The Effects of a Known Control Room Envelope Breach on the Control Room Differential Pressure, Outside Airflow and Potential Unfiltered Inleakage

Presented By

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Background

- Seabrook Station had performed an engineering calculation that would allow up to a 24 in^2 breach and still maintain control room outside airflow, ΔP, and unfiltered inleakage within design parameters.
- The surveillance test for testing the control room for unfiltered inleakage was due in 2009 and it was decided that this would be a good opportunity to prove that the engineering calculation was valid.
- Test will strengthen the basis for the existing program allowing breaches in the control room envelope, supporting on-line maintenance activities.

Background

- Performing the test will demonstrate full compliance with RG 1.197.
- Testing will validate the breach control program.
- Any Regulatory challenge to the engineering basis for allowing openings in the CRE could result in suspending the breach control program until the test is performed. Openings in the CRE would then only be allowed in Modes 5 and 6 with no irradiated fuel movement.

Justification

- Implementation of a Control Room Habitability Program per Reg. Guide 1.197.
- Existing allowance for up to a 24 $in.^2$ breach in the CRE.
- Existing allowance based on limiting air out-leakage from the CRE such that the ΔP remains $\geq$ 0.125 in. WG to all adjacent areas.
- Acknowledges NRC recognition that a positive ΔP in the CRE **DOES NOT** indicate unfiltered inleakage design basis is met.

Risks

- Performing the test could invalidate the design basis for openings in the CRE boundary.
- Breach opening must be able to be rapidly restored to normal conditions.
- During any of the testing with or without an opening, a failure to meet the unfiltered inleakage acceptance criteria could result in an entry into a Technical Specification Action requiring remediation of the problem within 90 days.

Process

- During the course of normal inleakage testing, introduce breach of a known area.
  - Removal of access door lockset, replaced with a movable plate.
  - Move plate to create breaches of varying areas.
- Monitor
  - ΔP of the CRE to adjacent areas.
  - Changes in air flow.
  - Impact on inleakage.

Door Breach Sizes (in^2)

- 0.00
- 5.75
- 11.50
- 17.25
- 23.70

Door Breach


C325
STOP
THINK
ACT
REVIEW
STAR PROGRAM
USE PULL HANDLE
WHEN OPENING DOOR.
CAUTION
HIGH DIFFERENTIAL
PRESSURE ACROSS DOOR
USE CAUTION
WHEN OPENING
DOOR
CAUTION
OPEN/CLOSE
DOOR SLOWLY
C325
TECHNICAL REQUIREMENTS FIRE DOOR
SECURITY DOOR
DOOR DIFFICULT
TO OPEN
FIRE ALARM

Door Breach (5.75 in^2)

Measuring Door Breach

Door Breach (23.70 in^2)

Acceptance Criteria

- CRE must maintain a $\Delta P \geq 0.125$ in. W.C. to all adjacent areas.
- Total pressurization flow must be ≤ 600 CFM.
- Total unfiltered inleakage must be ≤ 150 CFM.

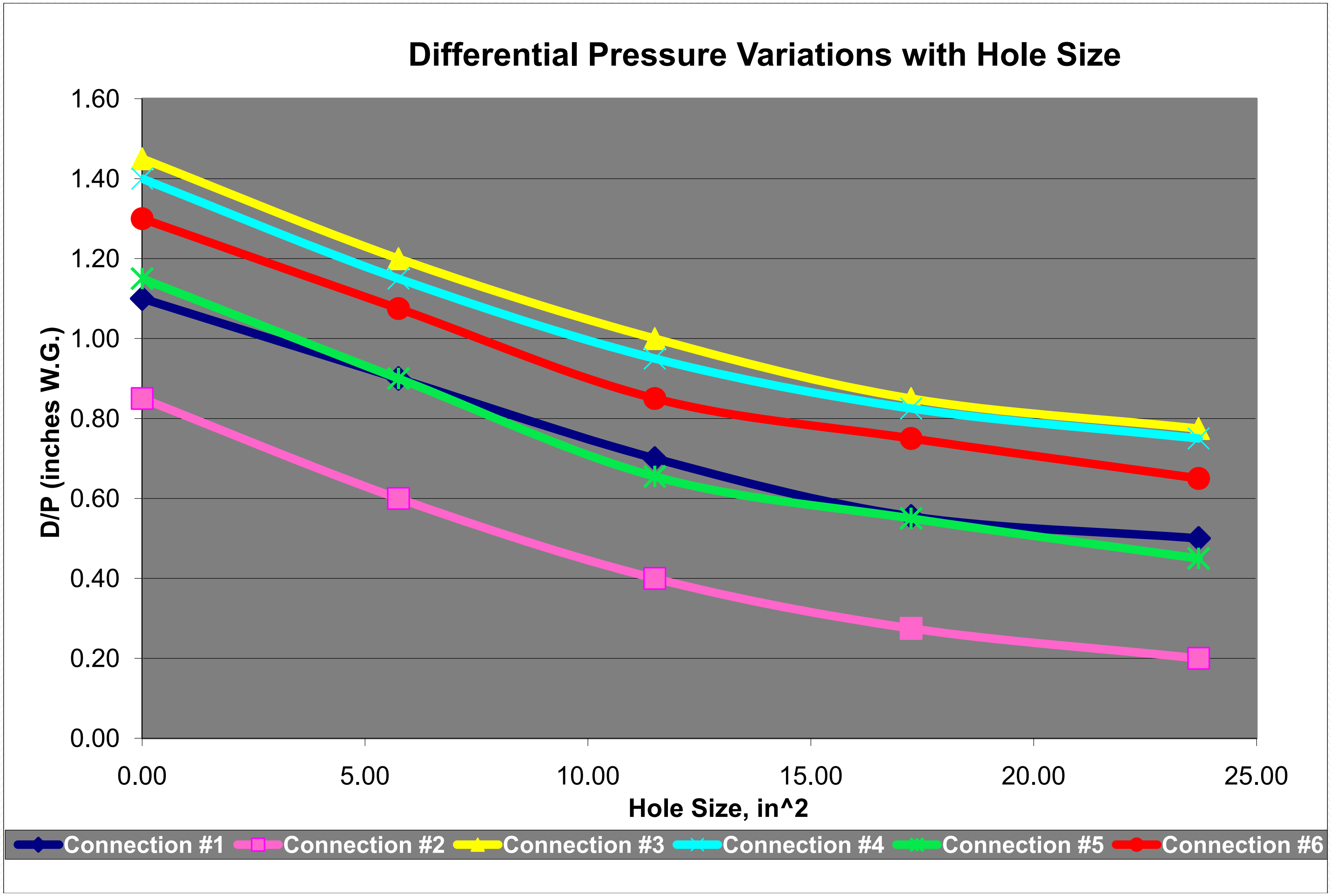
Differential Pressure

Opening Size, in^2	Connection #1	Connection #2	Connection #3	Connection #4	Connection #5	Connection #6
0.00	1.100	0.850	1.450	1.400	1.150	1.300
5.75	0.900	0.600	1.200	1.150	0.900	1.075
11.50	0.700	0.400	1.000	0.950	0.655	0.850
17.25	0.555	0.275	0.850	0.825	0.550	0.750
23.70	0.500	0.200	0.775	0.750	0.450	0.650

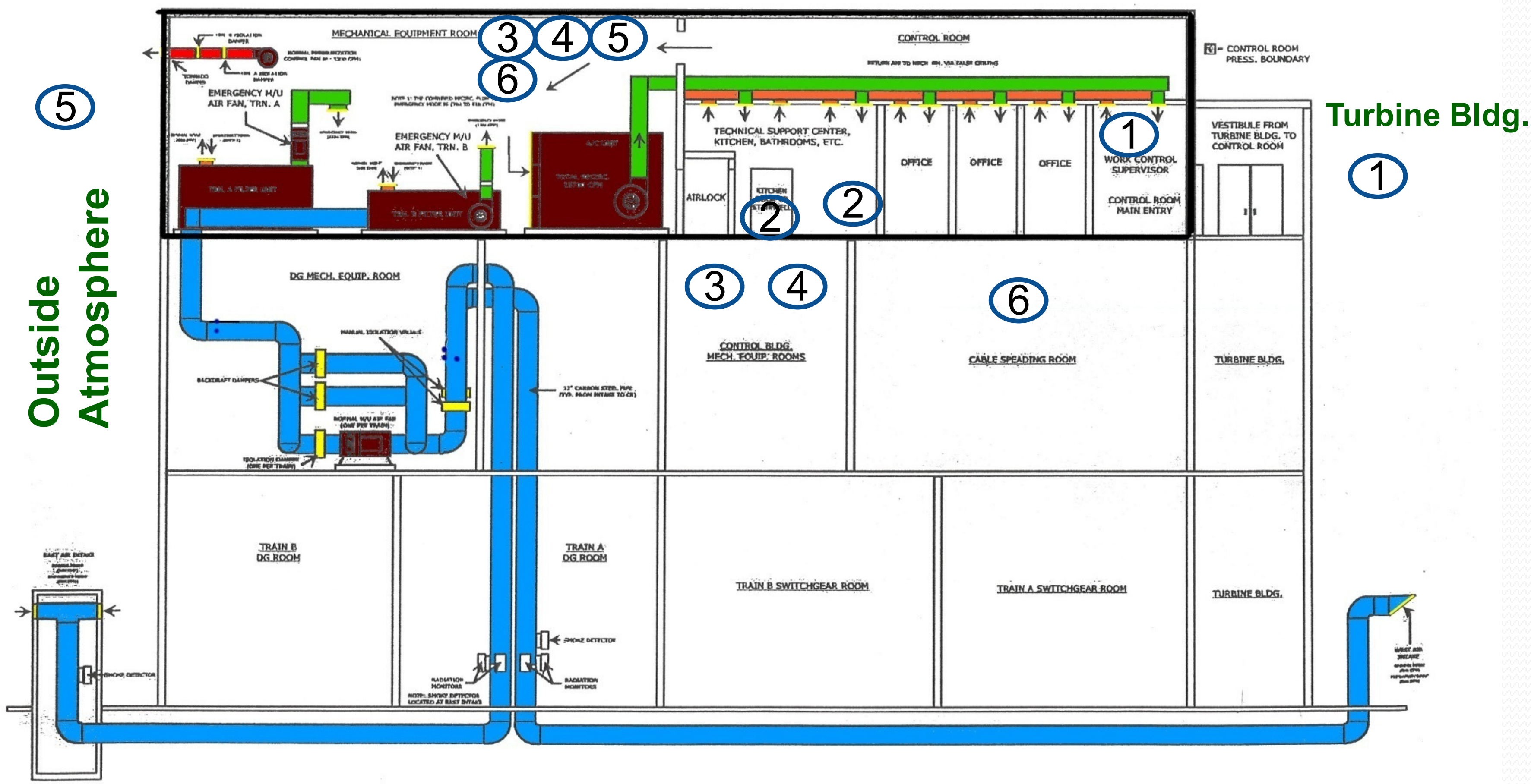
Worst Case

Connection #1 – Control Room to Turbine Building
Connection #2 – Control Room to Back Door Stairwell
Connection #3 – Control Room Filter & Fan Room to “A” Mechanical Room
Connection #4 - Control Room Filter & Fan Room to “B” Mechanical Room
Connection #5 - Control Room Filter & Fan Room to Outside Atmosphere
Connection #6 - Control Room Filter & Fan Room to Cable Spreading Room

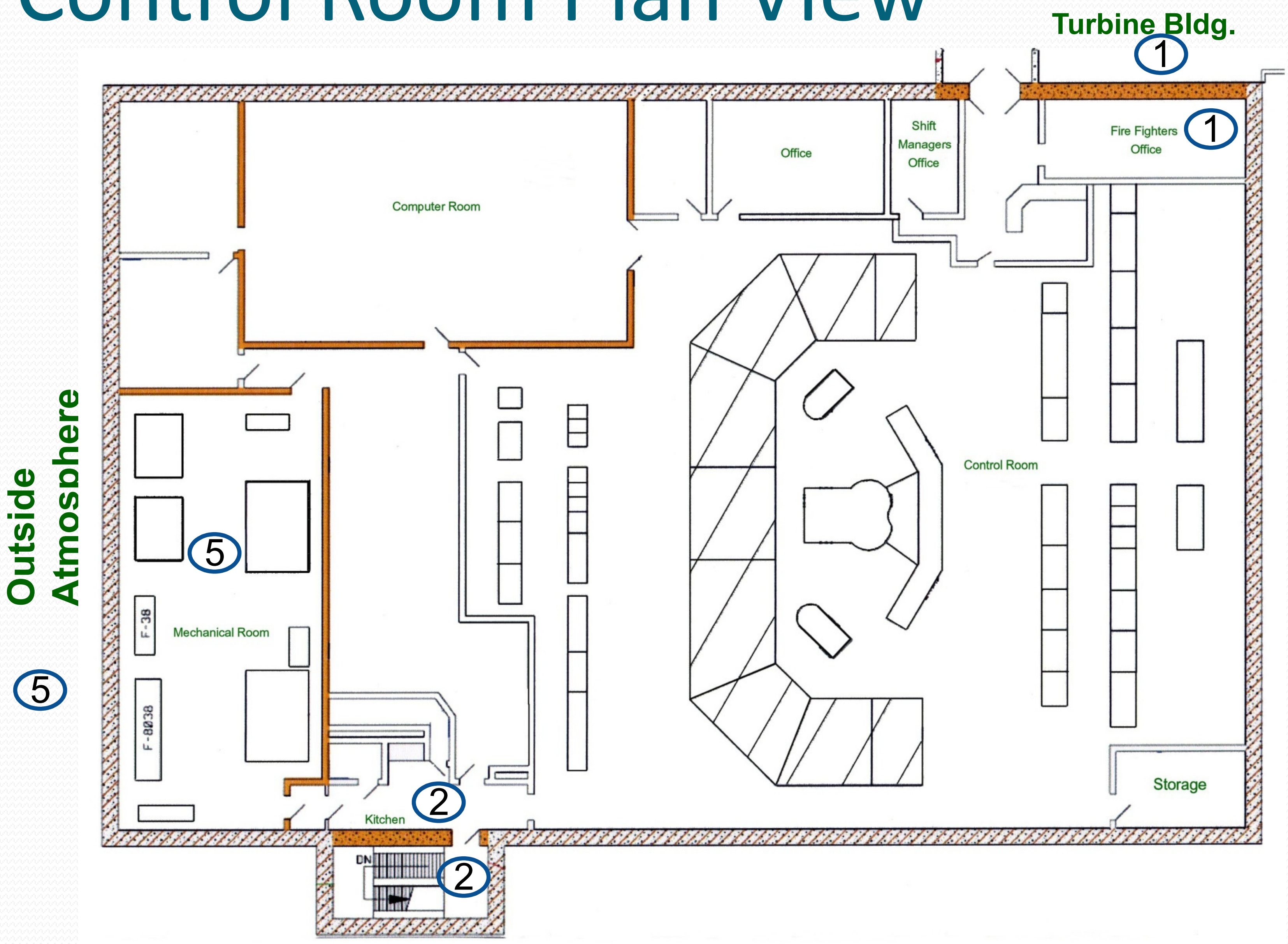
Differential Pressure



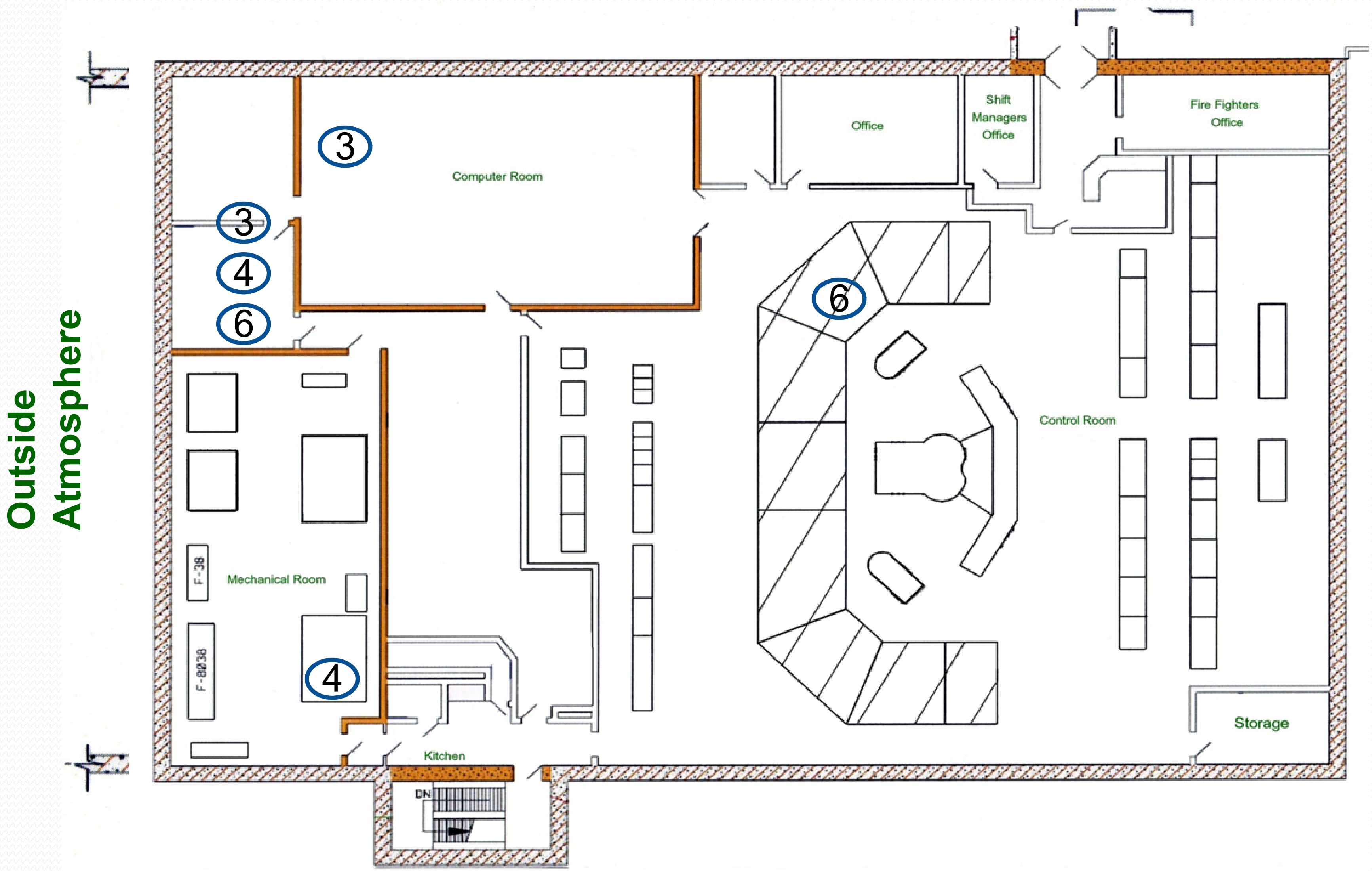
Control Room Elevation View



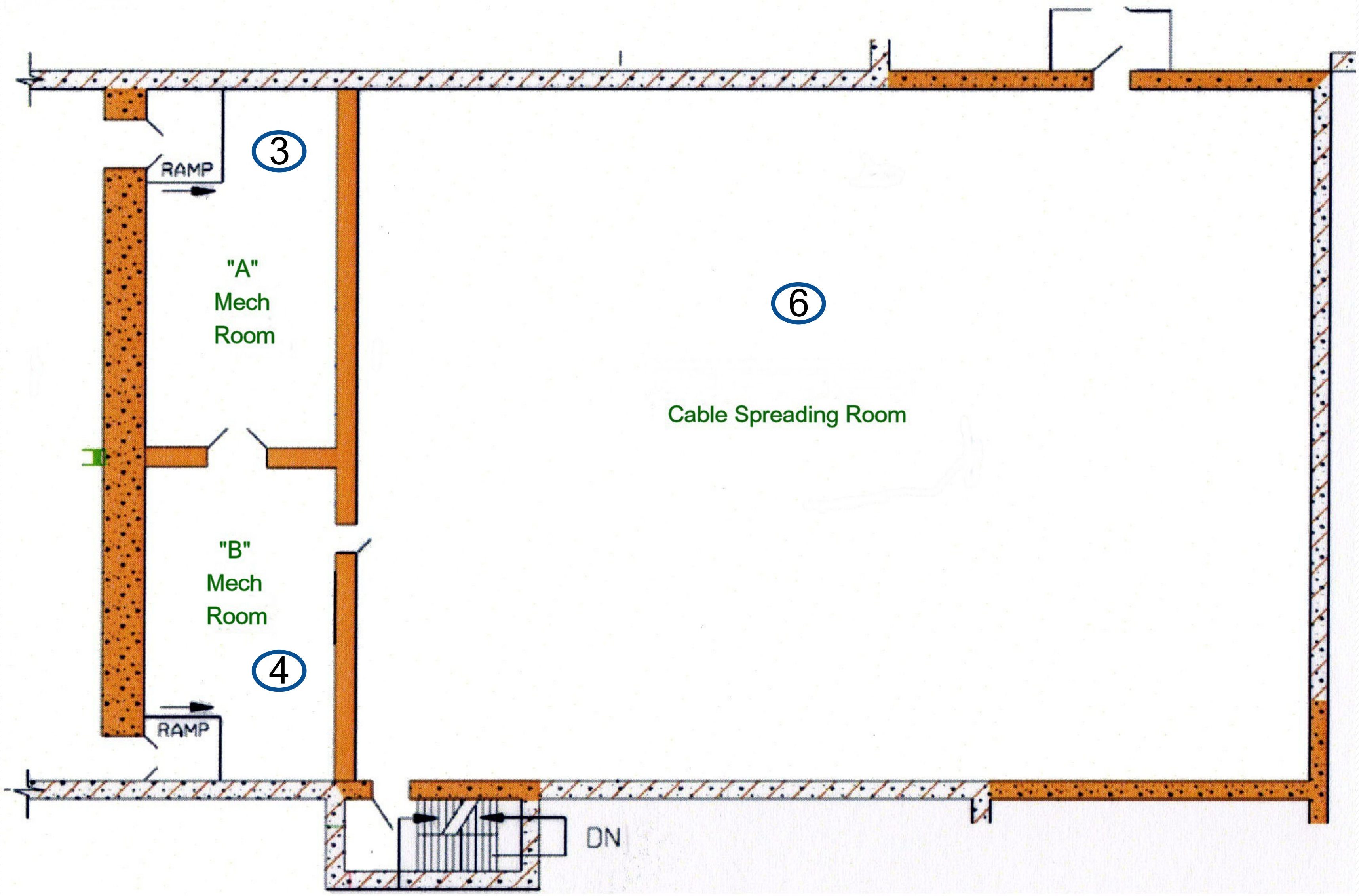
Control Room Plan View



Control Room Plan View



Cable Spreading Room Plan View



Δ Pressure Start of Test (Example)

Δ Pressure End of Test (Example)

A Shortridge AIRDATA MULTIMETER Was Used To Measure All Airflow Velocities And Differential Pressures

ADM-870 AIRDATA MULTIMETER

Air Flow (Start of Test)

Duct Traverse Readings, sfpm (All velocities must be corrected to std. conditions before entering.)

Reading	A	B	C	D	E	F	G	H	I	J	Sub Tot
1	350	292	369	373	358	376	399	388	373	336	3614
2	377	361	368	375	370	393	386	374	316	276	3596
3											0
4											0
5											0
6											0
7											0
8											0
9											0
10											0
										Total	7210

Calculation

Duct Cross section, sq ft	0.785 (round duct)	Duct Pressure, "Hg	30.10
Traverse readings count	20	Dry air density, lb/cu ft	0.0748
Average velocity, sfpm	360.5		
Volumertic flow rate, scfm	283		

Air Flow (End of Test)

Duct Traverse Readings, sfpm (All velocities must be corrected to std. conditions before entering.)

Reading	A	B	C	D	E	F	G	H	I	J	Sub Tot
1	499	564	615	606	659	646	663	642	610	571	6075
2	568	643	627	631	630	639	644	637	567	463	6049
3											0
4											0
5											0
6											0
7											0
8											0
9											0
10											0
										Total	12124

Calculation

Duct Cross section, sq ft	0.785 (round duct)	Duct Pressure, "Hg	30.10
Traverse readings count	20	Dry air density, lb/cu ft	0.0754
Average velocity, sfpm	606.2		
Volumertic flow rate, scfm	476		

Starting Unfiltered Inleakage

	SF_6 Concentrations in Sample Members, ppb				Delta t	Cuml.	Concentration
	Date	Time	C_{TRACER}	C_{ZONE}	min	Time	Equilibrium
SM1	03/Sep/2009	19:00	253.378	227.616	0.00	0	N/A
SM2	03/Sep/2009	19:10	252.063	226.361	10.00	10.00	
SM3	03/Sep/2009	19:20	253.170	229.480	10.00	20.00	
SM4	03/Sep/2009	19:30	258.326	227.396	10.00	30.00	
SM5	03/Sep/2009	19:40	263.398	229.108	10.00	40.00	
SM6	03/Sep/2009	19:50	256.654	228.048	10.00	50.00	
SM7	03/Sep/2009	20:00	257.593	227.370	10.00	60.00	
SM8	03/Sep/2009	20:10	254.718	228.291	10.00	70.00	
SM9	03/Sep/2009	20:20	255.357	227.244	10.00	80.00	
SM10	03/Sep/2009	20:30	259.484	227.363	10.00	90.00	0.010873O.K.
SM11							
SM12							
SM13							
SM14							
SM15							
SM16							
SM17							
SM18							
SM19							
SM20							

Average concentration, ppb	256.41	227.83	
Calculated Tracer gas flow, cfm (SF_6 Flow)			6.36E-05
Equilibrium concentration from regression			0.007
Calculated Unfiltered Inleakage, scfm			38
Calculated Uncertainty at 95% confidence level, +/- scfm			5

Ending Unfiltered Inleakage

	SF_6 Concentrations in Sample Members, ppb				Delta t	Cuml.	Concentration
	Date	Time	C_{TRACER}	C_{ZONE}	min	Time	Equilibrium
SM1	04/Sep/2009	3:30	265.077	242.425	0.00	0	N/A
SM2	04/Sep/2009	3:40	265.123	243.850	10.00	10.00	
SM3	04/Sep/2009	3:50	266.345	243.647	10.00	20.00	
SM4	04/Sep/2009	4:00	264.606	243.903	10.00	30.00	
SM5	04/Sep/2009	4:10	266.122	242.412	10.00	40.00	
SM6	04/Sep/2009	4:20	263.921	243.018	10.00	50.00	0.025934O.K.
SM7							
SM8							
SM9							
SM10							
SM11							
SM12							
SM13							
SM14							
SM15							
SM16							
SM17							
SM18							
SM19							
SM20							

	C_{TRACER}	C_{ZONE}	
Average concentration, ppb	265.20	243.21	
Calculated Tracer gas flow, cfm (SF_6 Flow)			1.13E-04
Equilibrium concentration from regression			0.007
Calculated Unfiltered Inleakage, scfm			43
Calculated Uncertainty at 95% confidence level, +/- scfm			3

Summary

- **Acceptance Criteria**
  - CRE must maintain a $\Delta p \geq 0.125$ in. W.C. to all adjacent areas.
  - Total pressurization flow must be ≤ 600 CFM.
  - Total unfiltered inleakage must be ≤ 150 CFM.
- **Zero Breach**
  - Pressurization Flowrate = 283 SCFM.
  - Unfiltered Inleakage = 38 ±5 SCFM.
  - Pressure (Connection #2 (Worst Case)) = +0.850” W.C.
- **Breach Of 23.70 in^2**
  - Pressurization Flowrate = 476 SCFM.
  - Unfiltered Inleakage = 43 ±3 SCFM.
  - Pressure (Connection #2 (Worst Case)) = +0.200” W.C.

Conclusions

- Validates the engineering calculation for maximum breach size.
- Demonstrates full compliance with RG 1.197.