QUAD CITIES UNITS 1 & 2

SPECIAL REPORT NO.1

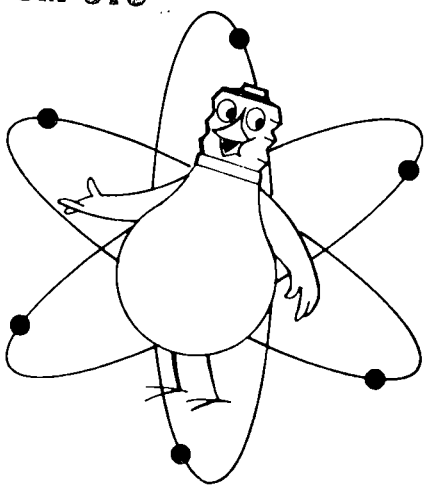
AND

SUPPLEMENTARY INFORMATION FOR

DRESDEN UNITS 2 & 3

SPECIAL REPORT NO.4A

Modified Off-gas System



Commonwealth Edison
Company

QUAD CITIES UNITS 1 & 2 SPECIAL REPORT NO. 1
AND
SUPPLEMENTARY INFORMATION FOR
DRESDEN UNITS 2 & 3 SPECIAL REPORT NO. 4 A

Modified Off-Gas Systems

COMMONWEALTH EDISON COMPANY

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AND
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Modified Off-Gas Systems

1. INTRODUCTION

The purpose of this report is to describe modifications being made to the Dresden Units 2 & 3 and the Quad Cities Units 1 & 2 off-gas systems. The intent to make such modifications was indicated in a meeting with Dr. Peter A. Morris on December 3,1970. The desirability of making these modifications was indicated in a letter to Commonwealth Edison from Dr. Morris, dated December 4, 1970.

The modification consists of the addition of General Electric's catalytic recombiner charcoal bed (RECHAR) system plus the necessary auxiliaries.

2. OBJECTIVE

The objective of the gaseous radwaste system is to keep the levels of radioactive material in the effluent to unrestricted areas as low as practicable.

3. MODIFICATION DESIGN BASES

The design bases for the modification will be a curie reduction factor of 40 relative to the existing system, assuming the condenser air in-leakage rate is 18.5 standard cubic feet per minute (SCFM).

4. OFF-GAS COMPOSITION

Noncondensible radioactive off-gas is continuously removed from the main condenser by the air ejector. The air ejector off-gas will normally contain activation gases, principally N-16, O-19, and N-13 which have short half-lives and are essentially decayed prior to leaving the holdup pipe. The air ejector off-gas will also contain radioactive isotopes of krypton and xenon. The concentration of these noble gases depends on the amount of tramp uranium in the coolant and on the cladding surfaces (usually extremely small) and the number and size of fuel cladding leaks.

5. DESCRIPTION OF MODIFICATIONS

The off-gas treatment system, as modified, is shown in Figure 1. The fission gases, activation gases, and radiolytic hydrogen and oxygen are removed from the main condenser by the air ejectors. This mixture is diluted with steam to provide cooling for the catalytic recombiner (heat is produced during the hydrogen-oxygen recombination). The mixture is then routed through a preheater to the catalytic recombiner. Preheating the mixture is necessary to ensure optimum recombiner performance.

In the recombiner, the radiolytic hydrogen and oxygen are catalytically converted to water (in the form of superheated steam). This steam, along with the steam used for dilution, trace quantities of unreacted hydrogen and oxygen, air, and radioactive gases, exits the recombiner to a condenser where the steam is condensed to liquid and returned to the reactor condensate system. The noncondensible effluent is then routed to the existing holdup piping where the shorter-lived radioactive isotopes (principally N-13, N-16, O-19, and certain isotopes of xenon and krypton) decay either to nonradioactive isotopes or radioactive

particulate daughter products. With the present holdup piping, the mixture traverse time is increased from 30 min to approximately four hr by removal of the radiolytic hydrogen and oxygen.

Upon leaving the holdup pipe, the effluent is cooled again for removal of water vapor, passed through a moisture separator for further drying, and then heated in a reheater for humidity control. Before entering the charcoal adsorbers, the effluent is filtered to remove the previously noted particulate daughter products. The 12 charcoal adsorption beds (~74,000 lb of charcoal) permit selective adsorption and delay of the xenons and kryptons from the carrier gas (principally air). Following the charcoal adsorbers, the effluent is filtered again to remove particulate daughter products and then discharged through the existing 310-ft concrete chimney.

This modified (RECHAR) system results in a reduction of the off-gas activity (curies) by a factor of approximately 40 relative to the existing system. Table 1 shows the estimated release rates of various isotopes of krypton and xenon for both the existing and the modified systems assuming the same input.

If the existing system, with a 30-min holdup pipe, results in a release rate of approximately 100,000 μc/sec, then the modified system with the (RECHAR) installation will result in a release rate of approximately 2,500 μc/sec. Shielding will be provided as necessary for process piping and equipment.

6. EQUIPMENT DESCRIPTION

The equipment containing process off-gas is designed per Section III, subsection ND, Class 3, Nuclear Power Plant Components, and shall be Seismic Class II. The modified off-gas system as described by this report is non-safety related; therefore, the quality assurance requirements are defined by Quality Procedure 2.2, Paragraph 2.2 of the Commonwealth Edison Company "Quality Assurance Manual—Nuclear Generating Stations", which reads as follows:

> **Non-Safety Related**—This category includes all items of equipment, materials, systems, and structures which do not affect nuclear safety as defined for Class A. This category may be treated as a single entity or may be subdivided as established by each project.
>
> No formal Quality Assurance Program as defined in this manual is required. However, some procedures contained within the manual may be used as a guide.

Redundancy of the air ejector, preheater, recombiner, off-gas condenser, water separator, cooler-condenser, moisture separator, particulate filters, and charcoal vault air conditioning units is provided for operating convenience and maintenance. Valving is provided for selecting either one or both recombiner trains. Each recombiner train consists of a third-stage air ejector, preheater, recombiner, off-gas condenser, and a water separator. Provision is made for the 2 hydrogen analyzers to sample the effluent from either one or both recombiner trains. Either one or both cooler condenser trains (cooler condenser, moisture separator, reheater, and prefilter) may be selected for operation. The charcoal can be operated in one of three modes: (a) all 12 vessels in series; (b) 3 parallel strings of 4 vessels; or (c) bypassing of all charcoal. Valving is provided to return the modified off-gas system to the existing system by bypassing and isolating the installed RECHAR system equipment.

7. INSTRUMENTATION AND CONTROL

The activity of the effluent entering and leaving the modified off-gas system is continuously monitored. This system is also monitored by flow, humidity, and temperature instrumentation and hydrogen analyzers for operation and control. Table 2 lists process instruments that cause alarms and notes whether the parameters are indicated or recorded in the control room.

8. SYSTEM PERFORMANCE

The modified off-gas system operates at a pressure of approximately 5 psig or less so the differential pressure that could cause leakage is small. To preclude leakage of radioactive gases the system is welded wherever possible, and bellows seal valve stems or equivalent are used. The entire system is designed to maintain its integrity in event of a hydrogen-oxygen detonation.

The holdup pipe and the charcoal adsorbers provide for radioactive decay of the major activation gases and fission gases in the main condenser off-gas. The adsorbers provide a 14.6-day xenon and a 19.4-hr krypton holdup. The daughter products that are solids are removed by filtration following the holdup and/or are retained on the charcoal. Final filtration of the charcoal adsorber effluent precludes escape of charcoal fines and particulates that would contain radioactive materials.

Operational control is maintained by the use of radiation monitors to keep the release rate within the limits established by the technical specifications. An existing radiation monitor at the beginning of the existing 30-min holdup continuously monitors gaseous radioactivity release from the reactor and, therefore, continuously monitors the degree of fuel leakage and input to the charcoal adsorbers. This existing radiation monitor is and will be used to isolate the off-gas system upon detection of high radioactivity to prevent unacceptably high activity from entering the plant vent chimney. A continuous gas sampling radiation monitor is also provided at the outlet of the charcoal adsorbers to continuously monitor the effluent of the modified off-gas system. This gas sampling radiation monitor is used to provide an alarm upon detection of high radiation in the off-gas. Provision is also made for sampling of the influent and effluent gases.

The charcoal adsorbers are designed to limit the temperature of the charcoal to well below the charcoal ignition temperature, thus precluding overheating or fire and consequent escape of radioactive materials. In addition, a radiation monitor is provided to monitor the radiation level in the charcoal bed vault. High radiation will cause an alarm in the control room.

To protect the recombiner, the dilution steam supply pressure is monitored and alarmed on low pressure. The recombiner temperatures are monitored and alarmed to indicate any deterioration of performance. A hydrogen analyzer downstream of the recombiners provides an additional check. The preheaters are heated with steam rather than electrically to eliminate the presence of potential ignition sources and to limit the temperature of the gases in event of cessation of gas flow. Although iodine input into the off-gas system is small by virtue of its retention in reactor water and condensate, the charcoal will effectively remove it by adsorption and prevent its release. Shielding is provided for off-gas system equipment to maintain safe radiation exposure levels for plant personnel.

9. INSPECTION AND TESTING

The gaseous waste disposal systems are used on a routine basis and do not require specific testing to assure operability.

Monitoring equipment will be calibrated and maintained on a specific schedule and on indication of malfunction. The system will be functionally tested prior to placing it in service to verify its initial operability.

10. ACCIDENT ANALYSIS

The accident analysis was based upon the machine-calculated isotope inventories of the RECHAR system equipment. These equipment inventories (as listed in Table 3) are based upon the following parameters:

1. Reactor rated at 2527 MWt
2. 18.5 SCFM air in-leakage

292.5

3. 100,000 μCi/sec diffusion gas mixture after 30-min delay
4. 12 charcoal beds—74,000 lb of charcoal
5. Retention of daughter products by equipment
   a. Off-gas condenser—100% but washed out
   b. Water separator—100% but washed out
   c. Holdup pipe—60% but washed out
   d. Prefilter—100%
   e. Carbon beds—100%
   f. Post filter—100%

The assumptions generally give conservative daughter inventories or do not have a significant effect on daughter inventories. For example, 100% washout in the off-gas condenser removes daughter products from the prefilter, but this represents less than one min of delay compared to 4 hr of delay experienced in the holdup pipe. Washout of 60% in the holdup pipe is conservative compared to 60 to 99% that has been measured in the EVESR facility at Vallecitos.

At Dresden 2, iodine activities were measured in the reactor water, condensate pump discharge, and off-gas after being discharged from the 30-min holdup. The iodine inventories of Table 3 are based upon these measurements and the standard plant iodine source term at 100,000 μCi/sec diffusion gas mixture after 30-min delay. The RECHAR system has a 4-hr holdup and several other features that are expected to reduce iodine reaching the prefilter and charcoal (e.g., the precious metal recombiner and a 45°F dewpoint of the gas stream versus 120°F dewpoint of a 30-min holdup system).

10.1 Charcoal Beds (4-ft diameter X 21 ft tall, dished heads, and 350 psig design pressure)

The charcoal vessels are contained in a single vault which is not accessible during operation because of the activity level. No failure of the vessels due to operator error can be postulated; the only postulated failure to these vessels that could result in loss of carbon would be failure of the vessel supporting structure allowing it to fall out of the vertical position followed by failure of the concrete structure surrounding the vessel. A circumferential failure of the vessel could result from concrete falling on the vessel under one of two conditions:

1. Bending Load—the vessel being supported in the center and loaded on each end. This could possibly result in a tear around 50% of the circumference.

2. Shearing Load—the vessel being supported at the bottom and loaded from above near the same point.

In either case, not more than 10 to 15% of the carbon would be displaced from the vessel. Iodine is strongly bonded to the charcoal and would not be expected to be removed by exposure to the air. One percent loss of iodine is a conservative estimate.

Measurements made at KRB indicate that off-gas is about 30% richer in krypton than air. Therefore, if this carbon is exposed to air, it will eventually reach equilibrium with the noble bases in the air. However, the first few inches of carbon will blanket the underlying carbon from the air. A 10% loss of noble gas from a failed vessel is conservative because of the small fraction of carbon exposed to the air.

10.2 Prefilter (24-in. diameter by 4 ft high, 350 psig design pressure)

Because of the short length of the vessel, heavy wall thickness due to the design pressure, and collapsible nature of the filter media, a failure mechanism cannot be postulated that will result in emission of filter media or daughter products from this vessel. One percent release is used to illustrate the consequences of loss from this vessel.

10.3 Holdup Pipe

Pipe rupture and depressurization of the pipe is considered. The pipe will normally operate at less than 15.6 psia and depressurize to 14.7 psia. The loss is conservatively taken as 20%. The model used an assumed plateout or washout of 60% in calculating the holdup pipe inventory.

To provide an estimate of hypothetical radiological doses from equipment failures, assumptions of percentages of the activity contained in the most significant components listed in Table 1 were assumed to be released to the environment under very stable 1 m/sec meteorological conditions with an effective release height of zero meters. The estimated radiological exposures based on these considerations are presented in Table 4 and are compared to the limits in 10CFR20 and 10CFR100.

10.4 Charcoal Temperature

The charcoal adsorbers operate at essentially room temperature and are designed to limit the temperature of the charcoal to well below the charcoal ignition temperature, thus precluding overheating or fire and consequent escape of radioactive materials. The adsorbers are located in a shielded room, maintained at a constant temperature by an air conditioning system that removes the decay heat generated in the adsorbers. The maximum centerline temperature of the charcoal is less than 10°F above room temperature when the flow is stopped. The decay heat of 50 Btu/h is sufficiently small compared to the thermal mass of the charcoal vault, that even if the vault cooling is lost, the temperature rise will not be sufficient to cause charcoal ignition.

The charcoal is maintained at 77°F by the vault air conditioning system. Due to the thermal inertia of the steel charcoal vessels and the massive concrete vault walls, temperature changes caused by failure of the vault air conditioning system will be sufficiently slow that the resulting changes in charcoal adsorption coefficient will not result in a rapid release of adsorbed radioactivity. In order to maintain consistent operation of the system, a redundant vault air conditioning system is supplied to allow for maintenance and operational convenience. During a plant outage when the condenser is not maintained at vacuum, there is no gas flow in the charcoal and holdup is very high even if the charcoal reaches ambient temperature.

10.5 Conclusion

The accident analysis indicates there is no undue hazard to the health and safety of the public resulting from installation and operation of the off-gas treatment system. The failure of equipment in the RECHAR system would result only in a fraction of the off-site doses (Table 4) presently permitted.

Table 1
ESTIMATED KRYPTON AND XENON RELEASE RATES PER UNIT
(Release rates are given in μCi/sec, based on a diffusion mixture and the same input)

Isotope	Half-Life	30-Minute Holdup System	Recombiner-Charcoal System
Kr-83m	1.86 hr	2,850	5
Kr-85m	4.40 hr	5,000	400
Kr-85	10.74 hr	10	10
Kr-87	76 min	14,800	2
Kr-88	2.79 hr	16,000	300
Kr-89	3.18 min	250	–
Xe-131m	11.96 day	10	5
Xe-133m	2.26 day	200	10
Xe-133	5.27 day	5,000	1,500
Xe-135m	15.70 min	8,000	–
Xe-135	9.16 hr	17,500	–
Xe-137	3.82 min	1,000	–
Xe-138	14.20 min	28,500	–

Table 2
PROCESS INSTRUMENT ALARMS

Parameter	Main Control Room Indicated	Main Control Room Recorded
Preheater discharge temperature — low	X	
Recombiner catalyst temperature — high/low		X
Offgas condenser drain well (dual) level — high/low		
Offgas condenser gas discharge temperature — high		
H_2 analyzer (offgas condenser discharge) (dual) — high		X
Radiation		X
Cooler — condenser discharge temperature — high/low		X
Glycol solution temperature — high/low		X
Glycol storage tank level — low		
Prefilter P — high	X	
Humidity (charcoal bed inlet) — high		X
Charcoal bed temperature — high		X
Charcoal vault temperature — high/low		X
Radiation (gas sampling)		X
Gas flow (post filter inlet) — high/low		X
Post filter P — high	X	

Table 3

INVENTORY ACTIVITIES – AMBIENT RECHAR – DRESDEN
(μc)

Component	Preheater	Recombiner	Offgas Condenser	Water Separator	Holdup Pipe	Cooler Condenser	Moisture Separator	Reheater	Prefilter	Charcoal Vessel Train	First Charcoal Vessel	Afterfilter
Residence Time	0.8 Sec	0.9 Sec	50 Sec	5.1 Sec	4 Hr	178 Sec	6.5 Sec	14.5 Sec	43.5 Sec	Kr 19.4 Hours Xe 14.6 Days	Kr-1.6 Hours Xe 1.2 Days	43.5 Sec
Operating Time	0	0	0	0	0	0	0	0	1 Yr	10 Yr	10 Yr	1 Yr
Solid Daughter Capture	0	0	100%	100%	60%	0	0	0	100%	100%	100%	100%
Solid Daughter Washout		–	100%	100%	100%	-	-	–	0	0	0	0
Isotope												
Kr-83M	2.80 + 3	3.50 + 3	1.75 + 5	1.78 + 4	2.61 + 7	1.38 + 5	5.00 + 3	1.11 + 4	3.33 + 4	7.42 + 6	3.35 + 6	2.49 + 1
Kr-85M	4.56 + 3	5.69 + 3	2.84 + 5	2.90 + 4	6.07 + 7	5.36 + 5	1.95 + 4	4.35 + 4	1.30 + 5	6.51 + 7	1.54 + 7	6.11 + 3
Kr-85	6.54 + 0	8.18 + 0	4.09 + 2	4.17 + 1	1.18 + 5	1.48 + 3	5.40 + 1	1.20 + 2	3.61 + 2	5.87 + 5	4.84 + 4	3.67 + 2
Kr-87	1.63 + 4	2.04 + 4	1.02 + 6	1.03 + 5	1.18 + 8	3.98 + 5	1.43 + 4	3.19 + 4	9.53 + 4	1.44 + 7	8.43 + 6	2.32 + 0
Rb-87	0	0	0	0	0	0	0	0	0	1.99 - 3	1.17 - 3	0
Kr-88	1.53 + 4	1.91 + 4	9.54 + 5	9.71 + 4	1.74 + 8	1.25 + 6	4.54 + 4	1.01 + 5	3.03 + 5	1.00 + 8	3.33 + 7	2.44 + 3
Rb-88	4.40 + 0	1.61 + 1	1.64 + 4	1.61 + 2	9.71 + 7	6.02 + 5	2.34 + 4	5.24 + 4	5.87 + 6	1.00 + 8	3.33 + 7	9.86 + 4
Kr-89	1.39 + 5	1.73 + 5	7.91 + 6	7.30 + 5	3.93 + 7	0	0	0	0	0	0	0
Rb-89	4.18 + 1	1.69 + 2	1.62 + 5	1.40 + 3	2.36 + 7	5.06 + 1	1.72 + 0	3.81 + 0	3.44 + 2	0	0	0
Sr-89	0	0	4.43 - 1	0	4.64 + 4	4.30 + 2	1.57 + 1	3.51 + 1	1.52 + 7	0	0	0
Y-89M	0	0	1.71 - 1	0	4.64 + 4	4.30 + 2	1.57 + 1	3.51 + 1	1.52 + 7	0	0	0
Kr-90	2.87 + 5	3.52 + 5	1.08 + 7	5.90 + 5	5.21 + 6	0	0	0	0	0	0	0
Rb-90	4.58 + 2	1.84 + 3	1.29 + 6	6.05 + 3	3.13 + 6	0	0	0	0	0	0	0
Sr-90	0	0	1.92 - 2	0	3.45 + 1	2.90 - 1	1.06 - 2	2.36 - 2	5.07 + 4	0	0	0
Y-90	0	0	0	0	7.25 - 1	1.21 - 2	4.45 - 4	9.94 - 4	5.02 + 4	0	0	0
Kr-91	1.84 + 5	2.16 + 5	2.91 + 6	2.80 + 4	6.61 + 4	0	0	0	0	0	0	0
Rb-91	7.12 + 2	2.80 + 3	1.02 + 6	7.16 + 2	3.96 + 4	0	0	0	0	0	0	0
Sr-91	9.10 - 3	3.87 - 2	4.54 + 2	2.52 - 2	9.81 + 3	0	0	0	0	0	0	0
Y-91	0	0	0	0	1.00 + 1	7.05 + 1	2.57 + 0	5.74 + 0	2.85 + 6	0	0	0
Kr-92	1.92 + 4	1.96 + 4	7.53 + 4	5.02 - 1	2.23 - 1	0	0	0	0	0	0	0
Rb-92	1.00 + 3	3.51 + 3	1.09 + 5	1.59 - 1	1.34 - 1	0	0	0	0	0	0	0
Sr-92	1.96 - 2	1.83 - 1	3.22 + 2	0	8.57 - 2	4.04 - 4	1.46 - 5	3.26 - 5	3.14 - 2	0	0	0
Y-92	0	0	3.67 - 1	0	3.01 - 2	3.60 - 4	1.31 - 5	2.93 - 5	6.86 - 2	0	0	0
Kr-93	1.22 + 3	1.11 + 3	2.69 + 3	0	1.37 - 5	0	0	0	0	0	0	0
Rb-93	6.09 + 1	2.04 + 2	4.74 + 3	0	8.24 - 6	0	0	0	0	0	0	0

QUAD CITIES

INVENTORY ACTIVITIES – AMBIENT RECHAR – DRESDEN (Continued)
(μc)

Component	Preheater	Recombiner	Offgas Condenser	Water Separator	Holdup Pipe	Cooler Condenser	Moisture Separator	Reheater	Prefilter	Charcoal Vessel Train	First Charcoal Vessel	Afterfilter
Sr-93	2.42 - 2	2.22 - 1	2.87 + 2	0	8.24 - 6	0	0	0	0	0	0	0
Y-93	0	0	1.17 - 1	0	1.88 - 6	0	0	0	0	0	0	0
Zr-93	0	0	0	0	0	0	0	0	0	0	0	0
Nb-93M	0	0	0	0	0	0	0	0	0	0	0	0
Kr-94	2.93 + 0	1.98 + 0	1.98 + 0	0	0	0	0	0	0	0	0	0
Rb-94	2.87 - 1	8.04 - 1	5.80 + 0	0	0	0	0	0	0	0	0	0
Sr-94	0	6.63 - 3	2.31 + 0	0	0	0	0	0	0	0	0	0
Y-94	0	0	3.25 - 2	0	0	0	0	0	0	0	0	0
Kr-95	2.05 - 1	1.39 - 1	1.38 - 1	0	0	0	0	0	0	0	0	0
Rb-95	2.30 - 2	6.36 - 2	3.96 - 1	0	0	0	0	0	0	0	0	0
Sr-95	0	0	2.36 - 1	0	0	0	0	0	0	0	0	0
Y-95	0	0	6.43 - 3	0	0	0	0	0	0	0	0	0
Zr-95	0	0	0	0	0	0	0	0	0	0	0	0
Nb-95M	0	0	0	0	0	0	0	0	0	0	0	0
Kr-97	0	0	0	0	0	0	0	0	0	0	0	0
Rb-97	0	0	0	0	0	0	0	0	0	0	0	0
Sr-97	0	0	0	0	0	0	0	0	0	0	0	0
Y-97	0	0	0	0	0	0	0	0	0	0	0	0
Zr-97	0	0	0	0	0	0	0	0	0	0	0	0
Nb-97	0	0	0	0	0	0	0	0	0	0	0	0
Xe-131M	9.58 + 0	1.20 + 1	5.99 + 2	6.10 + 1	1.71 + 6	2.11 + 4	7.70 + 2	1.72 + 3	5.15 + 3	1.01 + 8	1.20 + 7	2.21 + 3
Xe-133M	1.70 + 2	2.12 + 2	1.06 + 4	1.08 + 3	2.98 + 6	3.59 + 4	1.31 + 3	2.92 + 3	8.77 + 3	5.61 + 7	1.77 + 7	9.97 + 1
Xe-133	4.36 + 3	5.45 + 3	2.73 + 5	2.78 + 4	7.76 + 7	9.49 + 5	3.46 + 4	7.73 + 4	2.32 + 5	3.03 + 9	5.19 + 8	3.50 + 4
Xe-135M	2.57 + 4	3.21 + 4	1.58 + 6	1.58 + 5	4.16 + 7	1.20 + 2	4.11 + 0	9.09 + 0	2.67 + 1	8.20 + 2	8.20 + 2	2.91 - 4
Xe-135	1.53 + 4	1.91 + 4	9.55 + 5	9.73 + 4	2.37 + 8	2.63 + 6	9.57 + 4	2.13 + 5	6.40 + 5	7.00 + 8	6.23 + 8	0
Cs-135	0	0	0	0	7.88 - 2	1.24 + 3	4.52 + 1	1.01 + 2	2.19 + 8	2.11 + 3	1.87 + 3	0
Xe-137	1.68 + 5	2.10 + 5	9.71 + 6	9.10 + 5	5.82 + 7	0	0	0	0	0	0	0
Cs-137	0	0	1.96 1	1.70 - 3	3.60 + 2	3.04 + 0	1.11 - 1	2.47 - 1	5.31 + 5	0	0	0
Ba-137M	0	0	1.47 - 2	0	3.54 + 2	3.04 + 0	1.11 - 1	2.47 - 1	5.31 + 5	0	0	0
Xe-138	8.89 + 4	1.11 + 5	5.43 + 6	5.42 + 5	1.29 + 8	1.22 + 2	4.12 + 0	9.12 + 0	2.67 + 1	7.42 + 2	7.42 + 2	0

INVENTORY ACTIVITIES – AMBIENT RECHAR – DRESDEN (Continued)

(μc)

Component	Preheater	Recombiner	Offgas Condenser	Water Separator	Holdup Pipe	Cooler Condenser	Moisture Separator	Reheater	Prefilter	Charcoal Vessel Train	First Charcoal Vessel	Afterfilter
Cs-138	1.30 + 1	5.17 + 1	5.23 + 4	4.96 + 2	7.64 + 7	3.21 + 4	1.13 + 3	2.52 + 3	4.83 + 5	7.42 + 2	7.42 + 2	0
Xe-139	2.94 + 5	3.63 + 5	1.21 + 7	7.54 + 5	8.38 + 6	0	0	0	0	0	0	0
Cs-139	1.44 + 2	5.78 + 2	4.50 + 5	2.37 + 3	5.03 + 6	1.74 - 2	5.66 - 4	1.25 - 3	6.87 - 2	0	0	0
Ba-139	3.94 - 2	5.52 - 2	1.16 + 3	5.79 - 1	4.26 + 6	1.26 + 4	4.53 + 2	1.01 + 3	5.00 + 5	0	0	0
Xe-140	2.24 + 5	2.68 + 5	4.71 + 6	9.14 + 4	3.08 + 5	0	0	0	0	0	0	0
Cs-140	9.45 + 2	3.74 + 3	1.61 + 6	2.51 + 3	1.85 + 5	0	0	0	0	0	0	0
Ba-140	0	1.78 - 3	2.18 + 1	2.78 - 3	1.65 + 3	1.36 + 1	4.97 - 1	1.11 + 0	1.22 + 5	0	0	0
La-140	0	0	1.03 - 2	0	5.51 + 1	9.09 - 1	3.34 - 2	7.45 - 2	1.23 + 5	0	0	0
Xe-141	3.37 + 3	3.09 + 3	7.45 + 3	0	3.81 - 5	0	0	0	0	0	0	0
Cs-141	4.04 + 1	1.41 + 2	1.03 + 4	0	2.28 - 5	0	0	0	0	0	0	0
Ba-141	7.10 - 3	6.67 + 2	2.01 + 2	0	2.28 - 5	0	0	0	0	0	0	0
La-141	0	0	1.80 - 1	0	1.07 - 5	0	0	0	0	0	0	0
Ce-141	0	0	0	0	0	0	0	0	0	0	0	0
Xe-142	2.06 + 2	1.71 + 2	2.90 + 2	0	2.56 - 9	0	0	0	0	0	0	0
Cs-142	2.43 + 1	7.23 + 1	6.30 + 2	0	0	0	0	0	0	0	0	0
Ba-142	7.14 - 2	6.06 - 1	2.56 + 2	0	0	0	0	0	0	0	0	0
La-142	0	0	8.09 - 1	0	0	0	0	0	0	0	0	0
Xe-143	1.49 + 0	1.01 + 0	1.01 + 0	0	0	0	0	0	0	0	0	0
Cs-143	2.06 - 1	5.50 - 1	2.75 + 0	0	0	0	0	0	0	0	0	0
Ba-143	3.35 - 3	2.62 - 2	3.25 + 0	0	0	0	0	0	0	0	0	0
La-143	0	0	8.93 - 2	0	0	0	0	0	0	0	0	0
Ce-143	0	0	0	0	0	0	0	0	0	0	0	0
Pr-143	0	0	0	0	0	0	0	0	0	0	0	0
Xe-144	2.99 + 2	3.48 + 2	4.16 + 3	2.74 + 1	5.54 + 1	0	0	0	0	0	0	0
Cs-144	7.01 + 1	2.12 + 2	4.52 + 3	2.06 + 1	3.22 + 1	0	0	0	0	0	0	0
Ba-144	1.12 + 0	9.45 + 0	4.13 + 3	2.38 + 0	3.22 + 1	0	0	0	0	0	0	0
La-144	3.91 - 3	8.17 - 2	1.48 + 3	5.94 - 2	3.22 + 1	0	0	0	0	0	0	0
Ce-144	0	0	0	0	1.37 - 2	0	0	0	0	0	0	0
Pr-144	0	0	0	0	1.23 - 2	0	0	0	0	0	0	0
N-13	5.78 + 3	7.21 + 3	3.51 + 5	3.46 + 4	5.89 + 6	8.16 - 2	2.68 - 3	5.90 - 3	1.71 - 2	3.33 - 1	1.32 - 1	3.85 - 5

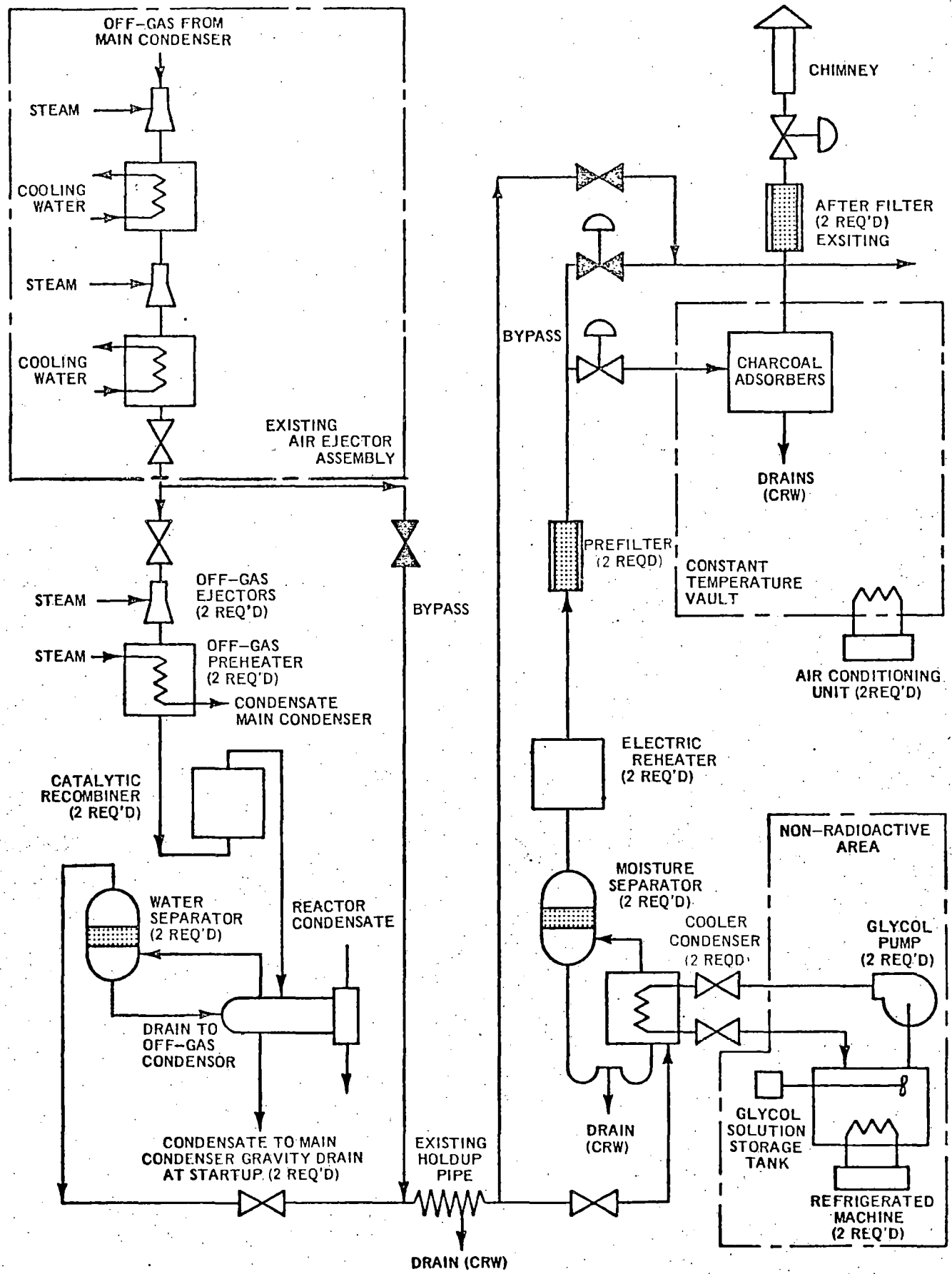
INVENTORY ACTIVITIES – AMBIENT RECHAR – DRESDEN (Continued)
(μc)

Component	Preheater	Recombiner	Offgas Condenser	Water Separator	Holdup Pipe	Cooler Condenser	Moisture Separator	Reheater	Prefilter	Charcoal Vessel Train	First Charcoal Vessel	Afterfilter
N-16	5.22 + 7	5.94 + 7	5.44 + 8	1.30 + 6	1.88 + 6	0	0	0	0	0	0	0
N-17	4.43 + 3	4.76 + 3	2.62 + 2	3.52 + 0	2.61 + 0	0	0	0	0	0	0	0
O-19	7.12 + 5	8.69 + 5	2.41 + 7	1.13 + 6	7.99 + 6	0	0	0	0	0	0	0
Iodine	–	–	–	--	--	–	–	–	1.34 + 7	1.34 + 7	1.34 + 7	–
Kr + Xe (Gas)	1.49 + 6	1.82 + 6	5.89 + 7	4.17 + 6	9.80 + 8	5.96 + 6	2.16 + 5	4.83 + 5	1.45 + 6	4.08 + 9	2.23 + 9	4.61 + 4
Solid Daughters	3.51 + 3	1.33 + 4	4.74 + 6	1.37 + 4	2.10 + 8	6.48 + 5	2.50 + 4	5.85 + 4	2.60 + 8	1.00 + 8	3.33 + 7	9.86 + 4
Kr Gas	6.69 + 5	8.10 + 5	2.41 + 7	1.59 + 6	4.23 + 8	2.32 + 6	8.42 + 4	1.88 + 5	5.61 + 5	1.87 + 8	6.05 + 7	8.95 + 3
Xe Gas	8.24 + 5	1.01 + 6	3.48 + 7	2.58 + 6	5.57 + 8	3.64 + 6	1.32 + 5	2.95 + 5	8.86 + 5	3.89 + 9	1.17 + 9	3.72 + 4
TOTAL	5.44 + 7	6.21 + 7	6.32 + 8	6.65 + 6	1.21 + 9	6.61 + 6	2.42 + 5	5.39 + 5	2.75 + 8	4.19 + 9	2.28 + 9	1.45 + 5

Table 4
RADIOLOGICAL EXPOSURES—RECHAR SYSTEM COMPONENT FAILURE

Component Failed	Primary Activity Released	Percent Released	Dresden 2 & 3 Resultant Exposure (800 meters)	Quad-Cities 1 & 2 Resultant Exposure (1200 ft)	10CFR20	10CFR100
First Carbon Bed	Iodine	1	12.4 mr	17.4 mr	1500 mr	300,000 mr
12 Carbon Beds	Noble Gas	10	1.0 mr	1.77 mr	500 mr	25,000 mr
Prefilter	Particulates	1	18.5 mr	48.0 mr	500 mr	25,000 mr
Holdup Pipe	Particulates	20	20.3 mr	53.0 mr	500 mr	25,000 mr

292.1A


OFF-GAS FROM MAIN CONDENSER
STEAM
COOLING WATER
STEAM
COOLING WATER
EXISTING AIR EJECTOR ASSEMBLY
STEAM
OFF-GAS EJECTORS (2 REQ'D)
STEAM
OFF-GAS PREHEATER (2 REQ'D)
CONDENSATE MAIN CONDENSER
BYPASS
CATALYTIC RECOMBINER (2 REQ'D)
WATER SEPARATOR (2 REQ'D)
REACTOR CONDENSATE
DRAIN TO OFF-GAS CONDENSOR
CONDENSATE TO MAIN CONDENSER GRAVITY DRAIN AT STARTUP (2 REQ'D)
EXISTING HOLDUP PIPE
DRAIN (CRW)
CHIMNEY
AFTER FILTER (2 REQ'D) EXSITING
BYPASS
CHARCOAL ADSORBERS
DRAINS (CRW)
PREFILTER (2 REQD)
CONSTANT TEMPERATURE VAULT
AIR CONDITIONING UNIT (2REQ'D)
ELECTRIC REHEATER (2 REQ'D)
NON-RADIOACTIVE AREA
MOISTURE SEPARATOR (2 REQ'D)
COOLER CONDENSER (2 REQD)
GLYCOL PUMP (2 REQ'D)
DRAIN (CRW)
GLYCOL SOLUTION STORAGE TANK
REFRIGERATED MACHINE (2 REQ'D)

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