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U.S. Nuclear Regulatory Commission
Nuclear Reactor Regulatory DSI/RP
Mail Stop 416
Washington, DC 20555

Attention: J. Hayes

Subject: Generic Studies Related to Generic Issue 83 on Control Room Habitability Fin A-2328

Gentlemen:

Enclosed is the Plant Visit Summary Report for the visit to the D. C. Cook Nuclear Station on September 15-19, 1986. If you have any questions concerning this report, contact me at (FTS 583-7657).

Very truly yours,

John W. Driscoll
John W. Driscoll
Argonne Project Manager

JWD:jt

cc: D. W. Cissel, EBR-II
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PLANT VISIT SUMMARY REPORT

1. Plant: D. C. Cook Nuclear Station

2. Utility: Indiana & Michigan Electric Co.

3. Location: Bridgman, Michigan

4. NRC Region: III

5. Visit Date: September 15-19, 1986

6. Participants from Argonne National Laboratory: M. D. Carnes
   J. W. Driscoll
   R. A. Evans

7. Scope:

   The plant visit was made to gather information on control room habitability - Generic Issue 83. As a part of the review, the Plant Technical Specifications were reviewed and compared to the safety analysis (including III.D.3.4. submittal and the NRC staff safety evaluation) and plant procedures to determine what operational practices are being employed. System airflow measurements were made to determine the unfiltered air inleakage into the control room envelope and system performance.

8. <u>System Description</u>

   The D. C. Cook Station is a two-unit station with a separate control room for each unit. The control rooms are accessed through common security doors but are divided into separate independent ventilation zones. The ventilation zones are identical for the two units except that Unit 1 supplies ventilation for the kitchen area and Unit 2 supplies ventilation for the toilet.

The control room envelope consists of the control room, computer room, and HVAC equipment room. Unit 1's envelope also includes the kitchen and Unit 2's envelope includes the toilet.

The HVAC system for each unit includes redundant air handling units (AHU) equipped with chilled water coils for air conditioning. Electrical heating coils are located downstream of each AHU. The AHU's have an outside air makeup supply to provide the necessary fresh air makeup. The AHU circulates and conditions air to the control room during all modes of system operation and is completely isolated from the pressurization/cleanup filter train.

The pressurization/cleanup filter train consists of a single filter unit with a prefilter, HEPA filter, and charcoal adsorber. There are two fans associated with the filter train. The filter train has an outside air intake which is mechanically stopped at a predetermined setting in the closed position to allow 1100 cfm makeup for Unit 1 and 800 cfm in Unit 2.

9. Findings

9.2 Procedures

9.1.1 Procedures 2-OHP-4030.STP.025S, "South Control Room Pressurizer/Cleanup Filter System Operability Test" and 2-OHP.4030.STP.025N, "North Control Room Pressurizer/Cleanup Filter System Operability Test" should have the title changed and any references to the fan changed from north and south to east and west or the fan numbers ACRF-1 and ACRF-2 should be used as labeled on P&ID OP-2-15149.

9.1.2 In the procedures in item 8.2.1 (above) and the applicable procedures for Unit 1, it would seem to be a good engineering practice to record filter train differential pressures when the filter train is tested.

9.1.3 Procedure 1-OHP 4021-028-015, "Operation of the Control Room Pressurizer/Cleanup Filter System," references procedures 1-OHP.4030-STP-024N and .024S. The referenced procedures should be 024E and 024W.

9.1.4 Procedures **12THP 4030 STP-229 should have a step that requires adequate levels of lighting when making the visual inspection.

9.1.5 Procedure **1 THP 6040 PER.094, "Control Room Ventilation Balancing," should have an acceptance criteria for the quanity of outside air makeup.

9.2 Safety Analysis

9.2.1 Carbon Dioxide Fire Extinguishing System for Computer Rooms

The fire extinguishing system for the computer rooms are equipped with a CO_2 fire extinguishing system which is manually actuated. On actuation of the CO_2 system, the computer room ventilation supply is isolated. However, the computer room communicates with the HVAC equipment room via grated louvers. There is a fire damper between the louvers but isolation requires heat to melt a fuseable link which allows the fire damper to close. the fire damper appears to be the louvered or venetian blind type that have demonstrated a propensity of "hanging up" on an edge when they are released after the fusible link melts. Thus, in the event of actuation of the computer room CO_2 system, CO_2 will probably be circulated throughout the control room envelope due to the failure of the fire damper to isolate the computer room.

9.2.2 Toxic Gas

The Cook Station is staffed by six people per unit. There are two emergency breathing units in the control room with 10 additional units immediately outside the control room for a total of 12 units readily available. Reg. Guide 1.95 requires that there be one extra emergency air breathing unit for every three units required. Reg. Guide 1.95 also requires the emergency air breathing units be donned and in use within two minutes of receiving a chlorine alarm. It is doubtful that operators could don the air breathing units in two minutes if the units are outside the control room. Therefore a total of 16 units should be available to the control room.

9.2.3 Charcoal Adsorber Efficiency

The FSAR Section 9.10.2 indicates that charcoal adsorbers have a removal efficiency of 99.9% of entrained methyl iodide or iodine vapor and Table 14.3.5-9 indicates a removal efficiency of 95% for the same charcoal adsorber.

If a charcoal efficiency of 95% is to be used in the calculations for control room operator exposure for a DBA, the charcoal must be tested for an efficiency of 99.3%. Using a test criteria of 90% as required by Technical Specification would require a value of 30% be used for the dose calculation.

The dose calculations following a DBA should be reevaluated based on allowable charcoal efficiencies based on actual test specifications. If 1100 cfm filtered air makeup and 10 cfm unfiltered inleakage is assumed, the thyroid dose is 17 Rem per Figure 3, Technical Specification page B3/4 7-5c of the

July 10, 1986 Submittal. Using this as a basis and assuming 90% instead of 95% for charcoal efficiency, the GDC-19 thyroid dose would be exceeded.

9.2.4 Single Failure Criterion

The outside air intakes for the air handling units should have two isolation valves in series to meet the single failure criteria.

Reg. Guide 1.95 requires that the Cl_2 detectors cause an automatic isolation of the control room within 10 seconds of sensing chlorine in the duct and that the Cl_2 be sensed by two physically separated channels for each fresh air inlet. Cook has only one channel on the normal outside air inlet in each unit and the Cl_2 detectors actuates alarms with isolation by manual operation.

9.3 Technical Specifications

The following comments are based on the July 10, 1986 Technical Specification Submittal:

9.3.1 In Technical Specification 4.7.5.1.e.3, the HVAC Mechanical Equipment Room is part of the control room envelope, it should be maintained at 1/8-inch W.G. ΔP to surrounding areas.

9.3.2 In Technical Specifications 4.7.5.1.c.3, 4.7.5.1.d.1 and 4.7.5.1.d.2, laboratory test for charcoal does not have the correct acceptance criteria. If 95% efficiency is assumed for the safety analysis, the laboratory test should demonstrate an efficiency of $\geq$99.3% ($\leq$0.7% penetration).

9.3.3 In Technical Specification 4.7.5.1.c.3, the laboratory test conditions for charcoal should be specified at 30°C, 95% R.H. Test method ASTM D 3803 should be specified.

9.3.4 Specification 4.7.5.1.a. requires once every 12 hours the control room temperature be verified ≤120°F. A more realistic temperature should be selected based on equipment qualification temperatures and a temperature survey to determine where the hottest areas of the control room are and what effect those hot spots have on instrumentation.

9.3.5 The inplace test for HEPA filter and/or charcoal adsorbers in Specification 4.7.5.1.c.1, 4.7.5.1.c.2, 4.7.5.1.c.3, 4.7.5.1.d.2, 4.7.5.1.f, and 4.7.5.1.g should specify <0.05% penetration per ANSI N509-1980.

9.3.6 In Specification 4.7.5.1.c.2, an additional step should be added to verify isolation on a high radiation signal from the control room area monitor.

9.4 <u>HVAC Flow and CRE Temperature Measurements</u>

9.4.1 <u>Temperature Data</u>

Air temperature was measured in the control rooms with both plants operating near full power.. Data was taken with the HVAC system in normal, toxic gas and pressurization/cleanup modes of operation. Data sets were taken on different days.

Temperature Data
Unit 1

Location	System Configuration and AHU In Service Normal Mode ACRA-2	Toxic Gas Mode ACRA-2	Pressurization/ Cleanup Mode ACRA-2
Average Temperature in Occupied Area of Control Room	*85.1°F	68.6°F	No data
Average Temperature in Back of Main Control Panels	*88.6°F	72.6°F	75.1°F
ΔT Between Back of Panels to Front of Panels	+3.5°F	+4.0°F	

Temperature Data
Unit 2

Location	System Configuration and AHU In Service Normal Mode ACRA-2	Toxic Gas Mode ACRA-2	Pressurization/ Cleanup Mode ACRA-2
Average Temperature Occupied Area of Control Room	67.2°F	No data	No data
Average Temperature in Back of Main Control Panels	72.9°F	72.5°F	75.2°F
ΔT Between Back of Panels to Front of Panel	+5.7°F		

* Temperature was not this high - translation in data error.

9.4.2 Flow Measurements

Flow measurements were taken in each unit with the HVAC system operating in three modes of operation and eight different configurations due to redundant equipment. Tables 1 through 4 list and summarize the flow data. Table 5 shows the differential pressure from the control rooms to the turbine building, control room to control room, mechanical equipment room to turbine building and mechanical equipment room to mechanical equipment room.

The following conclusions are made based on the data:

(1) There is significant amounts of inleakage from the outside air intakes through the charcoal adsorbers and into the control room envelope during the toxic gas mode of operation.

(2) There is a significant inleakage into the Unit 2 emergency filter train when the system is operating in the emergency mode of operation. The outlet flow was as much as 3000 cfm greater than the inlet. This would suggest that the installed flow measuring device can only reflect flow in the filter trains supply duct and may not be showing all the flow in the filter housing which exists due to filter housing leaks. It would seem appropriate to install a flow- measuring device in the outlet ductwork.

(3) The Unit 2 AHU supplies more air to the control room than the Unit 1 AHU's. The differential pressure data also verifies that Unit 2 control room is at a slightly positive pressure to the

Unit 1 control room. The mechanical equipment room ΔP also leads to the same conclusion.

(4) There is a significant outleakage (1050-4050 cfm from the Unit 1 AHU's (see Table 3).

(5) Unit 1 east emergency filter fan shows a considerable amount of inleakage and the west fan shows a considerable amount of outleakage.

(6) Bubble tight dampers leakage is approximately 50 cfm for Unit 1 and 40 cfm for Unit 2.

(7) There is more air returning from the control room and computer room than is being supplied in almost all modes of operation (see Tables 3 and 4).

(8) Smoke tests showed that air flowed into or out of the condensate drain lines for the air handling units. This condition existed in both Unit 1 and Unit 2 and the direction of flow varied depending upon which pieces of equipment were running. If a proper loop seal existed on the drain lines, there would be no air flow. Station personnel explained that drain piping from both equipment rooms are joined together and then go to a common loop seal. The condensate drain lines connect the two control rooms together. Therefore, if the integrity of one control room envelope is broken the other control room envelope is also broken.

(9) The discharge of the air handling units in the Unit 2 control room HVAC system has a consistently lower flow than the inlet to the

AHU's. The combination of branches (control room and computer room supplies) downstream of the AHU's discharge is always higher. The utility should investigate this condition and determine why the flow at points 5 and 6 are lower than the downstream combination of points 7 and 8 (see Table 2 and Table 4).

9.5 Outside Air Infiltration

The approach used by D. C. Cook to use a matrix for control room operator exposure allows for variable amounts of filtered and unfiltered inleakage. This method does not tie the utility to a single set of parameters. This is a good concept and should be considered for use by other utilities.

With the mechanical equipment room at a very low positive pressure ~0.02 in. H_2O, there is a high probability that the control room envelope will always see a significant amount of unfiltered inleakage. There is also as much as 39 cfm inleakage through the normal outside air intake during the pressurization/cleanup mode. Although the control room is being pressurized to greater than 0.125 in. H_2O, credit is only taken for 0.0625 in. H_2O. With this assumption, a value higher than 10 cfm should be used for unfiltered air inleakage due to ingress-egress. Assuming 20 cfm unfiltered inleakage due to ingress-egress and ~40 cfm inleakage across isolation dampers, the chart used for thyroid dose is at the upper limit of 60 cfm unfiltered inleakage. With 60 cfm unfiltered inleakage and 1100 cfm filtered outside air makeup, there is not much margin before the GDC-19 limit of 30 rem thyroid is reached.

9.6 LER Evaluation

There were no LER's associated with the loss of cooling to the control room envelope. The AHU capacity for both units seem to be more than adequate. However, the Technical Specification Limit of 120°F needs further evaluation (see Item 8.4.4).

D. C. COOK NUCLEAR STATION UNIT 1
CONTROL ROOM HVAC SYSTEM MEASUREMENNTS

	MODE OF OPERATION OPERATING AHU OPERATING FILTER FAN	NORM. SOUTH NONE	NORM. NORTH NONE	TOXIC NORTH NONE	TOXIC SOUTH NONE	EMERG SOUTH WEST	EMERG SOUTH EAST	EMERG NORTH EAST	EMERG NORTH WEST
1	NORMAL INTAKE (OUTSIDE)	44	233	4	5	9	7	6	9
5	NORTH AHU DISCHARGE	634	13337	13559	475	420	396	12094	13052
6	SOUTH AHU DISCHARGE	13955	348	341	12838	13092	12569	309	301
7	COMPUTER ROOM SUPPLY	1481	1772	1850	1770	1912	2315	1630	1875
8	CONTROL ROOM NORMAL SUPPLY	11275	10025	9687	11896	11160	10239	12004	10930
9	HVAC ROOM RETURN	1321	1544	1278	1444	1442	1411	1506	1450
11	NORMAL RETURN FROM CONTROL ROOM	6528	7400	6608	6664	7064	7240	5992	6656
11A	NORMAL RETURN FROM CONTROL ROOM	7528	7064	7336	8112	8136	7056	8728	8160
12	EMERG. FILTER OAI	72	196	172	256	884	820	940	1072
14	EMERG. FILTER SUPPLY TO C. R. (GRILL)	29	47	52	29	9068	7420	4435	7455
14A	EMERG. FILTER RETURN FROM C. R. (GRILL)	2404	914	1455	2607	4813	4912	4359	4417
15	FILTER TRAIN COMBINED INLET (DIRECT READING)	0	0	250	250	6200	6300	6000	6350
16	EMERG. FILTER TRAIN SUPPLY TO CONTROL ROOM	28	36	48	48	6188	5796	6120	5188
17	NORTH COMPUTER ROOM EXHAUST (GRILL)	1018	1130	1149	1096	1176	1111	1210	1147
18	SOUTH COMPUTER ROOM EXHAUST (GRILL)	1071	1065	932	972	1063	1214	1113	668
19	EXHAUST ABOVE MICROWAVE OVEN	228	239	268	246	245	247	261	247
20	OUTSIDE AIR SUPPLY TO AHU'S @ VFX-309	0	221	48	37	35	46	38	29

NOTE: ALL READINGS ARE IN CUBIC FEET PER MINUTE (CFM)

TABLE 1

D. C. COOK NUCLEAR STATION UNIT 2
CONTROL ROOM HVAC SYSTEM MEASUREMENTS

	MODE OF OPERATION OPERATING AHU OPERATING FILTER FAN	NORM. NORTH NONE	NORM. SOUTH NONE	TOXIC NORTH NONE	TOXIC SOUTH NONE	EMERG SOUTH WEST	EMERG SOUTH EAST	EMERG NORTH EAST	EMERG NORTH WEST
1	NORMAL INTAKE (OUTSIDE)	461	530	27	39	19	34	17	21
5	NORTH AHU DISCHARGE	15840	752	16743	451	269	309	14280	15008
6	SOUTH AHU DISCHARGE	958	15602	1212	1750	15579	16347	1014	1560
7	COMPUTER ROOM SUPPLY	1551	1929	1495	1762	2081	1919	1922	2124
8	CONTROL ROOM NORMAL SUPPLY	16552	16675	17066	18492	15892	17495	16061	16076
9	HVAC EQUIPMENT ROOM RETURN	776	812	721	721	759	1098	675	728
11	NORMAL RETURN FROM CONTROL ROOM	9192	8536	9824	9968	10864	8456	9552	9440
11A	NORMAL RETURN FROM CONTROL ROOM	8232	10056	9168	8272	7896	9728	8736	8440
12	OUTSIDE AIR SUPPLY TO EMERG. FILTER TRAIN	244	208	360	496	744	784	524	856
15	COMBINED INLET TO EMERG. FILTER TRAIN (DIRECT READING)	0	0	0	250	6350	6400	6250	6200
16	EMERG. FILTER TRAIN SUPPLY TO CONTROL ROOM	244	40	40	40	7488	9560	9820	9844
17	NORTH COMPUTER ROOM EXHAUST (GRILL)	821	1010	934	962	1151	1111	1119	1144
18	SOUTH COMPUTER ROOM EXHAUST (GRILL)	859	962	953	1002	1130	1166	1113	1046
19	TOILET EXHAUST	283	262	8	3	3	1	1	10

NOTE: ALL MEASUREMENTS ARE IN CUBIC FEET PER MINUTE (CFM)

TABLE 2

D. C. COOK UNIT 1 FLOW MEASUREMENTS DATA SUMMARY

DATA SET No.	AHU INLET VS AHU OUTLET VS SUPPLY TO C.R. & COMP	FILTER INLET VS FILTER OUTLET	COMP. RM. IN VS COMP. RM. OUT	CR SUPPLY VS CR EXHAUST	OAI TO FILTER VS C.R. RETURN VIA FILTER SUP. & RET.
	1+9+11+11A+19 = 5+6 = 7+8	15 = 16	7 = 17+18	8 = 11+11A+19+14+14A	12 = 14+14A
1	15649 = 14589 = 12756	0 = 28	1481 = 2089	11275 = 16717	72 = 2433
2	16480 = 13685 = 11797	0 = 36	1772 = 2195	10025 = 15664	196 = 961
3	15494 = 13900 = 12756	250 = 48	1850 = 2081	9687 = 15719	172 = 1507
4	16471 = 13313 = 13666	250 = 48	1770 = 2068	11896 = 17658	256 = 2853
				8+16=11+11A+14A+19	OAI TO FIL. + C.R. RET. = FILTER IN 12+14A = 15
5	16896 = 13512 = 13072	6200 = 6188	1912 = 2239	17348 = 20258	5697 = 6200
6	15961 = 12965 = 12554	6300 = 5796	2315 = 2325	16035 = 19455	5732 = 6300
7	16493 = 12403 = 13634	6000 = 6120	1630 = 2323	18124 = 19340	5299 = 6000
8	16522 = 13353 = 12805	6350 = 5188	1875 = 1815	16118 = 19480	5489 = 6350

NOTE: ALL MEASUREMENTS ARE IN CUBIC FEET PER MINUTE (CFM)

TABLE 3

D. C. COOK UNIT 2 FLOW MEASUREMENTS DATA SUMMARY

DATA SET No.	AHU INLET VS AHU OUTLET VS SUPPLY TO C.R. & COMP	FILTER INLET VS FILTER OUTLET	COMP. RM. IN VS COMP. RM. OUT	CR SUPPLY VS CR EXHAUST
	1+9+11+11A = 5+6 = 7+8	15 = 16	7 = 17+18	8 = 11+11A+19+12
1	18661 = 16798 = 18103	0 = 244	1551 = 1680	16552 = 17951
2	19934 = 16354 = 18604	0 = 40	1929 = 1972	16675 = 19062
3	19740 = 17955 = 18561	0 = 40	1495 = 1887	17066 = 19360
4	19000 = 17962 = 20254	250 = 40	1762 = 1964	18492 = 18739
				8+16=11+11A+14A+19
5	19538 = 15848 = 17973	6350 = 7488	2081 = 2281	23380 = 25113
6	19316 = 16656 = 19414	6400 = 9560	1919 = 2277	27055 = 24585
7	18980 = 15294 = 17983	6250 = 9820	1922 = 2232	25881 = 24539
8	18629 = 16568 = 18200	6200 = 9844	2124 = 2190	25920 = 24090

NOTE: ALL MEASUREMENTS ARE IN CUBIC FEET PER MINUTE (CFM)

TABLE 4

D. C. COOK DIFFERENTIAL PRESSURE MEASUREMENTS DATA

DATA SET No.	UNIT 1 CONTROL ROOM TO TURBINE BUILDING	UNIT 2 CONTROL ROOM TO TURBINE BUILDING	UNIT 1 CONTROL ROOM TO UNIT 2 CONTROL ROOM	UNIT 1 MECH. EQUIP. ROOM TO TURNINE BUILDING	UNIT 2 MECH. EQUIP. ROOM TO TURBINE BUILDING	UNIT 1 EQUIP. ROOM TO UNIT 2 EQUIP. ROOM
1	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
2	-0.01	NO DATA	NO DATA	+0.02	NO DATA	NO DATA
3	-0.02	-0.01	0.00	+0.02	NO DATA	-0.01
4	-0.03	NO DATA	0.00	+0.02	-0.02	0.00
5	+0.18	+0.19	-0.015	+0.02	+0.02	+0.01
6	+0.185	+0.165	-0.01	+0.025	+0.025	0.00
7	NO DATA	NO DATA	NO DATA	+0.01	+0.02	-0.015
8	+0.155	+0.15	NO DATA	+0.02	+0.02	-0.005

NOTE: ALL MEASUREMENTS ARE IN INCHES OF H_2O

TABLE 5