DØ CLEAN ROOM
ODH ANALYSIS
INSTRUMENT AIR CONSIDERATIONS

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DØ Engineering Note
3740.510-EN-276

Approved

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The following is an ODH analysis of the DØ clean room with the following parameters:

Exhaust – 2500 cfm recirculated, 520 cfm fresh air.

Volume – 57,170 cf.

Elevation, Pressure – 707.5', 742 mmHG.

The ODH problem in this case involves the instrument air line to the clean room, which is isolated by a check valve from the gaseous nitrogen trailer backup source (valve #CV787I, see DRG. NO. 3740.510-MA-273995, attached (the “to purging enclosure” line runs to the clean room)). Normally, the check valve prevents backflow through the instrument air line. But as we all know, valves can fail.

The estimated mean failure rate for a check valve to allow reverse flow is $3 \cdot 10^{-7}$.¹ Failure of the instrument air and the check valve would allow the seepage of gaseous nitrogen into the clean room. The failure of the instrument air is necessary to cause an ODH problem, due to the fact that the air pressure would keep the lower pressured gaseous nitrogen from flowing through the check valve. The compressor for the instrument air is fairly reliable, but to show the true nature of how safe this situation is, both cases that follow will assume that the compressor, and therefore the instrument air, has already failed.

Table A shows the standard ODH situation. Assuming everything is working correctly (all the gasses are flowing, the ventilation is active, etc.), the only consideration is the failure of the check valve concurrent with the instrument air failure. The table clearly shows an ODH classification of 0, which would hold even for an extreme leakage, and which does not even consider the likelihood

¹ From the Fermi Safety Manual, ODH section, Table III, NRC Equipment Failure Rate Estimates.

of the instrument air failure, which would lower the fatality rate even more. Note that the leak rate given in the tables following (50 scfm) is an overly generous amount considering the restricting nature of the small pipes and valve orifices, and that it is half of the compressor capacity.²

Table B is the same situation in the event of a power failure, estimated for eight times a year ($1 \cdot 10^{-3}$ fails/hour), which would deactivate any electrically powered building devices, such as fans and air compressors. This scenario assumes that the instrument air fails, the ventilation exhaust shuts down, and the check valve fails *at the same time*. The probability for this occurrence coinciding with the power failure is a multiple of the two failure rates, i.e. $3 \cdot 10^{-7} \times 1 \cdot 10^{-3} = 3 \cdot 10^{-10}$. Note that the ventilation failure would require that the minimum exhaust from the clean room to be identical to the leak resulting from the check valve failure, as an approximation of the leakage 'forcing' an exhaust rate. Again, the table shows that the ODH classification is well within the 0 range.

None of these analyses suggest that this check valve poses a safety hazard in any manner, so no ODH equipment need be implemented.

Note: Standard conditions defined at 70 °F, 1 atm.

² Estimate from conversation with George T. Mulholland and Kelly Dixon.

Clean Room, Oxygen Deficiency Hazard Analysis, Instrument Air Line.

TABLE A - STANDARD

Exhaust E 520	TC, min. V/E 109.94									
Volume V 57170	Elevation 707 ft	Pressure 742 mmHG								
ITEM	TYPE, SIZE	N	P FAIL RATE	GROUP FAIL RATE	L leak rate	L/E LEAK/EXH	fO ₂ {∞} FRACT O ₂	F Fatal. Factor	Ø Fatal. Rate	ODH Class
Check Valve		1	3.00E-07	3.00E-07	50	0.09615	1.90E-01	2.65E-08	7.95E-15	0

TABLE B - POWER FAILURE

Exhaust E 50	TC, min. V/E 1143.40									
Volume V 57170	Elevation 707 ft	Pressure 742 mmHG								
ITEM	TYPE, SIZE	N	P FAIL RATE	GROUP FAIL RATE	L leak rate	L/E LEAK/EXH	fO ₂ {∞} FRACT O ₂	F Fatal. Factor	Ø Fatal. Rate	ODH Class
Check Valve		1	3.00E-10	3.00E-10	50	1	0.00E+00	1.00E+00	3.00E-10	0

Special Notes: all event rates are per hour, flows are in scfm, volumes in cf and times in minutes.

REFERENCE: DØ Engineering Note 3740.510-EN-229, "General ODH Analysis Method and Conclusions"
Sept. 19, 1989, Rev. B.

DØ Instrument Air System

REV	DATE
E	DOUGLAS CLARK 1/18/90

ORIGINATED BY KELLY DIXON	3/10/89
FERMI NATIONAL ACCELERATOR LABORATORY	
DØ DETECTOR	
INSTRUMENT AIR FLOW DIAGRAM	
DRG.NO. 3740.510-MA-273995 1 of 2	REV. E