INTERIM GUIDELINES

FOR

CONTAINMENT PURGE OPERATION

CLINTON POWER STATION - UNIT 1

June 1984

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INTERIM GUIDELINES FOR CONTAINMENT PURGE OPERATION

1.0 INTRODUCTION

The Clinton Power Station (CPS) containment purge system design consists of a high volume Containment Building HVAC System (CBHS) and a low volume Continuous Containment Purge System (CCPS), as described in CPS Final Safety Analysis Report (Reference 1). It is proposed that the use of the 30,000 cfm CBHS will be limited to 500 hours per year during plant operating modes 1 through 3. The CBHS can be utilized on an unlimited basis during plant operating modes 4 and 5. The 8,000 cfm CCPS will be used continuously during operating modes 1 through 3 except during the operation of CBHS. Gaseous effluents based upon a continuous containment purge are found to be well within the applicable limits, as seen in CPS-FSAR Tables 11.3-9 and 11.3-11.

In accepting the CPS containment purge system design, the NRC has required that IPC develop and implement during plant operation prior to the first refueling outage, interim guidelines for containment purge operations (Reference 2, Section 6.2.4.1). It is intended that the guidelines will address the possibility of a reduction in the use of CCPS with due consideration given to containment airborne activity levels, and overall containment air quality.

2.0 CONSIDERATIONS FOR CONTAINMENT PURGE OPERATION

The containment purge system is designed to enhance personnel habitability in the containment, exclusive of the drywell, during all modes of operation. Control of environment for equipment and other considerations is not dependent upon the containment purge operation, in accordance with Branch Technical Position (BTP) CSB 6-4 (Reference 2).

The scope of the containment purge system in relation to habitability is control of radioactive and nonradioactive pollutants in the air to within the acceptable levels. Heat removal is accomplished through area coolers, which are designed to control local temperatures independent of CCPS or CBHS operation.

2.1 Airborne Radioactivity Levels

The containment airborne radioactivity level must be controlled and maintained in accordance with 10CFR20 and Regulatory Guide 8.8.

The airborne radioactivity limitations are discussed in 10CFR, Sections 20.103(a)(1), 20.130(a)(3) and 20.203(d). These regulations can be interpreted into the following guidelines:

a. If the airborne radioactivity in work areas is maintained below 1/4 MPC_R*, the workers occupying these areas will not be required to undergo an assessment of radioactivity intake.

b. Work areas where the airborne radioactivity exceeds 1/4 MPC_R, will have to be designated as "Airborne Radioactivity Areas."

The ALARA design guidance provided by the R.G. 8.8 with regard to the control of airborne radioactivity is summarized as follows:

a. The source terms used in the design shall be those corresponding to an offgas release rate of 100,000 μCi/sec, at 30 min decay, for BWR's.

b. The airborne radioactivity control systems (i.e., HVAC and leakage control) shall be designed to maintain airborne radioactivity in work areas well below MPC_R's.

c. Designs that permit repeated release of radioactivity material into work areas are contrary to ALARA philosophy.

d. Routine provisions of protection through use of individual respirators is generally unacceptable.

e. The spread of contamination shall be limited by maintaining air pressure gradients and airflows from the areas of low potential airborne contamination to areas of higher potential contamination.

The containment purge system design and operation should be thus based upon two main objectives, which are consistent with the ALARA philosophy. These objectives are as follows:

a. To maintain air pressure gradients and airflows from general access areas to radiation cubicles, where the potential for contamination is higher.

b. To maintain airborne radioactivity concentrations below ~1/4 MPC_R in general areas, and below ~1 MPC_R in radiation cubicles.

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*Maximum permissible concentrations per 10CFR20, Appendix "B", Table I, column 1.

2.2 Nonradioactive Pollutants

There are no stored sources of toxic material in the containment, the leakage of which may impair habitability. The fumes generated from chemicals used during cleaning and from welding operations during maintenance activity would be of concern.

3.0 FACTORS AFFECTING CONTAINMENT AIRBORNE RADIOACTIVITY LEVELS

The containment airborne radioactivity level is affected by the sources of airborne radioactivity and the operation and air flow volume of the containment purge system.

3.1 Sources of Airborne Radioactivity

There are three distinct sources of radioactivity that will contribute to the airborne activity in the general areas of the containment. They are the refueling pool, suppression pool and leakage of reactor coolant within the containment (outside the drywell).

a. The refueling pool may contribute significantly only during refueling operation. During such times, presumably, the high volume CBHS will be used. Hence the refueling pool is not used as a contributing source in developing these guidelines for the CCPS operation.

b. The suppression pool is exposed to areas of personnel access, in the Mark III containment, and hence contributes to the airborne radioactivity. During normal power operation the suppression pool is contaminated by leakage of steam and reactor water. This aspect, and the resultant airborne radioactivity levels in the containment general areas have been analyzed in the General Electric Company Document 22A5718, "Containment Dose Reduction Study." The results of this study, which was prepared for the standard GE Mark III design, are approximately true for Clinton. They indicate that under expected operating conditions the suppression pool could contribute an airborne level of about 0.1 MPC_R.

The suppression pool can also contribute heavily to the airborne radioactivity levels following the safety/relief valve blowdown. This condition is expected to be of a transient nature, and is not included in this evaluation. Further, Clinton's design includes a suppression pool cleanup system, which can be used when necessary.

c. The leakage of reactor coolant and steam within the primary containment (outside the drywell) also contributes to the airborne radioactivity. It is found to be the largest contributor during normal power operation. The leakage is expected to occur primarily within the cubicles which house the reactor water cleanup system components.

3.2 Containment Purge Operation

The effects of the low volume CCPS operation only will be considered here. The use of the purge system has two effects on the containment airborne radioactivity level.

a. It established pressure boundaries and prevents, to a great extent, the spread of airborne contamination from radiation cubicles to general areas.

b. It removes the airborne radionuclides, thus reducing their levels in containment areas.

If the containment purge is isolated, the airborne radioactivity in the containment starts building up towards an asymptotic value. The projected buildup of iodine activity in Clinton containment is depicted in Figure 1, based upon a design basis reactor coolant concentration and a rate of coolant leakage outside the drywell of 1.0 gpm with a partition factor of 0.01. (The coolant leakage assumed is equivalent to that determined by the total offsite release considerations of Appendix I to 10CFR50. This is not to be confused with the total coolant leakage permissible, per the technical specifications, because most of the latter occurs inside the drywell.) It is seen from Figure 1 that the iodine activity builds up to 1/2 of the asymptotic value in about 100 hours and to its asymptotic value of 93 MPC in about 1,000 hours. The iodine level exceeds 1/4 MPC in about 1 hour following CCPS isolation.

4.0 INDICATORS OF CONTAINMENT AIRBORNE RADIOACTIVITY

The indicators of the containment airborne radioactivity can be of two types: the direct measurement, and an indication of its potential via the reactor coolant radioactivity concentration.

4.1 Airborne Radioactivity Measurement

In order to be able to measure airborne levels of the order of 1/4 MPC with confidence, continuous air monitors (CAM) with measurement capability below this value will be needed. CPS employs state-of-the-art CAM's which are capable of measuring 1/10 MPC in one hour of its occurrence.

The greatest potential for airborne activity exists within and in the vicinity of the radiation cubicles, regardless of whether the purge is operating or not. If the purge is operating and the pressure boundaries are maintained, the potential for airborne activity to enter the general areas exists only through the leakage of air from those area coolers which are located outside of the rooms that they serve. A list of CPS containment cubicles, their locations and the location of their area coolers is provided in Table 1. The cubicle locations are also shown in Figures 2, 3 and 4. Based upon this information it is determined that the monitoring for airborne activity will be very effective at the following locations.

a. Containment Building elevation 778'-0", Az. 300°

b. Containment Building elevation 803'-3", Az. 45°

c. Containment Building elevation 737'-0", any azimuth.

4.2 Reactor Coolant Radioactivity Concentration

Reactor coolant concentration and its leakage outside the drywell largely determine the airborne activity in the containment. Figure 1 provides the airborne levels based upon the design basis coolant activity concentration, which is 1.5×10^{-2} μCi/cc for I-131, and a leak rate of 1 gpm at a partition factor of 0.01. If the coolant concentration and/or its leak rate are smaller, the equilibrium airborne level in the containment will accordingly be smaller.

Based upon maintaining the containment airborne level at or below 1/4 MPC, a threshold coolant concentration can be defined as one that will lead to 1/4 MPC in the containment with the purge isolated. Once the threshold value is exceeded, the use of the containment purge becomes necessary for maintaining containment airborne level at or below 1/4 MPC. (This threshold value is not to be confused with the technical specification value of the coolant concentration, which is based upon the offsite dose considerations, and is intended to accommodate transient conditions.) Since the design basis coolant concentration leads to 93 MPC in containment, the threshold concentration corresponding to 1/4 MPC would be 4×10^{-5} μCi/cc of I-131. It is possible to measure such a concentration from a coolant sample taken either at the reactor building sampling panel or the postaccident sampling panel.

Similarly, the threshold value of coolant leak rate can be defined as one that will lead to airborne level of 1/4 MPC at design basis coolant concentration and with purge isolated. The threshold leak rate is determined to be ((1/4)/93x1.0) or 0.003 gpm at 0.01 partition factor. This is an immeasurably small leak rate, and hence cannot serve as a guideline for purge operation. It indicates, however, that even small leak rates can lead to higher than acceptable airborne activity.

5.0 INTERIM GUIDELINES FOR PURGE OPERATION

5.1 Bases and Discussion

Containment purging is needed for personnel accessibility which is required in the Mark III containment. During plant operations prior to the first refueling, IPC will determine the accessibility requirements more precisely through a Data Gathering Program and Containment Access Management Program (References 3 and 4). The present guidelines are proposed for interim use.

From Section 3.2 above, it is seen that the airborne activity level is heavily dependent upon whether the purge is operating or is isolated. Initiation of the purge operation can be based upon the measured airborne radioactivity level or the reactor coolant I-131 concentration level, as discussed in Sections 4.1 and 4.2 above. The CCPS is designed to maintain 1/4 MPC in containment general areas with the coolant concentrations at the design basis levels, and its leakage at 1 gpm at 0.01 partition factor. Once the purge is initiated, the airborne level in the containment is expected to decrease generally to a level below 1/4 MPC, unless design basis conditions exist.

Termination of the containment purge will be based upon the elimination of the origins of airborne radioactivity. Table 2 provides a listing of the origins of airborne activity, and the ways that they can be eliminated. It is further noted that the purge cannot be terminated based upon a low airborne level, because without any change in the sources contributing to the airborne level it will build up again quite rapidly to unacceptable levels. Thus, basing the purge termination on low airborne level will result in cyclic use of the purge system and cyclic opening and closing of the containment isolation valves. Such an operation could be very harmful to the life and dependability of the isolation valves, and is to be avoided.

5.2 Description

The following guidelines for the containment purge operation are proposed based on the above information and discussion. These guidelines apply to the use of the low volume CCPS only.

a. Initiate CCPS operation after an airborne level of 1/4 MPC or greater is measured at any of the three locations given in Section 4.1 above. IPC proposes to use a portable CAM at each of these locations, which will feed information to the main control room.

b. Initiate CCPS operation after the coolant I-131 concentration is measured in a sample to be higher than the threshold value of 4×10^{-5} µCi/cc.

c. Put the CCPS in use for the duration of any welding operations or cleaning tasks using chemicals within the containment.

d. Once initiated, leave the CCPS on until one of the ways of removal of the origins of airborne activity, as listed in Table 2, has been implemented.

It is anticipated that the CCPS may be in continuous use for extended periods of time. The guidelines, however, provide the operator with criteria based upon which he may keep the system isolated until the airborne radiation in the containment becomes a potential problem.

6.0 REFERENCES

1. Final Safety Analysis Report, Clinton Power Station, Section 9.4.6.

2. NUREG-0853, Supplement No. 2, "Safety Evaluation Report Related to the Operation of Clinton Power Station Unit No. 1," U.S. Nuclear Regulatory Commission, May 1983.

3. LRG-II Position Paper 4-CSB, "Containment Purge Operational Data Gathering and Evaluation Program," June 1984.

4. LRG-II Position Paper 5-CSB, "Containment Access Management Program," June 1984.

TABLE 1

RADIATION CUBICLES WITHIN THE CONTAINMENT

No.	Description	Location	Cubicle Cooler Within or Outside
1.	Reactor Water Cleanup System (RWCU) Valve Room	El. 816'-7"	Within
2.	Filter/Demineralizer (F/D) Holding Pump Cubicle	El. 803'-3"	None
3.	Pipe Cubicle	El. 789'-1"	Within
4.	RWCU Backwash Receiving Pump Cubicle	El. 778'-0"	Within
5.	RWCU Backwash Receiving Tank Cubicle	El. 778'-0"	Within
6.	RWCU Valve Room A	El. 789'-1"	Within
7.	RWCU Valve Room B	El. 789'-1"	Within
8.	Fuel Transfer Valve Room	El. 755'-0"	None
9.	Main Steam Pipe Tunnel	El. 755'-0"	Within
10.	Regenerative & Non-Regenerative Heat Exchanger Cubicle A	El. 789'-1"	Outside
11.	Regenerative & Non-Regenerative Heat Exchanger Cubicle B	El. 789'-1"	Outside
12.	F/D Vessel A	El. 803'-3"	Outside
13.	F/D Vessel B	El. 803'-3"	Outside

TABLE 2

ORIGINS OF CONTAINMENT AIRBORNE RADIOACTIVITY

Origin	Way to Remove/Improve
1. Leaky Fuel	Refueling
2. Power Level Change (Leads to iodine spiking)	Transient condition self-rectified
3. Reactor Water Cleanup System Malfunction	Maintenance*
4. Leaky Equipment Inside Containment	Maintenance*
5. Condensate Polisher Malfunction	Maintenance*
6. SRV Discharges	Transient condition self-rectified

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* Maintenance schedule and frequency is determined by the technical specification requirements and the existing approved plant maintenance program.

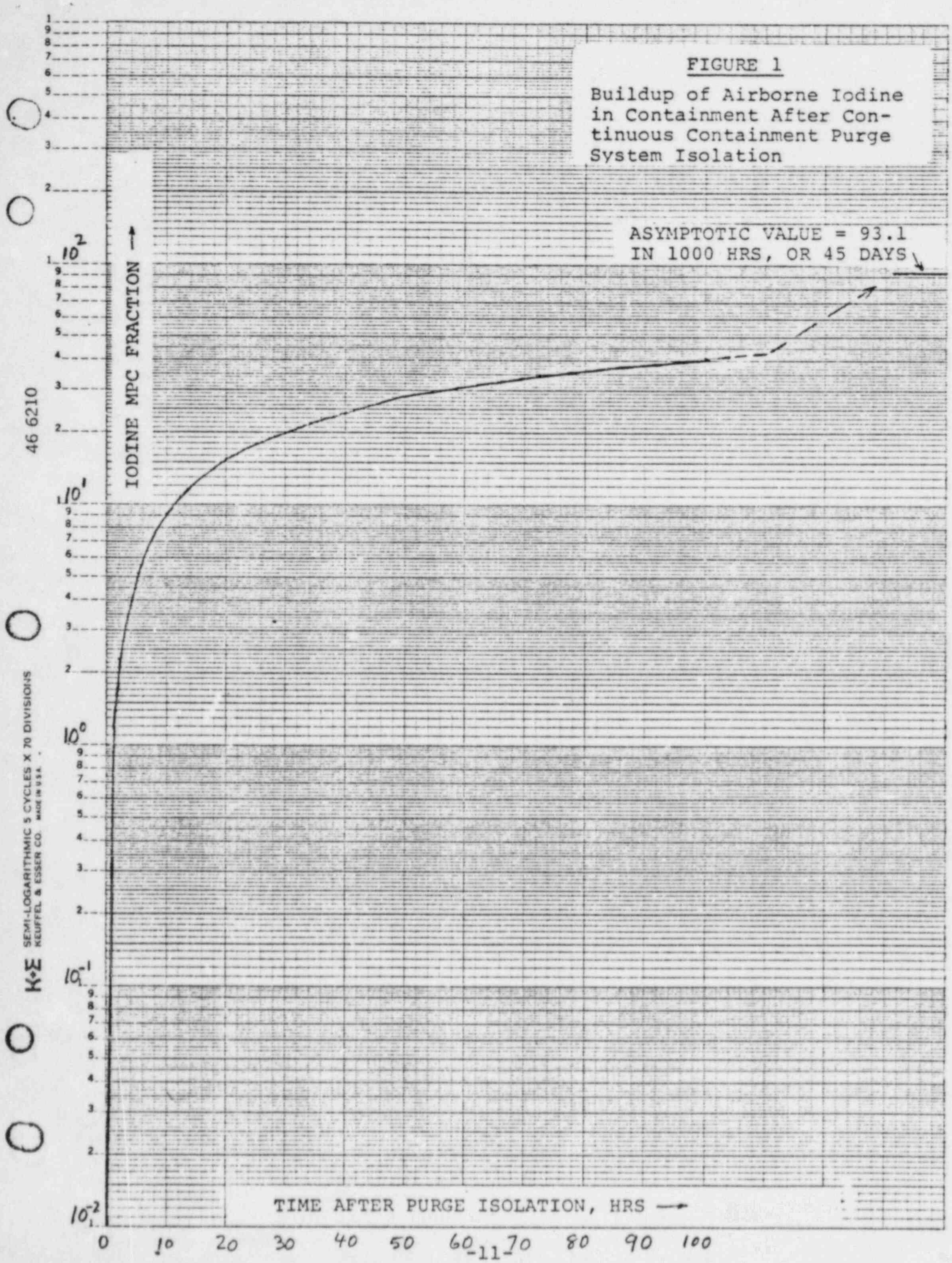
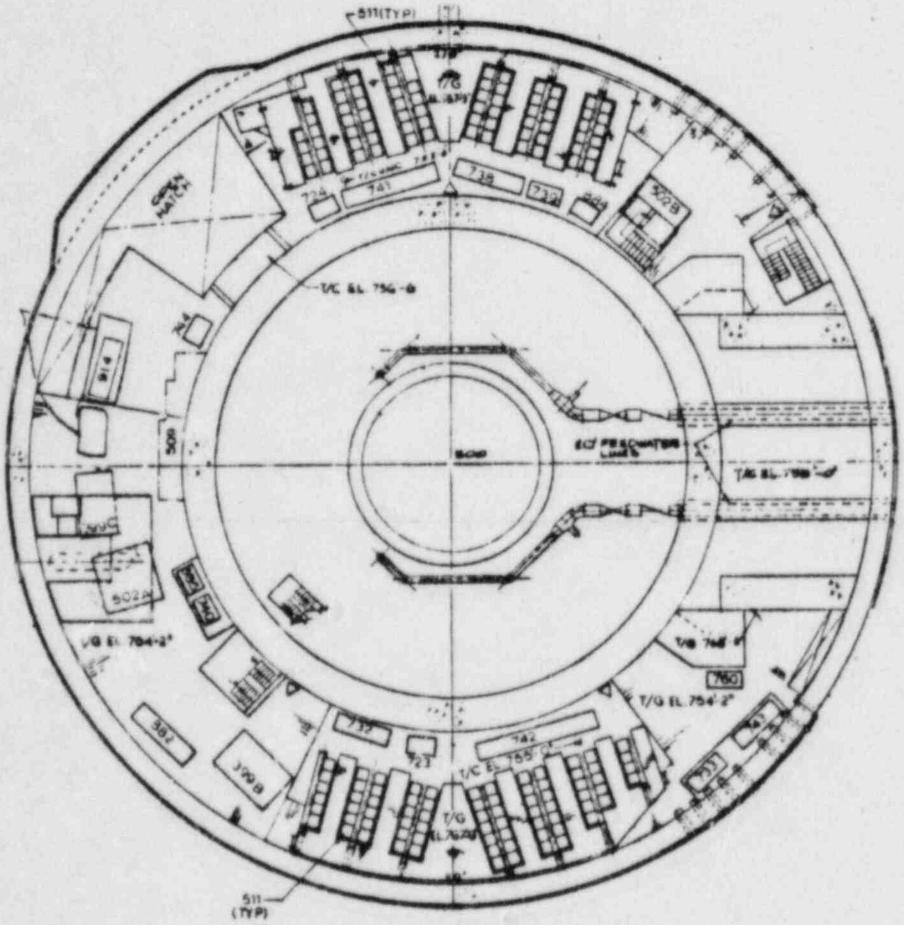


FIGURE 1
Buildup of Airborne Iodine in Containment After Continuous Containment Purge System Isolation
ASYMPTOTIC VALUE = 93.1
IN 1000 HRS, OR 45 DAYS
IODINE MPC FRACTION
TIME AFTER PURGE ISOLATION, HRS
10^2
10^1
10^0
10^{-1}
10^{-2}
0
10
20
30
40
50
60
70
80
90
100
46 6210
K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 2

Containment General Arrangement at Elevation 755'-0"

Showing Location of Containment Cubicles



ITEM	EQUIPMENT NAME
70	SURGE TANKS
197	SWITCHGEAR HEAT REMOVAL UNIT
506	ACCUMULATOR TANKS
549	FEEDWATER CHECKVALVE ACCUMULATOR TANK A & B
399	AREA COOLERS
500	REACTOR VESSEL
502	RECIR SYS FLOW CONTROL
509	CRD MASTER CONTROLS
511	HCU MODULES
519	RHR HEAT EXCHANGERS
530	FUEL PREP MACHINE
531	NEW FUEL INSPECTION STAND
532	JIB CRANE
533	FUEL HANDLING PLATFORM

ITEM	INSTRUMENT AND CONTROL PANELS EQUIPMENT NAME
723	RECIRC PUMP A INSTR PANEL
724	RECIRC PUMP B INSTR PANEL
732	JET PUMP INSTR PANEL A
733	REACTOR WATER CLNUP INSTR PANEL
738	JET PUMP INSTR. PANEL B
739	REACTOR VESSEL LVL. & PRESS. INSTR. PNL D
740	REACTOR VESSEL LVL. & PRESS. INSTR. PNL C
741	REACTOR VESSEL LVL. & PRESS. INSTR. PNL B
742	REACTOR VESSEL LVL. & PRESS. INSTR. PNL A
743	MAIN STEAM FLOW INSTR PANEL A
744	MAIN STEAM FLOW INSTR PANEL B
752	SHM/IHM DRIVE CONTROL RELAY
780	CONT BUILDING PROCESS SAMPLE INSTR PANEL
821	CRD & VESSEL TEMP RECORDER PNL
882	REACTOR SAMPLE PANEL
884	MAIN STEAM FLOW
885	MAIN STEAM FLOW
914	CRD PRESS CNT IP
537	HYDRAULIC UNIT
546	MASTER RELAY PNL
547	FUEL BLDG OPER PNL

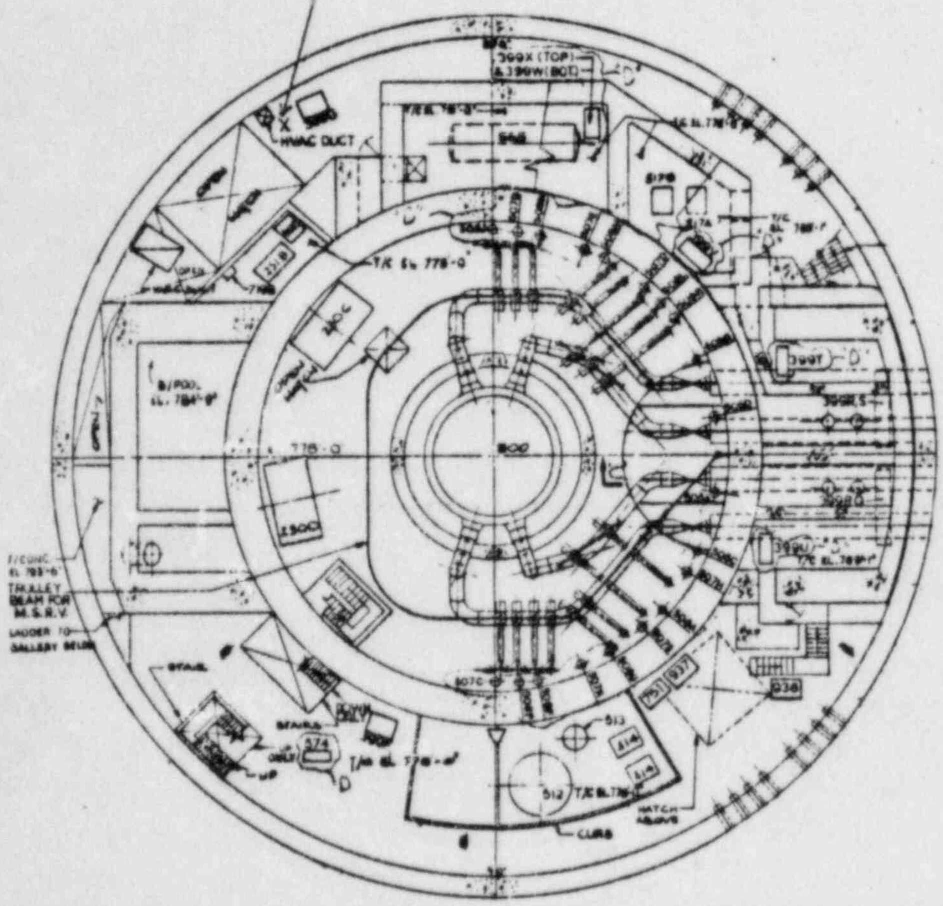
ITEM	ELECTRICAL EQUIPMENT
1018	[illegible]
5	5.9 KV SWITCHGEAR 1A
10	5.9 KV SWITCHGEAR 1B
11	4.1 KV SWITCHGEAR 1A
17	4.1 KV SWITCHGEAR 1B
19	480 V UNIT SUBSTATION 1D
20	480 V UNIT SUBSTATION 1E
2	480 V UNIT SUBSTATION 1L
9	480 V UNIT SUBSTATION 1M
413	AB MCC 1D
414	AB MCC 1E
415	AB MCC 1F, 1M8
416	AB MCC 1G, 1G8
492	AB MCC 1H
493	AB MCC 1I

FIGURE 3

Containment General Arrangement at Elevations 778'-0" and 789'-1"

Showing Location of Containment Cubicles

Approximate location of Portable Continuous Air Monitor



ITEM	EQUIPMENT NAME
124	175 TON CASK HANDLING CRANE
197	SWITCHGEAR HEAT REMOVAL UNIT
199	SWITCHGEAR HEAT REMOVAL COND. UNIT
217	FILTER DEMIN. RECIRCULATING PUMP
250	DRYWELL COOLERS
251	CGCS HYD. COMP.
[illegible]	AREA COOLERS
300	REACTOR VESSEL
505	ACCUMULATOR
574	COIL CABINET
507	ACCUMULATOR
508	ACCUMULATOR
512	STANDBY LIQ. CONTROL STOR. TANK
513	STANDBY LIQ. CONTROL TEST TANK
514	STANDBY LIQ. CONTROL PUMPS
[illegible]	[illegible]
[illegible]	[illegible]
379	BATTERY ROOM EX. FAN
408	COMBUSTION GAS CONN. UNIT
171	BATTERY ROOM EX. FAN

ITEM	INSTRUMENT PANELS
819	CONT. MONITORING SYS. SAMPLE PANEL A&B
734	SRM / IRM PREAMPLIFIER PANEL A
735	SRM / IRM PREAMPLIFIER PANEL B
736	SRM / IRM PREAMPLIFIER PANEL C
737	SRM / IRM PREAMPLIFIER PANEL D
751	STANDBY LIQ. CONTROL SYS. INSTRUMENT PANEL
[illegible]	LFMG AUX PNL
[illegible]	ESSENTIAL [illegible] PANEL
983	AUXILIARY BLDG. CAM.
984	FUEL BLDG. CAM.
970	CONTAINMENT BLDG. CAM. 2
936	F P IODINE GAS SAMPLE
937	F P PART SAMPLE
719	HYDROGEN COMP INSTR. PANEL
951	MSIV LEAK DET DIV 1
952	MSIV LEAK DET DIV 2
993	CONTROL PANEL SWITCHGEAR CONDENSER UNIT HPCS A B

ITEM	ELECTRICAL EQUIPMENT
[illegible]	4.1 KV SWITCHGEAR [illegible]
16	480 V UNIT SUBSTATION 1A
17	480 V UNIT SUBSTATION 1B
121	6.9 KV SWGR
517	LFMG SET
410	AB MCC A
411	AB MCC B
770	REMOTE SHUTDOWN PNL
[illegible]	BATTERY CHARGER
498	DC MCC 1A 1B
12	4.1 KV SWITCHGEAR 1A1
1020	MULTIPLEXER

FIGURE 4

Containment General Arrangement at Elevations 803'-3" and 816'-7"

Showing Location of Containment Cubicles

ITEM	EQUIP. NAME
251	CG HYD. COMPRESSOR
349	AREA COOLERS
550	REGEN HEAT EXCH.
551	NON-REGEN HT. EXCH.
553	RWCU PRECOAT TANK
554	RWCU RESIN TANK
555	RWCU BACKWASH REC. TANK
556	FILT./DEMIN. HOLDING PUMPS
557	RWCU PRECOAT PUMP
558	RWCU RESIN PUMP
559	FILT./DEMIN VESSEL
560	FILT./DEMIN. VESSEL
827	MULTIPLEXER
828	MULTIPLEXER
845	RWCU INST. RACK
846	CONTROL PANEL
719	HYDROGEN COMP INSTR. PANEL
368	CONTAINMENT AIR MONITOR
371	CONTAINMENT BLDG. TRANFER FAN
971	CONTAINMENT AIR MONITOR
408	COMBUSTION GAS COOLER UNIT