Fermilab

Particle Physics Division

Mechanical Department Engineering Note

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Project: MicroBooNE

Project Internal Reference:

Title: MicroBooNE Warm Gas High Voltage Test

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Key Words:

Abstract/Summary:

This engineering note shows the ODH calculations and procedures for doing a high voltage test of the MicroBooNE TPC inserted into the cryostat with the removable head on the vessel, but not welded.

Applicable Codes:

Procedure to do a Warm HV Test at DAB

Jim Kilmer

October 3, 2013

This procedure outlines the steps required to do a warm argon gas high voltage test of the final assembly of the cryostat before the removable head is welded on the cryostat.

1. Before the TPC is installed, close up all of the ports except the feedthroughs for the TPC and the high voltage feedthrough. If possible put as many of the real instruments in place as possible to close off these ports. An example is the argon level probes. These may have to be put in after the TPC is in place to make sure they are at the correct height.
2. Leave the bolts loose on one of the 10 inch flanges at the top of the cryostat as a relief valve for the vessel. The flange weighs at most 66.7 lbs and the area of the 10 inch pipe flange seal ID is 10.88 inches. Then the minimum pressure the flange will lift off at is .717 psi.
3. Install the TPC and complete all checks with the feedthroughs in place.
4. Weld on the HV feedthrough cup and insert the HV feedthrough. Be sure to take precautions to protect the PMTs and TPB plates from the ultraviolet flash of the welding.
5. Move the cryostat back into the tent so the head can be positioned on the open end.
6. Fit the head to the cryostat. Secure it in position by running a binder strap from one of the lifting lugs around the head and over to the opposite side lifting lug. The binder strap should have a minimum load rating of 5 tons.
7. Tape the joint with enough black 2” wide electrical tape to seal it
8. Run a ½” copper tube from the tube trailer outside to the lower sparger pipe on the cryostat.
9. Run a second 2” elephant hose from the upper sparger pipe to the outside for a vent. The tube should go out the roll-up door and up over the east concrete wall into the east side grass area. See the attached flow diagram.
10. Hook the inlet tube up to the tube trailer using a regulator that can reduce the argon to approximately 25 psi followed by a rotameter capable of a 20 scfm flow rate. A regulator used for purging welded pipes would work well here.
11. Set up a large fan inside the tent blowing to the outside of the tent to blow any potential leaked argon out of the tent to the high bay while mixing the argon with air. The fan chosen for this is the 36 inch fan at Lab F with a high speed flow rate of 12,000 cfm.

12. Start the flow of argon to the TPC by opening the trailer valves, setting the regulator to 20 psi and the rotameter to 20 cfm. The volume of the cryostat is 4300 cubic feet so a volume change is about 3.5 hours. The tube trailer holds about 10 volume changes.
13. Measure the exhaust purity at the end of the vent line using a welding purge monitor. Borrow the one in use at Lab F for cryogenic assembly. This instrument can measure oxygen in the argon down to 0.1%. Below that we'll have to rely on data from LAPD.
14. When the purity is sufficiently good, adjust the rotameter to ~ 1 scfm or less to leave a small purge on the cryostat.
15. Begin HV tests
16. When tests are completed, shut off the argon gas purge and disconnect the trailer.
17. To remove the gaseous argon from the vessel hook a vacuum pump to the end of the inlet tube outside and pump out the argon through the bottom sparger connection. Leave the vent line open to admit air to the cryostat.
18. Run the pump overnight and then secure the test.
19. Unless the cryostat must be reopened to do repairs uncovered by the test, leave the cryostat and head in position for Val-Fab.

ODH Analysis for MicroBooNE HV Test
Jim Kilmer
October 1, 2013

The MicroBooNE project would like to test the High Voltage system for the TPC in the cryostat before the vessel head gets welded back on the vessel.
To do this and get a meaningful result the project has devised a test where the cryostat is filled with gaseous argon while the head is justfitted to the cryostat, but not welded. Using the sparger pipes already inside the vessel we will use a purge method of putting in pure argon at the bottom and venting the top of the vessel to the outside. This method has been demonstrated to work well in LAPD and will get the required purity needed for the test.

The head will be supported by the gantry in the cleanroom and fitted to the open cryostat end, but not welded. The seam will be sealed using black electrical tape and the vessel will be kept at atmospheric pressure throughout the tests. The head will be held in place to the vessel using a binder strap and the two lifting lugs on the cryostat nearest the open end. A large fan will be used in the clean room to mix any leaking argon well with the air and blow it out of the cleanroom. This fan is a Dayton air circulator, Model 3C187C. A catalog cut is attached showing the fan's capability. At high speed the fan will move 12,241 cfm of air. This will ensure that any leakage of the end of the cryostat will be completely mixed with surrounding air. Gaseous argon will be provided by a tube trailer holding approximately 43,000 cubic feet of argon gas. This document is the ODH analysis for this test.

$Dzerovol := 624375 \cdot ft^3$ Volume of the Dzero high bay, not including pit

$R := 20 \cdot \frac{ft^3}{min}$ Purge Rate from TT into cryostat

$Q := 3660 \cdot \frac{ft^3}{min}$ Building ventilation rate.

The cryostat is approximately 4300 cubic feet in volume. The tube trailer will provide about ten volume changes. LAPD tests show that this will be more than adequate to attain the purity needed for the test. However this argon might pose an ODH hazard to building occupants. First calculate the oxygen reduction assuming that the entire flow goes into the room. At the purge rate the argone in the tube trailer will only last for 2150 minutes or almost 36 hours. Use Case A from FESHM 5064.

$n := 0 .. 72$

$t_n := 30 \cdot min \cdot n$

$$Ct_n := \left(\frac{0.21}{Q + R}\right) \cdot \left[Q + R \cdot e^{-\left(\frac{Q+R}{Dzerovol}\right) \cdot t_n}\right]$$

$n =$

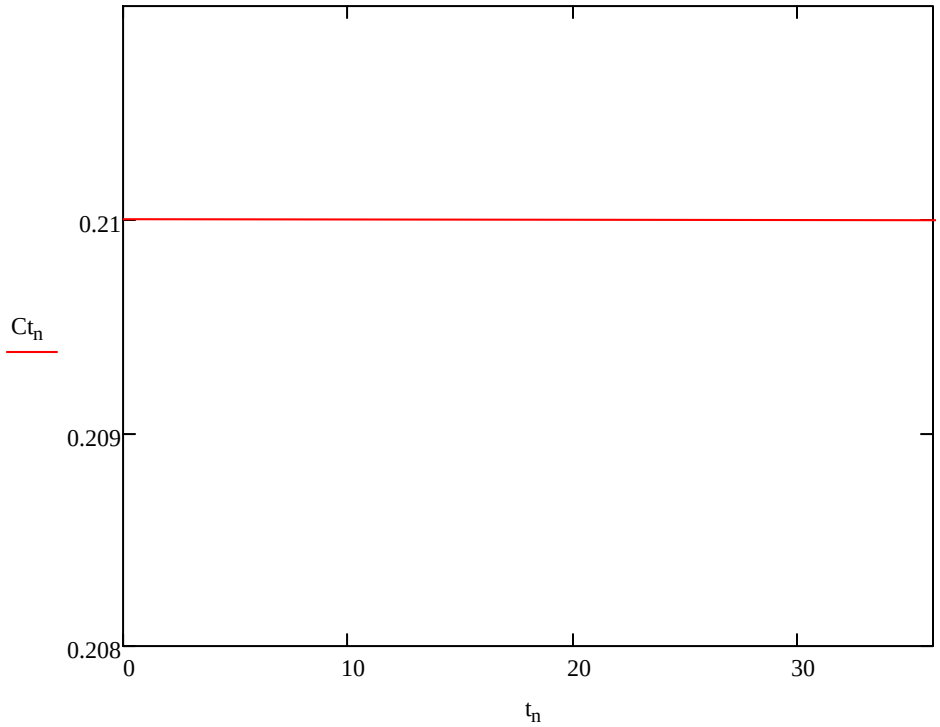
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
...

$t_n =$

0	·hr
0.5	
1	
1.5	
2	
2.5	
3	
3.5	
4	
4.5	
5	
5.5	
6	
6.5	
7	
...	

$Ct_n =$

	0
0	0.21
1	0.21
2	0.21
3	0.21
4	0.209
5	0.209
6	0.209
7	0.209
8	0.209
9	0.209
10	0.209
11	0.209
12	0.209
13	0.209
14	0.209
15	...



As can be seen from the plot above a complete break of the supply or vent line flowing at the rate of the purge has no effect on the oxygen concentration in the building. The recalculation of the case with the building make-up Q = 0 also has no effect on the oxygen concentration. Hence the fatality factor for the case of a small leak is zero.

The second case is a leak caused by the head seal tape giving way. Estimate the leak at 10% of the volume of the vessel per minute. This is a conservative estimate because with the vessel at atmospheric pressure the argon has no pressure across the leak except for the pressure generated by the head on the argon column.

$$R := \frac{430 \cdot ft^3}{min}$$

The new leak rate

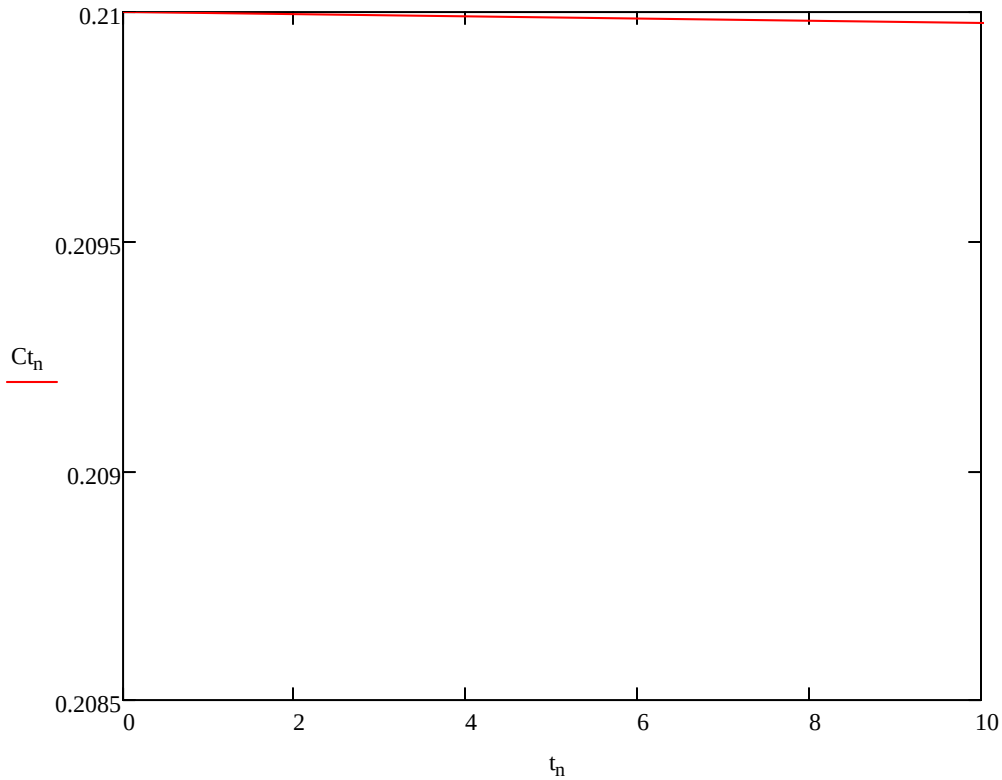
$$n := 0 .. 20$$

After 10 minutes the argon in the vessel is depleted

$$t_n := 30 \cdot sec \cdot n$$

$$Ct_n := \left(\frac{0.21}{Q + R}\right) \cdot \left[Q + R \cdot e^{-\left(\frac{Q+R}{Dzerovol}\right) \cdot t_n}\right]$$

$n =$	$t_n =$	$Ct_n =$
0	0 ·min	0.21
1	0.5	0.21
2	1	0.21
3	1.5	0.21
4	2	0.21
5	2.5	0.21
6	3	0.21
7	3.5	0.209
8	4	0.209
9	4.5	0.209
10	5	0.209
11	5.5	0.209
12	6	0.209
13	6.5	0.209
14	7	0.209
...	...	...



Case 1

P1=1
F1=0

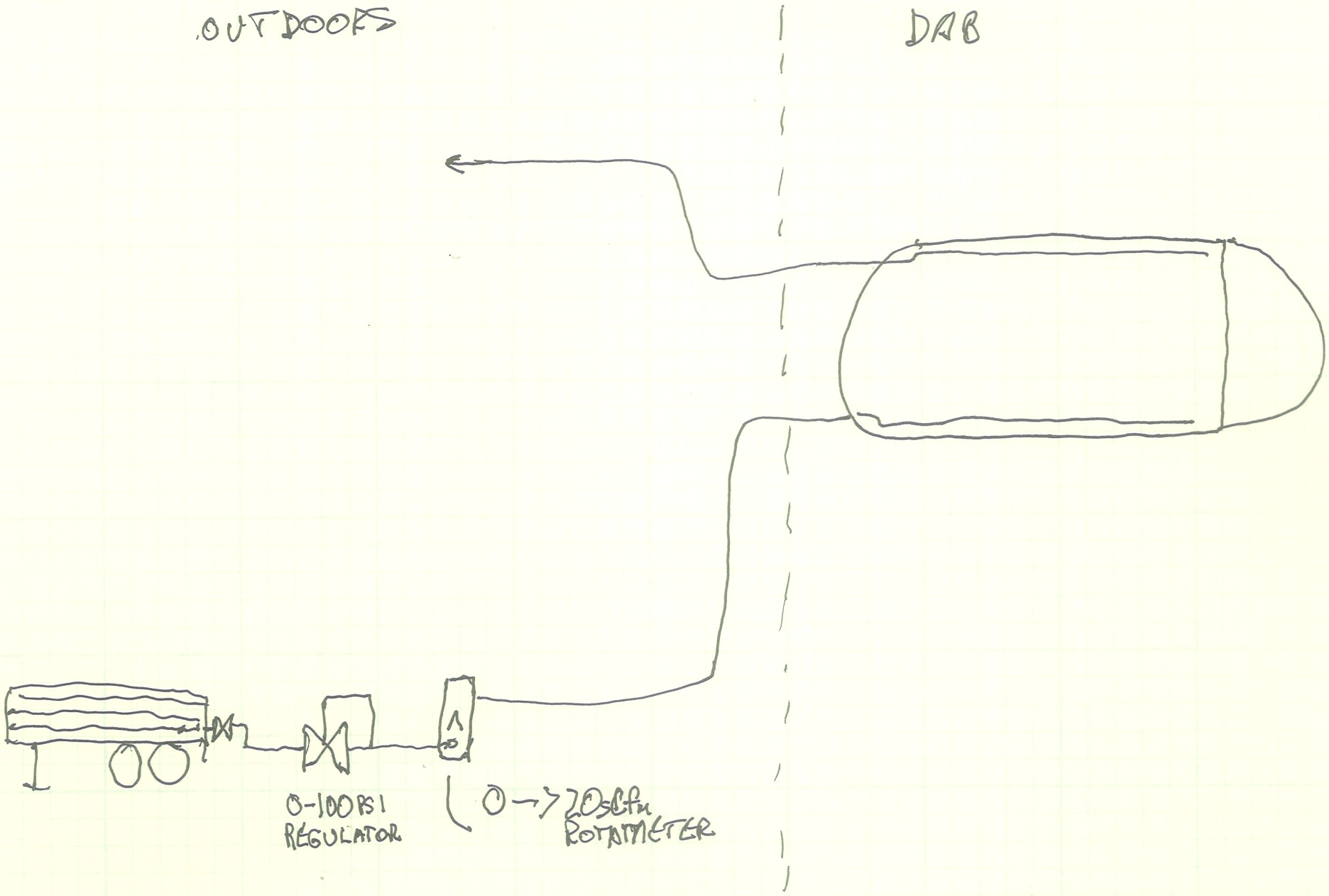
Case 2

P2=1
F1=0

Φ=P1F1 +P2F2

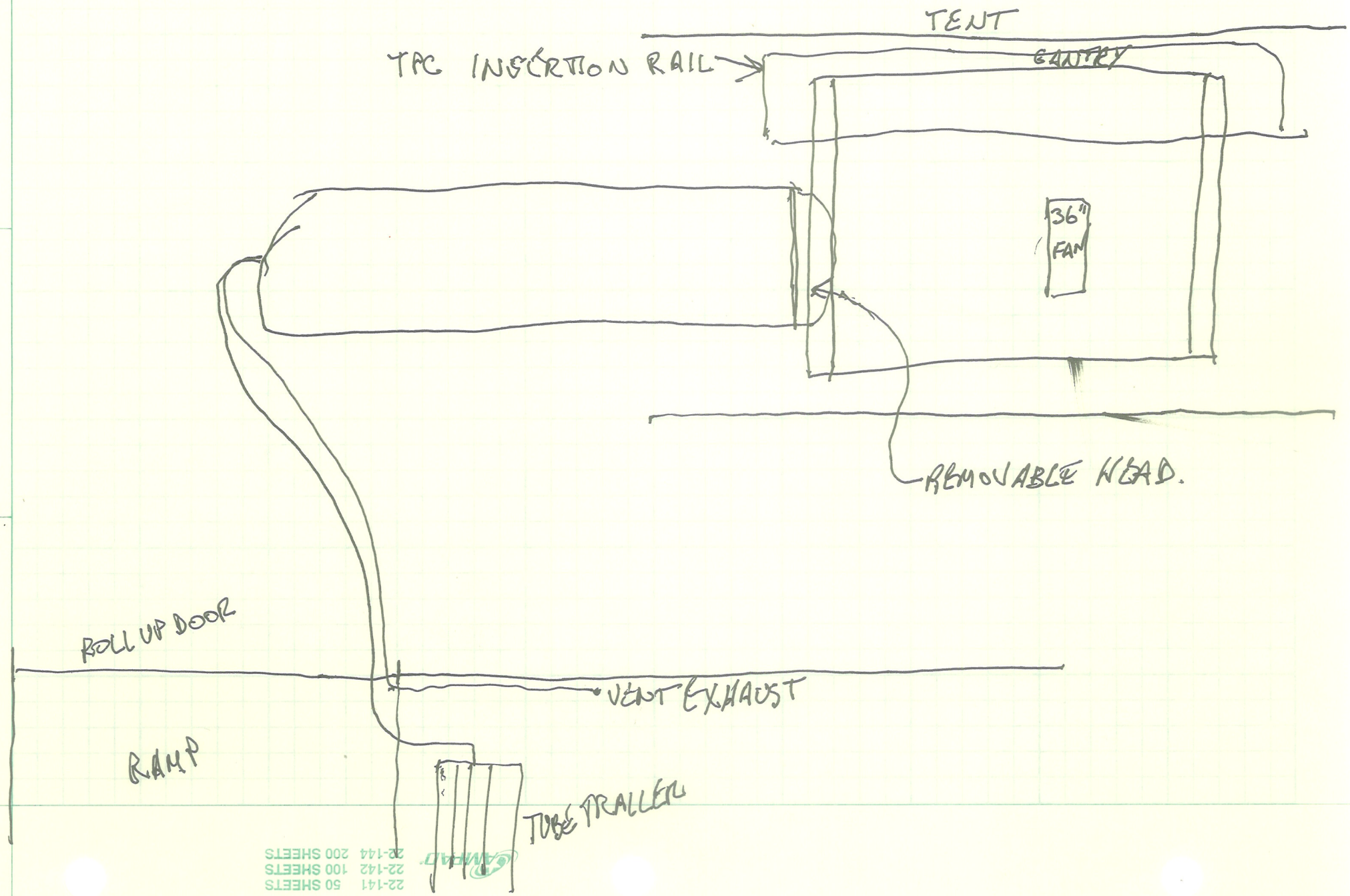
Φ=0

The fatality rate is zero so the ODH classification is ODH zero.



AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

LAYOUT AT DAB



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