991	152.18332	-3.34321
443	DWNRN1	horn_dn	1179.03531	100300.213	97794.7869	613.58142	152.18332	-3.34321
444	D2LOWE	drift	1181.72283	100297.841	97796.0389	613.42469	152.18332	-3.34321
445	UPHRN2	horn_up	1201.82168	100280.094	97805.4019	612.25248	152.18332	-3.34321
446	ACTRN2	horn2	1202.00114	100279.936	97805.4856	612.24202	152.18332	-3.34321
447	DWNRN2	horn_dn	1211.84364	100271.246	97810.0707	611.66797	152.18332	-3.34321
448	D2MEDE	drift	1217.18812	100266.527	97812.5604	611.35629	152.18332	-3.34321
449	UPHRN2	horn_up	1244.47251	100242.436	97825.2709	609.76502	152.18332	-3.34321
450	ACTRN2	horn2	1244.65197	100242.278	97825.3545	609.75455	152.18332	-3.34321
451	DWNRN2	horn_dn	1254.49447	100233.588	97829.9396	609.18051	152.18332	-3.34321
452	D2HIGE	drift	1259.83895	100228.869	97832.4293	608.8688	152.18332	-3.34321
453	UPHRN2	horn_up	1290.5026	100201.795	97846.714	607.08045	152.18332	-3.34321
454	ACTRN2	horn2	1290.68206	100201.636	97846.7976	607.06998	152.18332	-3.34321
455	DWNRN2	horn_dn	1300.52456	100192.946	97851.3827	606.49597	152.18332	-3.34321
456	IHD3	drift	1305.86904	100188.227	97853.8725	606.18425	152.18332	-3.34321
457	M_CAVE	POINT	1309.14988	100185.33	97855.4008	605.99292	152.18332	-3.34321
458	OVERHA	drift	1309.14988	100185.33	97855.4008	605.99292	152.18332	-3.34321
459	DKINHL	drift	1319.12085	100176.526	97860.0459	605.41139	152.18332	-3.34321
460	M_THAL	POINT	1337.64936	100160.167	97868.6774	604.33078	152.18332	-3.34321
461	DK_PCA	DECA44	1337.64936	100160.167	97868.6774	604.33078	152.18332	-3.34321
462	DK_PCB	DEC150	1483.26094	100031.601	97936.5106	595.83844	152.18332	-3.34321
463	DK_PCC	DEC150	1975.38594	99597.0842	98165.7674	567.13683	152.18332	-3.34321
464	DK_PCD	DEC100	2467.51094	99162.5678	98395.0242	538.43521	152.18332	-3.34321
465	DK_PCE	DEC100	2795.59428	98872.8901	98547.8621	519.3008	152.18332	-3.34321
466	DK_PCF	DEC125	3123.67761	98583.2125	98700.6999	500.16639	152.18332	-3.34321
467	DENCU	drift	3533.78178	98221.1154	98891.7473	476.24839	152.18332	-3.34321
468	DUMP	DUMP	3540.34344	98215.3219	98894.804	475.86571	152.18332	-3.34321
469	DENCD	drift	3564.35914	98194.1175	98905.9918	474.46506	152.18332	-3.34321
470	MU_UP	drift	3583.78168	98176.9685	98915.0398	473.33232	152.18332	-3.34321
471	MUOND	MUON	3588.71129	98172.616	98917.3362	473.04482	152.18332	-3.34321
472	MU_DN	drift	3590.3545	98171.1652	98918.1017	472.94899	152.18332	-3.34321
473	MUUP2	drift	3593.79862	98168.1242	98919.7062	472.7481	152.18332	-3.34321
474	MU_UP	drift	3633.23545	98133.3039	98938.0779	470.44807	152.18332	-3.34321
475	MUOND	MUON	3638.16507	98128.9513	98940.3743	470.16058	152.18332	-3.34321
476	MU_DN	drift	3639.80827	98127.5005	98941.1398	470.06474	152.18332	-3.34321
477	MUUP3	drift	3643.25239	98124.4595	98942.7442	469.86386	152.18332	-3.34321
478	MU_UP	drift	3702.40765	98072.229	98970.3018	466.41383	152.18332	-3.34321
479	MUOND	MUON	3707.33724	98067.8765	98972.5982	466.12633	152.18332	-3.34321
480	MU_DN	drift	3708.98044	98066.4257	98973.3637	466.0305	152.18332	-3.34321
481	MUUP4	drift	3712.4246	98063.3847	98974.9682	465.82961	152.18332	-3.34321
482	MU_UP	drift	3811.01666	97976.3339	99020.8973	460.07956	152.18332	-3.34321
483	MUOND	MUON	3815.94624	97971.9814	99023.1938	459.79206	152.18332	-3.34321
484	MU_DN	drift	3817.58944	97970.5305	99023.9593	459.69623	152.18332	-3.34321
485	SHIELD	drift	3821.0336	97967.4895	99025.5637	459.49534	152.18332	-3.34321
486	TUNNEL	TUNNEL	4409.14181	97448.2257	99299.5344	425.19584	152.18332	-3.34321
487	M_ENCU	EX_ENU	4484.72906	97381.4868	99334.7467	420.78745	152.18332	-3.34321

488	MIN_ND	EXP	4570.37268	97305.8687	99374.6439	415.79257	152.18332	-3.34321
489	M_ENCD	EX_END	4624.95981	97257.6716	99400.0734	412.60895	152.18332	-3.34321
490	ILWIMN	drift	4634.97675	97248.8272	99404.7398	412.02473	152.18332	-3.34321
491	MINOFU	EXP_F2	2413631.72	-2029748.9	1221637.64	-140084.97	152.18332	-3.34321
492	MINOFD	EXP_F2	2413690.88	-2029801.1	1221665.2	-140088.42	152.18332	-3.34321

FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT: MAXIMUM N_2 INTO THSR IF PIPE 'BROKE' FROM MI-60 DEWAR @ 100 PSI

NAME: D. POSHKA

DATE: 8/3/04

REVISION DATE:

$P_1 = 100$ PSIG $\therefore$ $P_1' = 115$ PSIA

$P_2 = 0$ PSIG

$\Delta P = 100$ PSIG

$\therefore \Delta P > 40\% P_1$ $\therefore$ $q'_m (cfm) = 678\, Y d^2 \sqrt{\frac{\Delta P\, P_1'}{K T_1 S_g}}$

Y = EXPANSION FACTOR

$\frac{\Delta P}{P_1'} = \frac{100}{115} = .87$ $\therefore$ $Y = .710$ @ sonic limit

d = pipe internal diameter $= 0.875 - 2(0.045)$
$= 0.785''$

$S_g = 28/29 = 0.96$

T = ABSOLUTE TEMPERATURE $= 460° + 80°F = 540°R$

$K = f \frac{L}{D}$ $D = \frac{0.785''}{12''/FT} = 0.0654$

$L = 360' + (1100 - 317) + 65 + 32 + 32 + 16 + 11 + 29 + 50$
$= 1378$ → Round to 1400' To INCLUDE OFFSETS.

f = ~~0.0~~ 0.010 for drawn tubing, ⌀1"

$\therefore K = 0.010 \cdot \frac{1400}{0.0654} = 214.0$

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT

NAME D. POSHKA

DATE 8/3/04 REVISION DATE

$$q_m' \text{ (cfm)} = 678 \times (.710)(0.785^2) \sqrt{\frac{100 \cdot 115}{214 \cdot 540 \cdot (.96)}}$$

$$= 678 * .710 * .785^2 \cdot 0.3219$$

$$= 95 \text{ cfm}$$

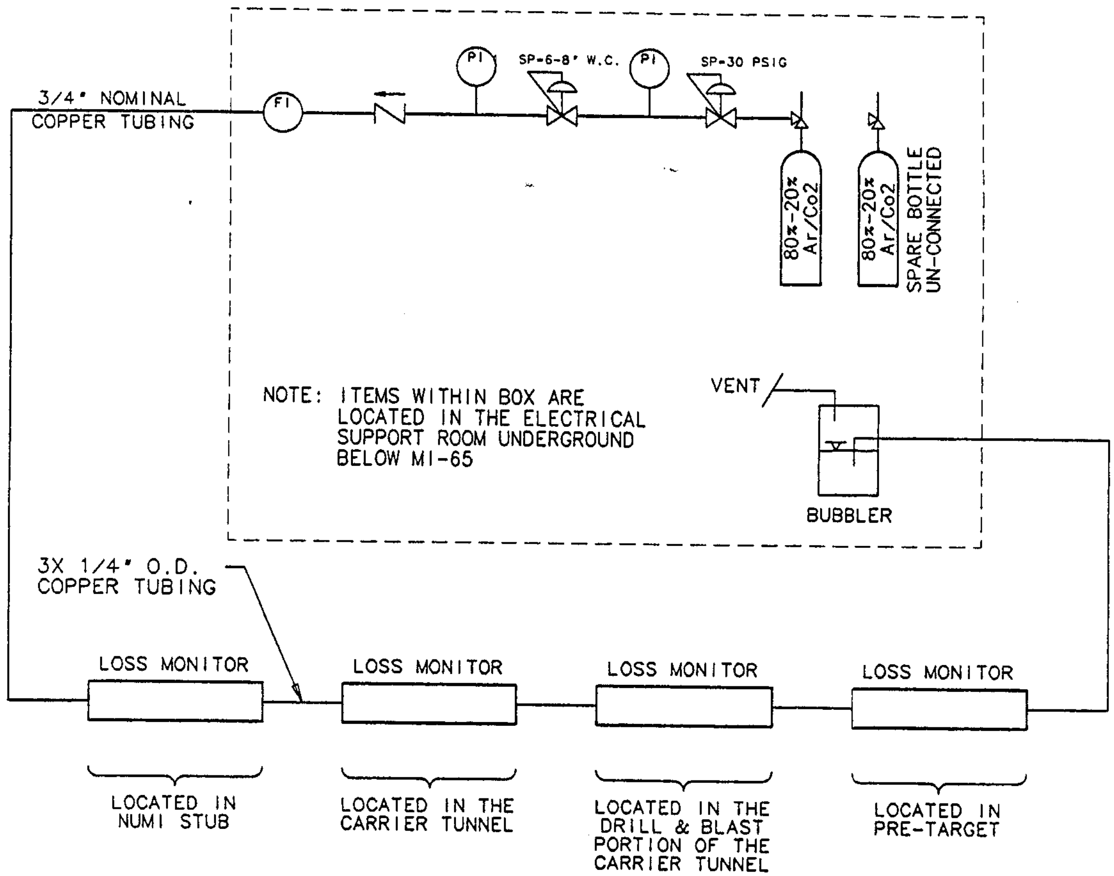
SO, ASSUMING THE WORST CASE, THE N_2 LEAK RATE INTO MI-65 THSR (TARGET HALL SUPPORT ROOM) WOULD BE 95 cfm, WITHOUT CONSIDERING ANY FLOW RESTRICTIONS

IF L = 360 + (~~[illegible]~~ 976 − 317) (PRE-TARGET), K =
= ~~[illegible]~~ 1019', q_m' =

SEE SPREAD SHEETS

IF ~~L =~~

REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE



UNLESS OTHERWISE SPECIFIED			ORIGINATOR	D.PUSHKA	30-JUL-2004
.XX	.XXX	ANGLES	DRAWN	R.L.SMITH	30-JUL-2004
± --	± ---	± -	CHECKED		
1. BREAK ALL SHARP EDGES MAX. 2. DO NOT SCALE DRAWING. 3. DIMENSIONS BASED UPON ASME Y14.5-1994 4. MAX. ALL MACH. SURFACES 5. DRAWING UNITS: INCHES			APPROVED	D. Pushka	30 Jul 04
			USED ON	***	
			MATERIAL	****	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NUMI/UTILITIES TOTAL LOSS MONITOR GAS SYSTEM SCHEMATIC

SCALE	DRAWING NUMBER	SHEET	REV
NONE	8875.117-MB-433163	1 OF 1	

CREATED WITH :	ideas9m3	GROUP:	PPD/MECHANICAL DEPARTMENT

ABBREVIATIONS

[illegible]

EQUIPMENT NUMBER IDENTIFICATION

[illegible]

EF	EXHAUST AIR VENTILATOR
FC	FAN COIL UNIT
SF	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
SCPWS	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

UTILITIES IN TARGET SHAFT

SYSTEM	DIA.	INS.	MAT'L	PRESSURE RATING	PRESSURE	FLOW	TEMP.
FP	*	NO	SCH40 STL.	300 PSI	*	*	N/A
LCWS	3"	NO	SCH160 STL.	300 PSI	NOT REQ'D	45 GPM	[illegible]
LCWR	3"	NO	SCH160 STL.	300 PSI	NOT REQ'D	45 GPM	[illegible]
SCHWR	4"	1 1/2"	SCH40 STL.	150 PSI	ΔP=15 PSI	212 GPM	[illegible]
SCHWS	4"	1 1/2"	SCH40 STL.	150 PSI		212 GPM	[illegible]
AHU-TGS-4	22"	NO	GALV. STL.	+2" WC	0.75" WC	[illegible] CFM / [illegible] CFM	[illegible] MIN.
AHU-TGS-5	14"	NO	GALV. STL.	+2" WC	0.75" WC	[illegible] CFM	[illegible] MIN.

* TO BE DETERMINED BY FP SUB-CONTRACTOR

UTILITIES IN MINOS SHAFT AND ENCLOSURE

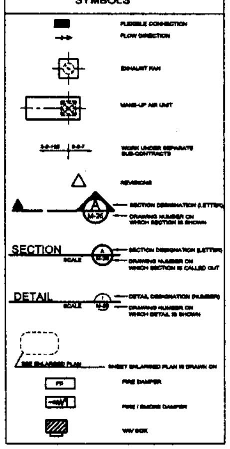
SYSTEM	DIA.	INS.	MAT'L	PRESSURE RATING	PRESSURE	FLOW	TEMP.
FP	NOTE 1	NO	SCH40 STL.	300 PSI	NOTE 1	NOTE 1	N/A
CWS	VARIES	1"	SCH40 STL.	150 PSI	ΔP=[illegible] PSI	[illegible] GPM	[illegible]
CWR	VARIES	NOTE 2	SCH40 STL.	150 PSI		[illegible] GPM	[illegible]
SD	[illegible]	NO	SCH40 STL.	300 PSI	N/A	[illegible] GPM	N/A
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AHU-MNS-[illegible]	[illegible]	NO	GALV. STL.	+2" WC	1.3" WC	[illegible] CFM	[illegible] MIN.
AHU-MNS-[illegible]	[illegible]	NO	GALV. STL.	+2" WC	1.3" WC	[illegible] CFM	[illegible] MIN.

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

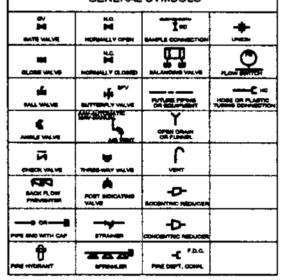
HVAC GENERAL NOTES

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'-6" 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.

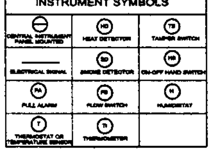
SYMBOLS



GENERAL SYMBOLS



INSTRUMENT SYMBOLS



REV.	DATE	DESCRIPTIONS
6	1/31/02	REVISION 6
	8/15/02	CONFORMED SET

REVISIONS

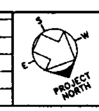
FLUOR DANIEL

MWH
MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

	A/E CONSULTANT	DATE
DRAWN	R. [illegible]	7/24/00
CHECKED	J. SANTOS / R. BRANTON	7/24/00

	FERMI LAB	DATE
FINAL REVIEW	J. [illegible]	01/10/02
DWG. ACCEPTED	E. CRUMPLEY	01/10/02
FESS ACCEPTED	S. HEVIN	01/10/02
SUBMITTED	R. PLUNKETT/S. BOGERT	01/10/02



SCALE:

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. 6

FAN COIL UNIT SCHEDULE

TAG NO.	AREA SERVED	MFR./MODEL NO.	SUPPLY FAN CFM	HP	V/Ø/HZ	FLA	ESP	COOLING COIL MBH TOTAL	MBH SENS.	FACE AREA (SQ.FT.)	ROWS	GPM	EWT	ΔT	PD	ELECTRIC HEATING COIL MBH OUTPUT	KW	FLA	ELECT. V/Ø/HZ	REMARKS
FC-T-1	TARGET POWER SUPPLY ROOM	TRANE / LPC	4000	5	460/3/60	6.6	0.36	202	132	7.5	8	40.6	50°F	10	6.44' WC	109	32	39	460/3/60	6-STAGE ELECTRIC REHEAT, 2" THROW AWAY FILTER
FC-M-1	MINOS HALL	TRANE / LPC	3200	2	460/3/60	3.2	0.1	96.1	76.6	7.5	6	48.0	55°F	3.8	15.0' WC	86	28	31	460/3/60	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 - 786 LO - 567	1/4	277/1/60	HI - 3.3 MED - 2.4 LO - 1.8	0.0	22.9	18.3	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 CFM	EXTERNAL S.P. IN. W.G.	MANUFACTURER	SELECTION DATA TYPE & MODEL #	SIZE	RPM	DRIVE	MOTOR DATA HP	VOLTS	PHASE	CYCLE	REMARKS ACCESSORIES PROVIDED WITH UNIT
SF-M-1	MUON ALCOVE 2	580	0.15	COOK	CENTRI-VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/6	120	1	60	INLET SCREEN
SF-M-2	MUON ALCOVE 3	580	0.15	COOK	CENTRI-VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/6	120	1	60	
SF-M-3	MUON ALCOVE 4	580	0.15	COOK	CENTRI-VANE INLINE CENTRIFUGAL 10CVI7D	10	1725	DIRECT	1/6	120	1	60	
EF-5	MUON ALCOVE VENTILATION	220	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	161XP-15	1725	BELT	1-1/2	460	3	60	
EF-2	UPSTREAM DECAY	3070 1000	0.85 0.15	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	161-10	VFD	BELT	1	460	3	60	
EF-3	DOWNSTREAM DECAY	3600	2.36	GREENHECK	UPBLAST CENTRIFUGAL MODEL CUBE	300XP-30	1390	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	0.50	GREENHECK	WALL MOUNT PROPELLER FAN MODEL S1	14-436-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 GPM	TOTAL FT. HD.	WATER TEMP.	DESIGN BASIS MANUFACTURER	SELECTION DATA TYPE	MODEL	MOTOR DATA RPM	HP	VOLTS	PHASE	CYCLE	REMARKS
SP-M-1 SP-M-2	MINOS ACCESS SHAFT SUMP PIT	380	400	55° - 60° F	GOULD	SUBMERSIBLE TURBINE	VIS-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	55° F	FLYGT	DUPLEX SUBMERSIBLE	BS3062.170	3450	0.9	460	3	60	40#
SP-T-3	TARGET ELEVATOR PIT	5	12	55° F	FLYGT	DEWATERING PUMP	SX-2	3450	0.25	115	1	6	
SP-M-3	MINOS ACCESS SHAFT SUMP PIT	480	400	55° - 60° F	GOULD	SUBMERSIBLE TURBINE	VIS 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	380	214	56° F	FLYGT	SUBMERSIBLE CIRCULATOR	BS2151.011	3450	30	460	3	60	SEE CONTROL NOTE
GWP-M1 GWP-M2	DECAY PIPE COOLING	70	180	70° F	BELL & GOSSETT	CIRCULATOR	SERIES 80 1½"x1½"x7B	3500	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. Lead/lag selection shall be based on run time as stocked and controlled by the duplex control panel. Lead/lag 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 rejection 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 in 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 lead/lag) 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 65°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.

NOTES:

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

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-031C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-T-3,4	TARGET EXIT STAIRWELL	TRANE UHEC-031C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-T-5	TARGET COMMON AREA	TRANE UHEC-031C0C0	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-051C0C0	5.0	40°F	277/1/60	18.1	1/125	400	12	8'-0"	
EUH-M-1, 2 & 3	MUON ALCOVES	TRANE UHEC-031C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-4	ABSORBER ENCLOSURE	TRANE UHEC-031C0C0	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-031C0C0	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-031C0C0	3.3	28°F	277/1/60	11.9	1/125	400	12	8'-0"	
EUH-M-14	MINOS ELEVATOR SHAFT	TRANE UHEC-051C0C0	5.0	40°F	277/1/60	18.1	1/125	400	12	8'-0"	
EDH-T-1	TARGET EXIT PASSAGEWAY	INDEECO/TFQU	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/TFQU	3.0	9.6°F	277/1/60	10.6	N/A	1000	N/A	N/A	2 STEP CONTROL W / PANEL

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	CDG WTR TEMP. °F	COMP.	KW	EER	POWER V/Ø/HZ	RLA/CKT.	LRA/CKT.	REMARKS
CH M-1	DECAY PIPE COOLING	TRANE CGWE-20	22	HCFC-22	40	62	50	–	80	2	14.5	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

VARIABLE AIR VOLUME TERMINAL UNIT SCHEDULE

TAG NO.	LOCATION	SERVICE	TYPE	CFM FIELD SETTING	CFM RANGE MINIMUM	CFM RANGE MAXIMUM	CONTROLS TYPE	CONTROLS HAND	INLET SIZE DIA.	MANUFACTURER AND MODEL NO.	UNIT SIZE	REMARKS
VAV-T-1	UPSTREAM	COMMON AREA	SINGLE DUCT PRESS. INDEPEN.	100	80	800	DDC	RIGHT	6"Ø	TITUS IDECV-3000	6	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 ENCLOSURE		440	80	500			6"Ø		6	
VAV-T-3	UPSTREAM	PRETARGET TUNNEL		210	80	500			6"Ø		6	
VAV-M-1	DOWNSTREAM	ABSORBER ACCESS TUNNEL		3800	580	4000			16"Ø		16	

REV.	DATE	DESCRIPTIONS
11	9/19/2003	REVISION 11
8	1/31/03	REVISION 8
7	10/14/02	CARRIER TUNNEL
	8/15/02	CONFORMED SET

REVISIONS

	A/E CONSULTANT	DATE
DESIGNED	R. WIMMER	10/08/01
DRAWN	P. ABAD	10/08/01
REVIEWED	G. HOOGHAERT	10/08/01
APPROVED	M. BRUEN	10/08/01

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA CHICAGO ILLINOIS

	A/E CONSULTANT	DATE
DESIGNED		
DRAWN	B. JEDINAK	7/24/03
CHECKED		
APPROVED		

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

SCALE: NONE

SK-101

PART OF PROJECT 6-7-9

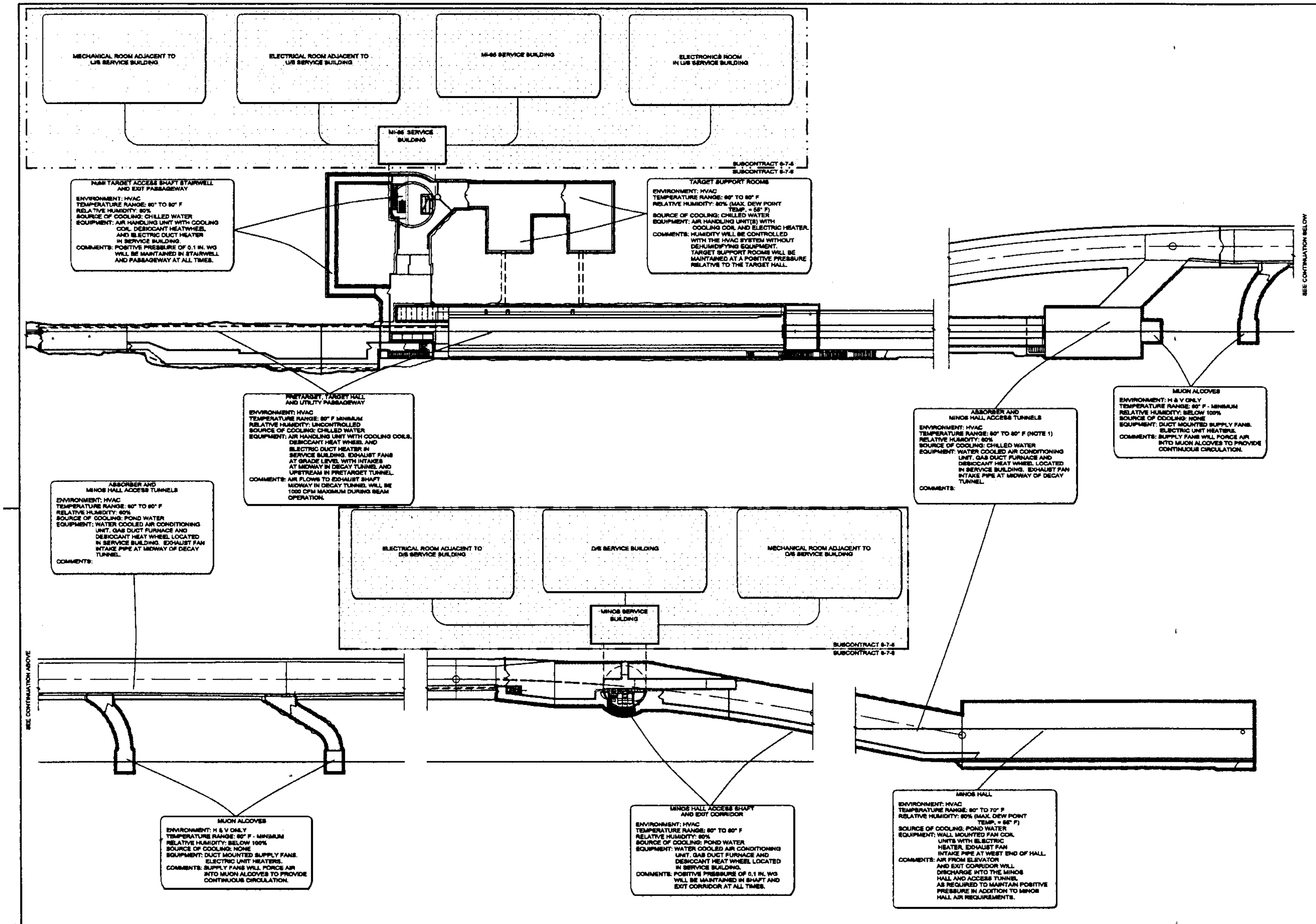
FERMI NATIONAL ACCELERATOR LABORATORY

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
3	10/30/02	REVISION 3
	8/15/02	CONFORMED SET

REVISIONS

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

DRAWN: P. ABAD

PROJECT NORTH

SCALE:

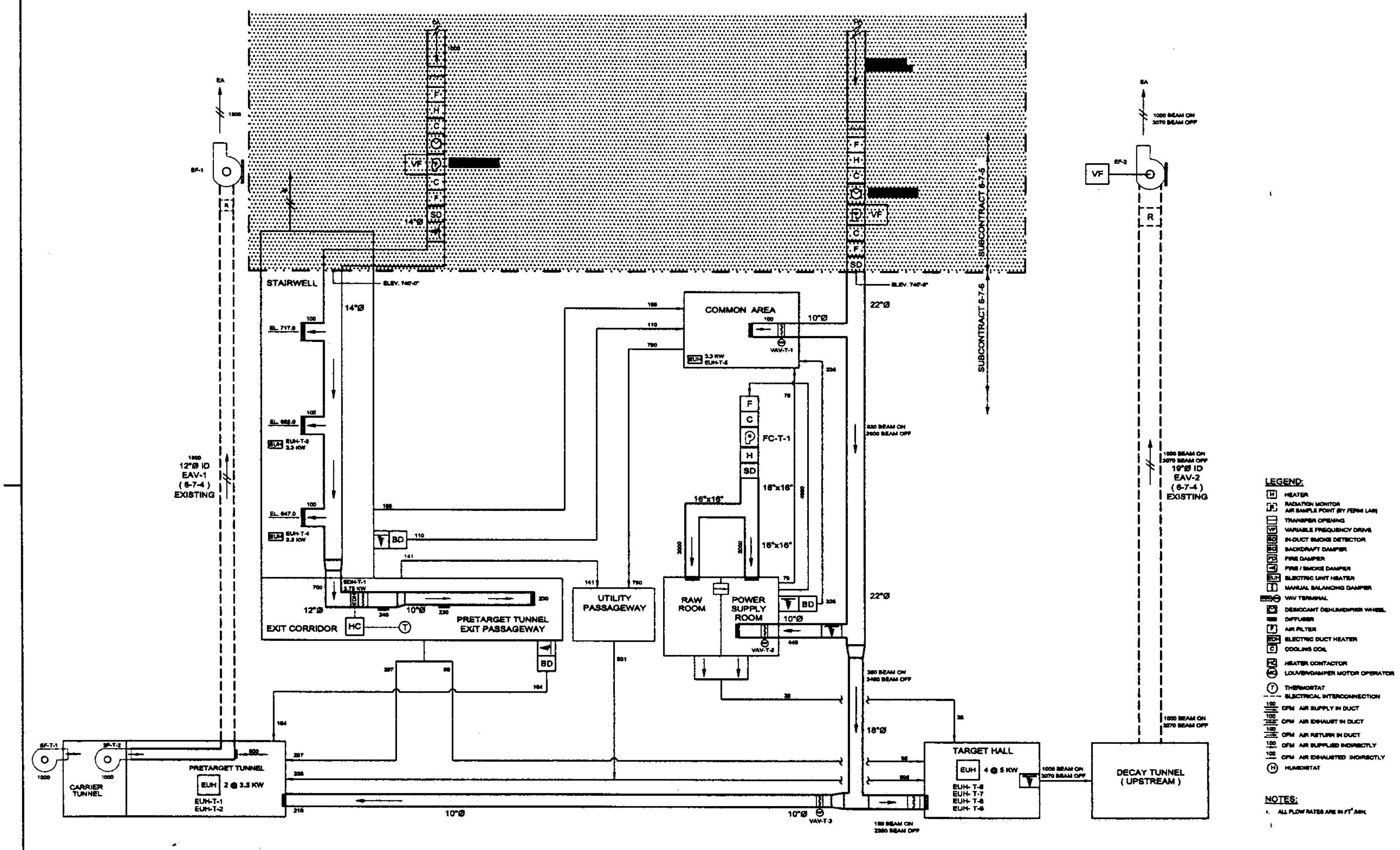
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

HVAC CRITERIA

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



PART OF PROJECT 6-7-9

REV.	DATE	DESCRIPTIONS
3	10/30/02	REVISION 3
2	10/14/02	CARRIER TUNNEL
	6/15/02	CONFORMED SET

REVISIONS

FLUOR DANIEL

MWH
MONTGOMERY WATSON HARZA

SCALE: NONE

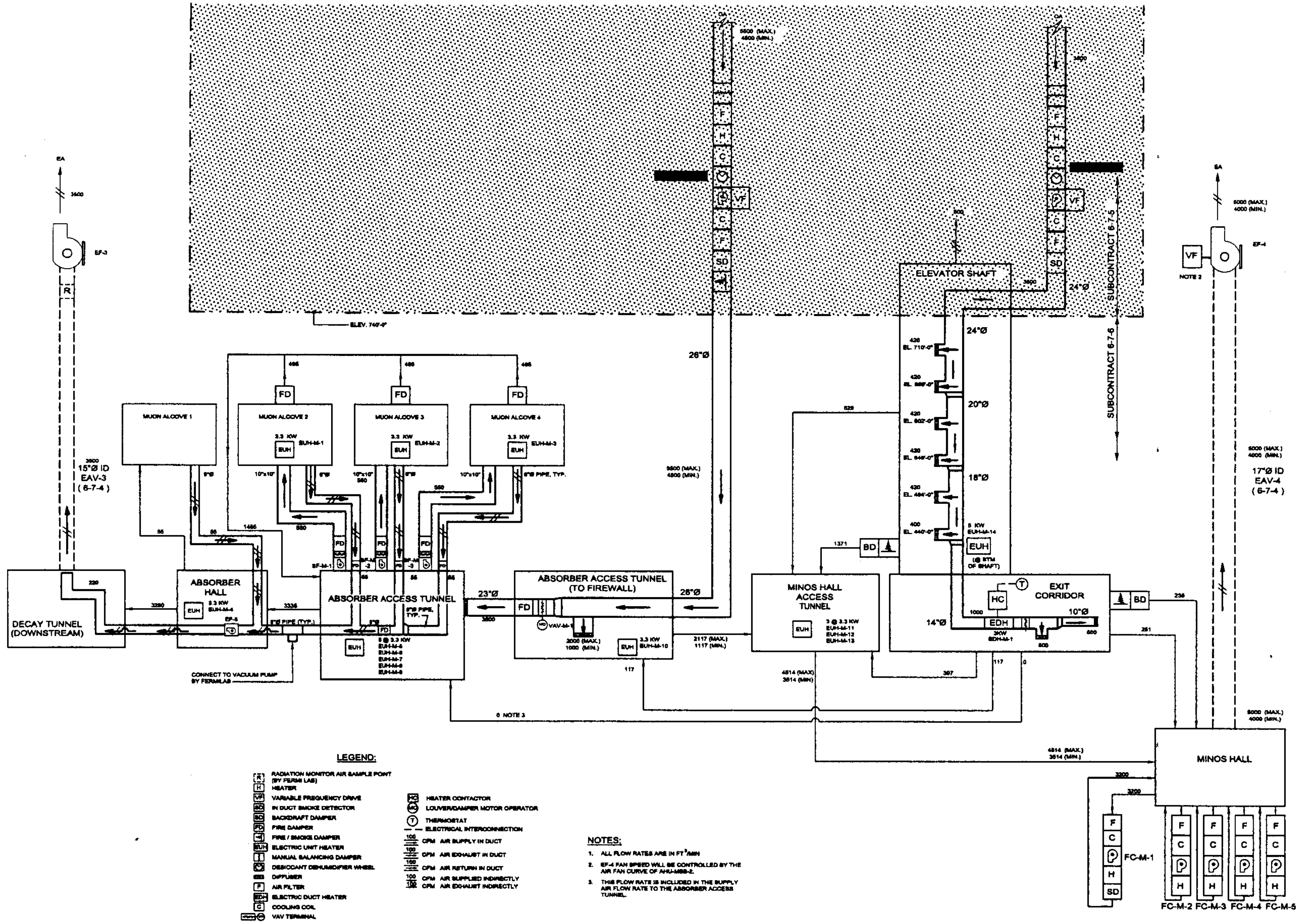
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

HVAC FLOW DIAGRAM - SHT. 1

DRAWING NO. 6-7-6 M-4 REV. 3



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-MSB-2.
3. THIS FLOW RATE IS INCLUDED IN THE SUPPLY AIR FLOW RATE TO THE ABSORBER ACCESS TUNNEL.

PART OF PROJECT 6-7-6

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

HVAC FLOW DIAGRAM - SHT. 2

DRAWING NO. 6-7-6 M-5 REV.

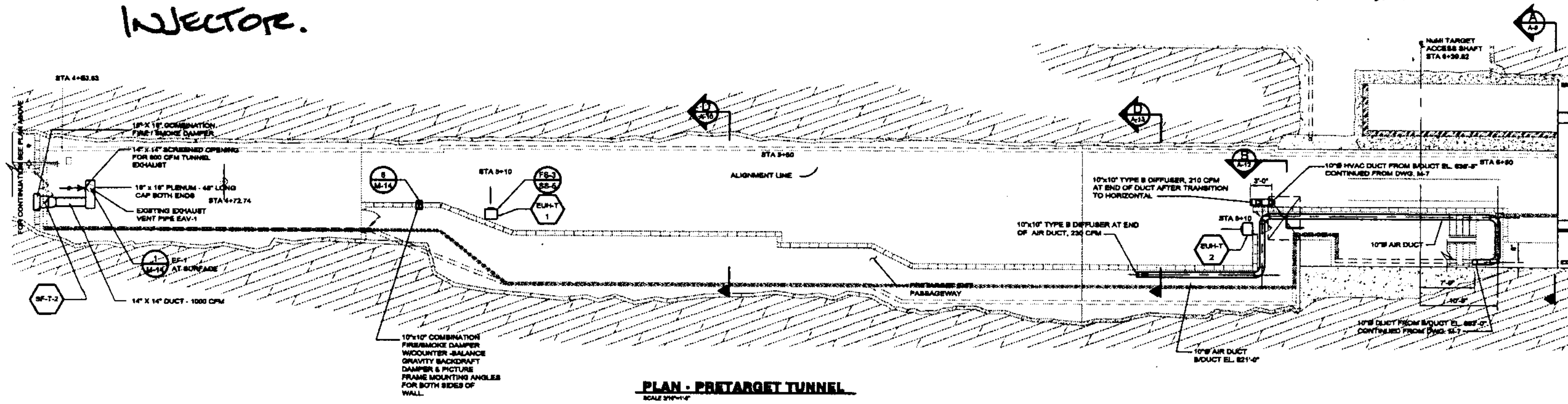
FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA

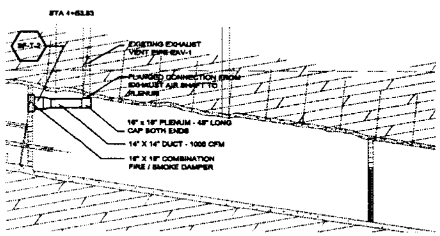
CONFORMED SET

SCALE: NONE

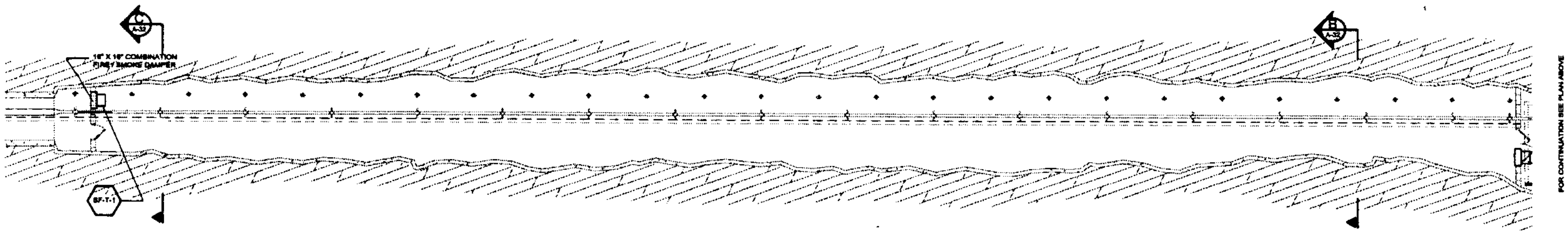
TLM IS INSTALLED ALONG ENTIRE TUNNEL SECTION SHOWN ON THIS DWG. ASLO EXTENDS U.S. TO THE NUMI STUB IN THE MAIN INJECTOR.



PLAN - PRETARGET TUNNEL



SECTION - PRETARGET TUNNEL



PLAN - CARRIER TUNNEL

PART OF PROJECT 6-7-9

REV.	DATE	DESCRIPTIONS
1	10/14/02	CARRIER TUNNEL
	6/15/02	CONFORMED SET

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

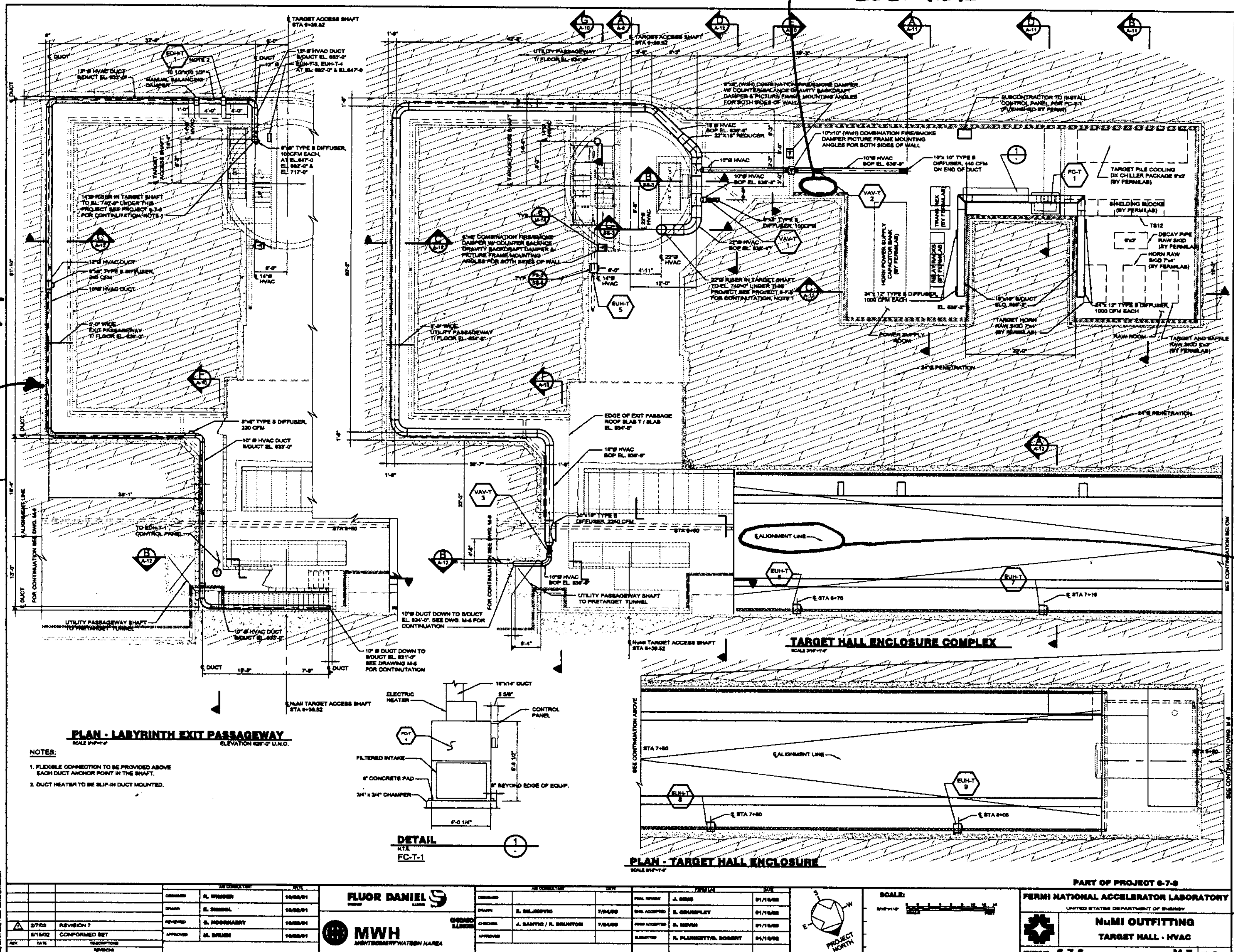
PRETARGET / CARRIER - HVAC

DRAWING NO. 6-7-6 M-6

TLM AR/CO2 Cylinder & Target Helium Cylinder Location

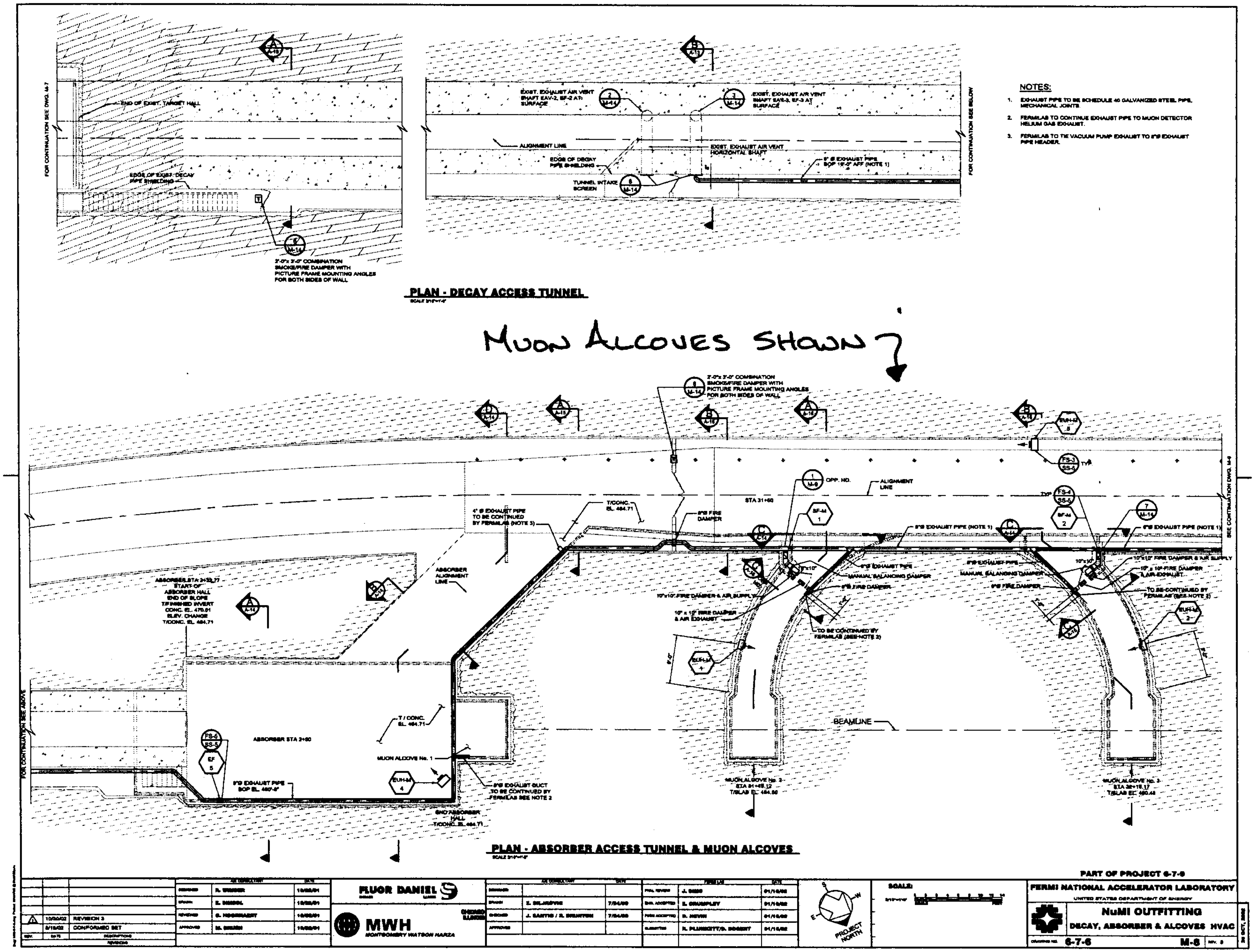
TLM and The Horn Raw Sys GN2 Pipe Chase Labyrinth Above

Personnel Labyrinth

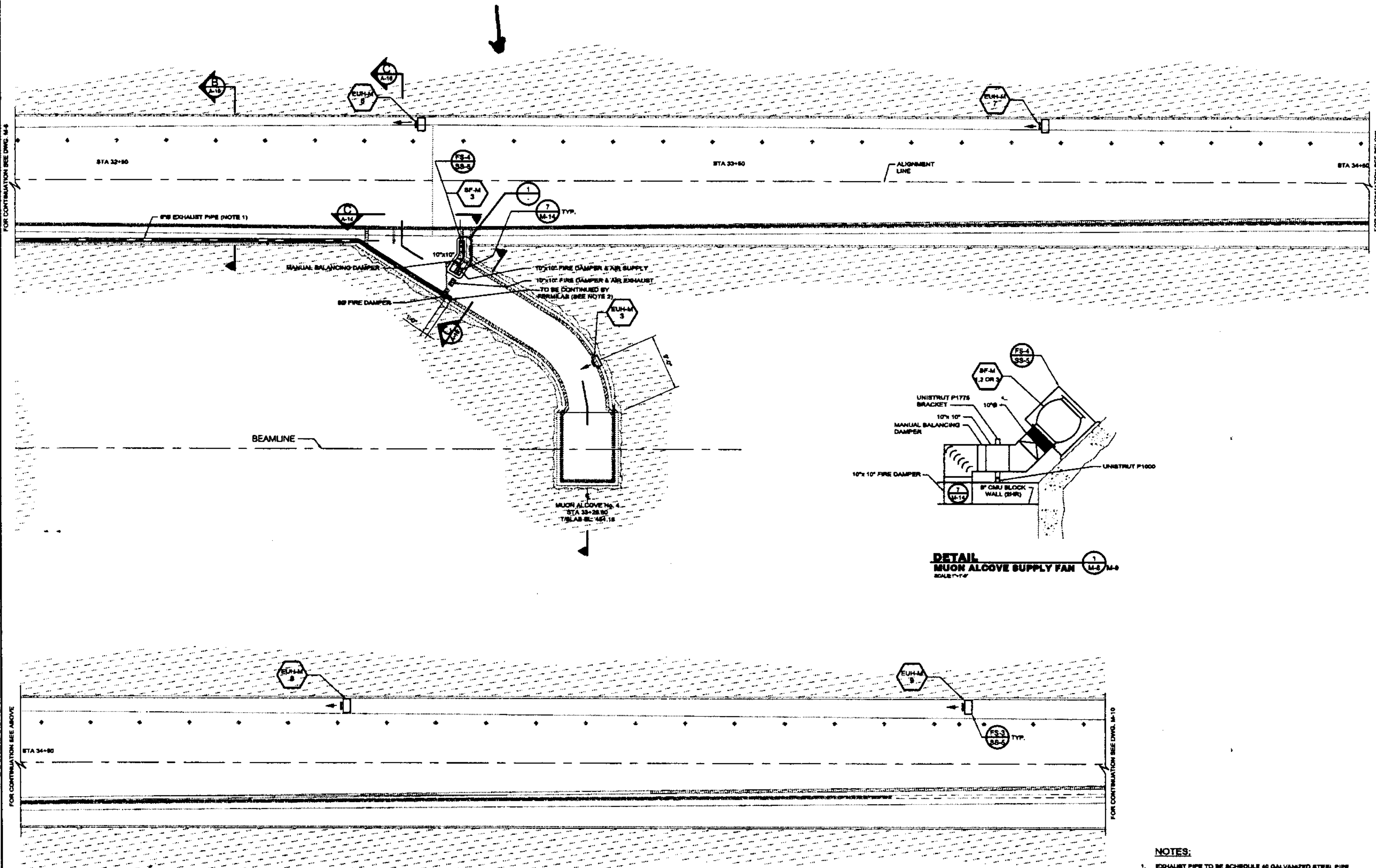


RAW Skid Locations w/ Possible GN2 or A cylinder during Commissioning

Location of the Target


PLAN - DECAY ACCESS TUNNEL
MUON ALCOVES SHOWN
PLAN - ABSORBER ACCESS TUNNEL & MUON ALCOVES
END OF EXIST. TARGET HALL
EDGE OF EXIST. DECAY PIPE SHIELDING
2'-0"x 3'-0" COMBINATION SMOKE/FIRE DAMPER WITH PICTURE FRAME MOUNTING ANGLES FOR BOTH SIDES OF WALL
EXIST. EXHAUST AIR VENT SHAFT EAV-2, SF-2 AT SURFACE
EXIST. EXHAUST AIR VENT SHAFT EAV-3, EF-3 AT SURFACE
ALIGNMENT LINE
EXIST. EXHAUST AIR VENT HORIZONTAL SHAFT
EDGE OF DECAY PIPE SHIELDING
TUNNEL INTAKE SCREEN
FOR CONTINUATION SEE DWG. M-7
FOR CONTINUATION SEE BELOW
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.
ABSORBER STA 2+60
MUON ALCOVE No. 1
BEAMLINE
STA 31+50
MANUAL BALANCING DAMPER
TO BE CONTINUED BY FERMILAB (SEE NOTE 3)
MUON ALCOVE No. 2
MUON ALCOVE No. 3
FOR CONTINUATION SEE ABOVE
SEE CONTINUATION DWG. M-9
PART OF PROJECT 6-7-6
SCALE:
PROJECT NORTH
FLUOR DANIEL
MWH
MONTGOMERY WATSON HARZA
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
NuMI OUTFITTING
DECAY, ABSORBER & ALCOVES HVAC
6-7-6
M-8

D.S. MOST MUON ALCOVE



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

PART OF PROJECT 6-7-9

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

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA — CHICAGO ILLINOIS

PROJECT NORTH

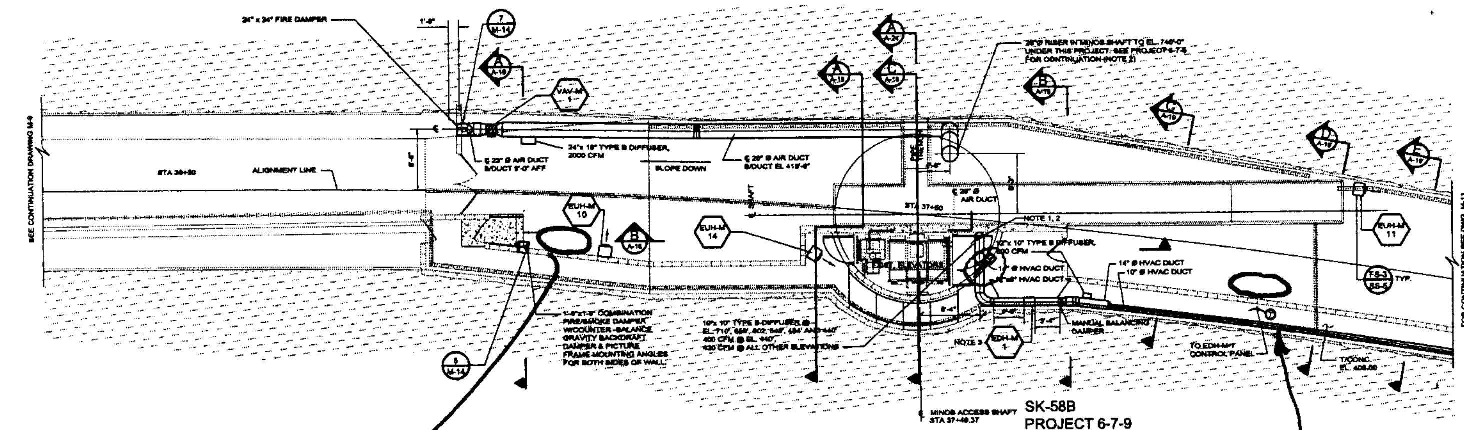
FERMI NATIONAL ACCELERATOR LABORATORY

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

LIKELY LOCATIONS OF MUON GAS SYSTEM CYLINDERS

NOTES:

1. THE AIR DUCT SIZE VARIES INSIDE THE MINOS ELEVATOR SHAFT. REFER TO DWG. M-6 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.

PART OF PROJECT 6-7-9

FLUOR DANIEL

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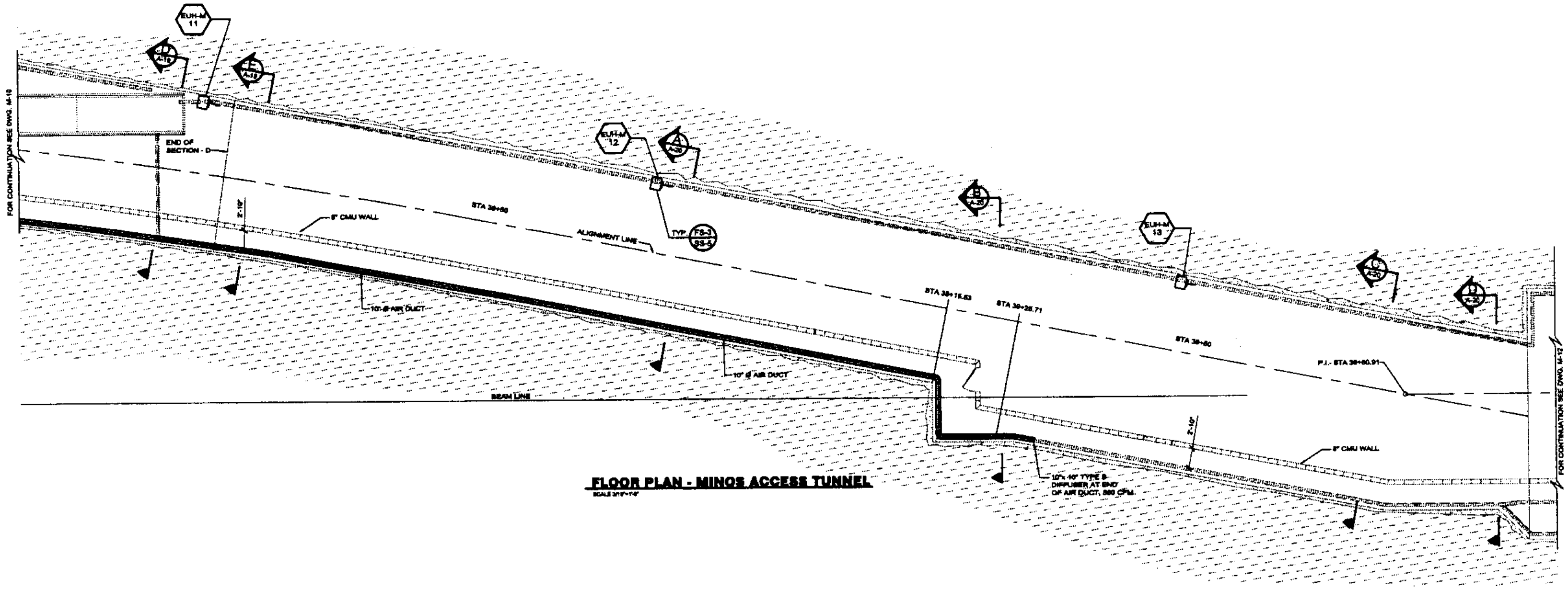
UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING
MINOS ACCESS TUNNELS - HVAC

6-7-6 M-10



FLOOR PLAN - MINOS ACCESS TUNNEL

	8/16/02	CONFORMED SET
REV	DATE	DESCRIPTIONS

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA

CHICAGO ILLINOIS

PROJECT NORTH

SCALE:

PART OF PROJECT 6-7-6

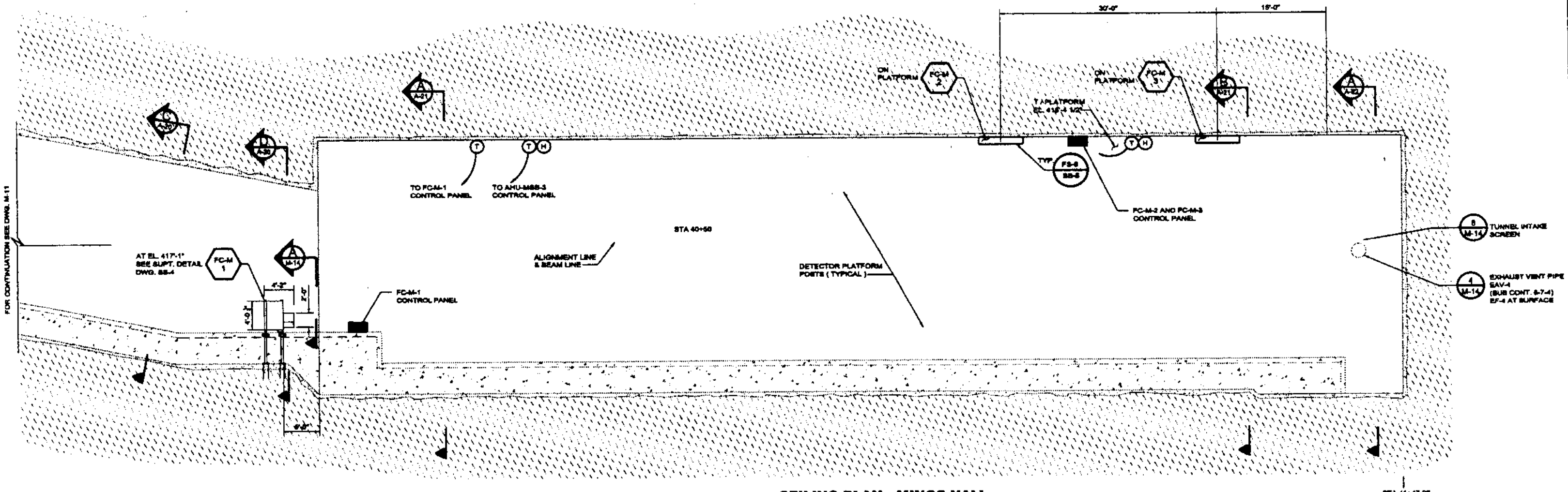
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

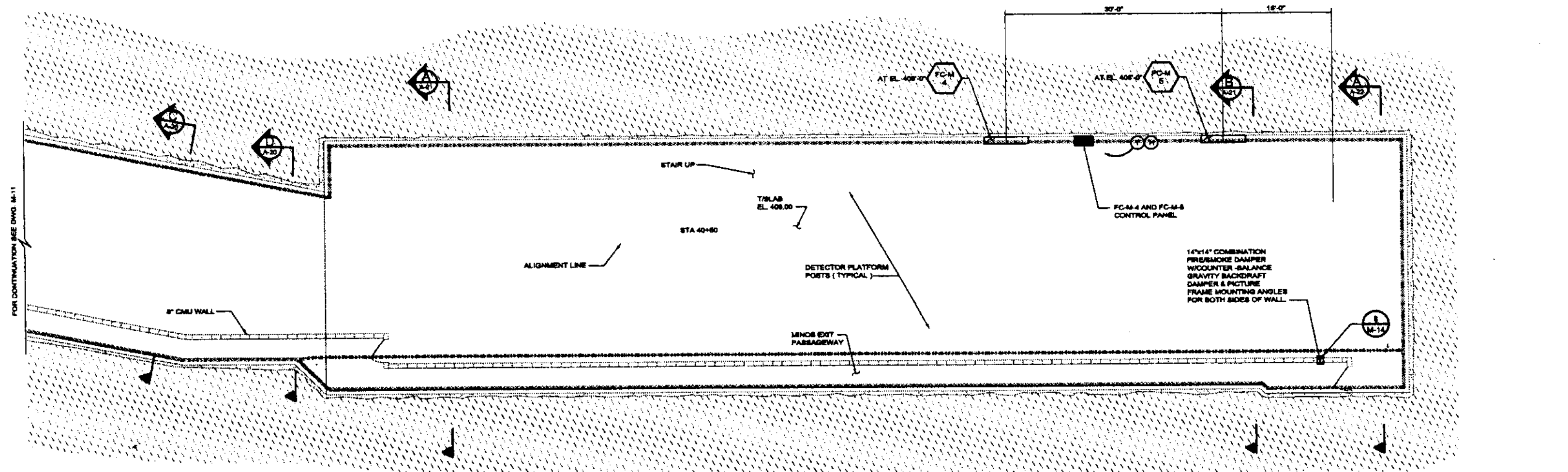
NuMI OUTFITTING

MINOS ACCESS & TUNNEL HVAC

DRAWING NO. 6-7-6 M-11



CEILING PLAN - MINOS HALL



FLOOR PLAN - MINOS HALL

PART OF PROJECT 6-7-6

REV.	DATE	DESCRIPTIONS
	5/16/02	CONFORMED SET

FLUOR DANIEL

MWH MONTGOMERY WATSON HARZA

SCALE:

PROJECT NORTH

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

NuMI OUTFITTING

MINOS HALL - HVAC

DRAWING NO. 6-7-6 M-12

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-TBB-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-6.

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 28 VOLTS) SHALL BE #18 SHIELDED, STRANDED CABLE, 2 OR 3 CONDUCTORS AS NEEDED. CONDUIT IS REQUIRED FOR CABLE BELOW 8' ABOVE FINISHED FLOOR LEVEL.

CONDUIT IS REQUIRED FOR HIGH VOLTAGE CABLE (GREATER THAN 28 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

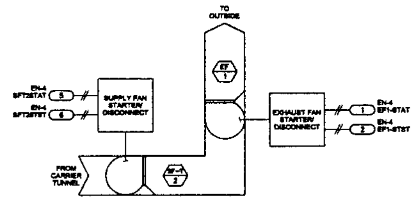
LOW VOLTAGE CABLE SHALL NOT BE TIE-WRAPPED OR TAPED TO EXISTING CABLE, PIPE, OR CONDUIT.

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

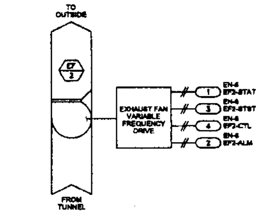
CABLES INSTALLED WITHIN AIR PLENUMS SHALL BE PLENUM RATED.

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-TBB-3.

EF-2 OPERATION: Exhaust Fan EF-2 shall be interlocked through software with dehumidifier AHU-TBB-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.

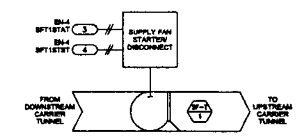
SF-T-2 OPERATION: Supply Fan SF-T-2 shall be interlocked through software with exhaust fan EF-1.

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

EXHAUST FAN BILL OF MATERIALS

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

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.

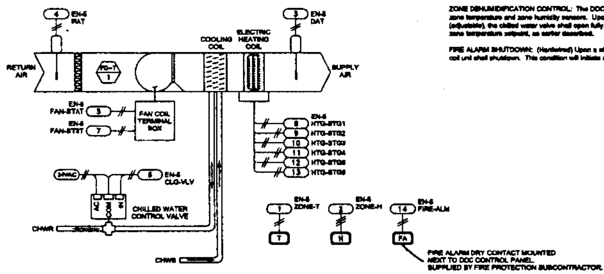
ZONE DEHUMIDIFICATION CONTROL: The DDC system shall calculate the zone dewpoint from the zone temperature and zone humidity sensors. Upon sensing a zone dewpoint of greater than 55°F (adjustable), the chilled water valve shall open fully. The electric reheat shall modulate to maintain the zone temperature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

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

(FOR INFORMATION ONLY - PROGRAMMING NOT IN CONTRACT)

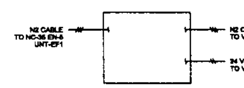
VAV OPERATION: VAV boxes shall be installed to control the airflow in the different duct branches for dehumidifier AHU-TBB-4. The VAV boxes shall be supplied with a Johnson Controls DDC controller, damper motor, and differential pressure sensor to sense airflow velocity. The DDC controller shall modulate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



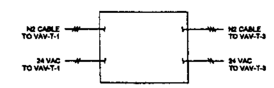
FAN COIL UNIT FC-T-1 CONTROL SYSTEM LAYOUT

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

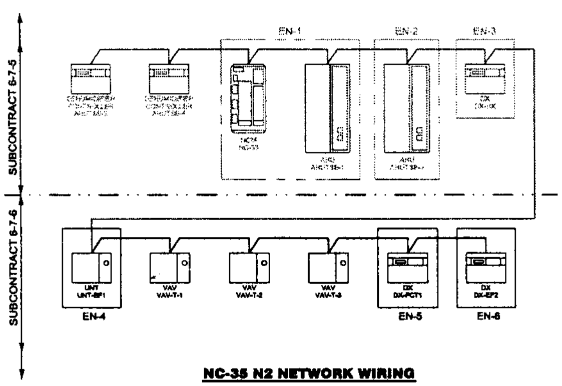
FAN COIL UNIT BILL OF MATERIALS



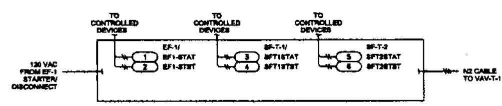
VAV-T-1 PANEL DETAIL



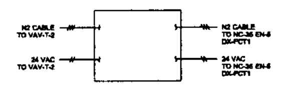
VAV-T-2 PANEL DETAIL



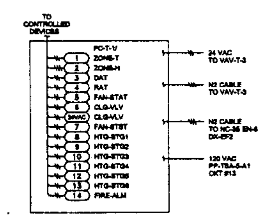
NC-35 N2 NETWORK WIRING



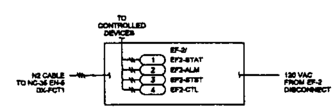
NC-35 EN-4 PANEL DETAIL



VAV-T-3 PANEL DETAIL



NC-35 EN-5 PANEL DETAIL



NC-35 EN-6 PANEL DETAIL

PART OF PROJECT 6-7-6

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

REVISIONS

	NAME	DATE
FINAL REVIEW	J. [illegible]	01/16/02
ENG. ACCEPTED	E. CRUMPLEY	01/16/02
FESS ACCEPTED	D. NEVIN	01/16/02
SUBMITTED	R. PLUNKETT / D. BOGERT	01/16/02

SCALE:

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

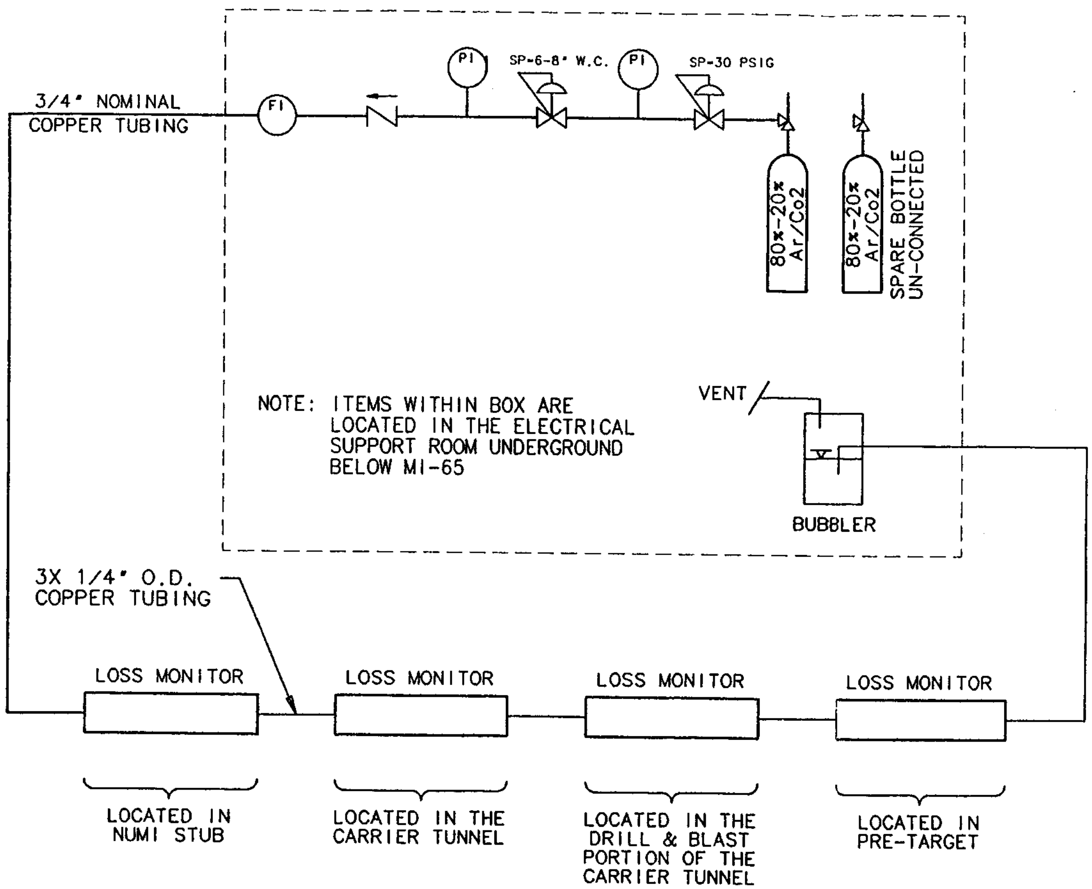
NuMI OUTFITTING

TARGET HVAC CONTROLS

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

14 OCT, 2002

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE

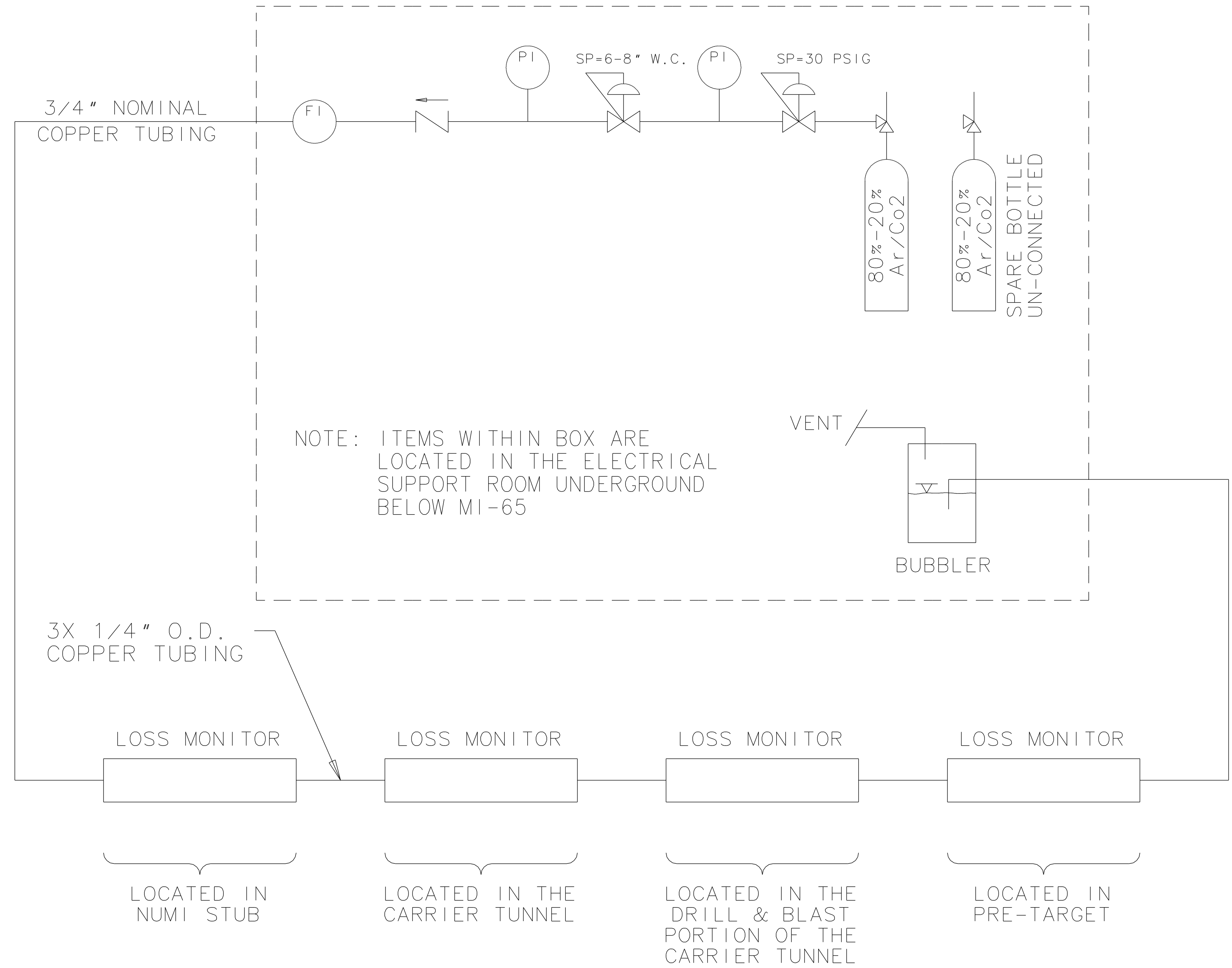


UNLESS OTHERWISE SPECIFIED			ORIGINATOR	D.PUSHKA	30-JUL-2004
.XX	.XXX	ANGLES	DRAWN	R.L.SMITH	30-JUL-2004
± --	± ---	± -	CHECKED		
1. BREAK ALL SHARP EDGES MAX. 2. DO NOT SCALE DRAWING. 3. DIMENSIONS BASED UPON ASME Y14.5-1994 4. MAX. ALL MACH. SURFACES X/ 5. DRAWING UNITS: INCHES			APPROVED	D. Pushka	30 Jul 04
			USED ON	***	
			MATERIAL	****	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NUMI/UTILITIES
TOTAL LOSS MONITOR
GAS SYSTEM SCHEMATIC

SCALE	DRAWING NUMBER	SHEET	REV
NONE	8875.117-MB-4331	1 OF 1	
CREATED WITH : Ideas9m3		GROUP: PPD/MECHANICAL DEPARTMENT	


3/4" NOMINAL
COPPER TUBING
FI
PI
SP=6-8" W.C.
PI
SP=30 PSIG
80%-20%
Ar/Co2
80%-20%
Ar/Co2
SPARE BOTTLE
UN-CONNECTED
VENT
NOTE: ITEMS WITHIN BOX ARE
LOCATED IN THE ELECTRICAL
SUPPORT ROOM UNDERGROUND
BELOW MI-65
BUBBLER
3X 1/4" O.D.
COPPER TUBING
LOSS MONITOR
LOSS MONITOR
LOSS MONITOR
LOSS MONITOR
LOCATED IN
NUMI STUB
LOCATED IN THE
CARRIER TUNNEL
LOCATED IN THE
DRILL & BLAST
PORTION OF THE
CARRIER TUNNEL
LOCATED IN
PRE-TARGET