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Docket No. 50-331

D. R. Muller, Assistant Director for Environmental Projects, L
THRU: G. K. Dicker, Chief, Environmental Projects 2, L

Original signed by Gordon K. Dicker

MEETING WITH IOWA ELECTRIC LIGHT & POWER COMPANY ON DUANE ARNOLD ENERGY CENTER, ARGONNE NATIONAL LABORATORY, SEPTEMBER 11, 1972

The meeting was held to review formal questions submitted to IELP by letter from D. R. Muller, August 28, 1972. A list of attendees is given in Enclosure 1.

Item by item review of the formal questions revealed that essentially all information was already in hand.

Exceptions included disposal of chemical waste, hydrologic data as related to water supply wells, transportation of radioactive materials, handling of gland seal exhaust gases, and gaseous effluent monitors.

Completion of all responses by IELP was expected to be completed by September 25, 1972, and formal submission is to be made by October 3, 1972.

Original signed by
L. B. Werner

Louis B. Werner, Project Manager
Environmental Projects Branch 2
Directorate of Licensing

Enclosure:
1. List of Attendees

cc: AEC PDR
Local PDR
P. F. Gustafson, ANL
K. D. Dance, ANL
A. Giambusso, DDRP, L
R. Boyd, ADBWR's, L
G. K. Dicker, EP-2, L
F. St. Mary, EP-2, L
G. Lear, BWR-1, L
R. Newton, OGC
DRO (3)

OFFICE ▶	EP-2:L	EP-2:L				
SURNAME ▶	LBW LBWerner:peb	GKD GKDicker				
DATE ▶	9/27/72	9/ /72				

LIST OF ATTENDEES

ARGONNE NATIONAL LABORATORY

SEPTEMBER 11, 1972

Iowa Electric Light & Power Company

J. Ward
K. Meyer
D. Flanagan

IELP Consultants

D. McDonald - University of Iowa
T. Broad - Bechtel

AEC

L. B. Werner

ORNL

K. Dance
E. Daniels
W. Mecham
M. Schumacher
N. Fragerio
B. Lewis

OFFICE ▶						
SURNAME ▶						
DATE ▶						

ENVIRON

Docket File

SEP 15 1972

Docket Number: 50-331

Daniel R. Muller, Assistant Director for Environmental Projects, L

RADWASTE SECTION FOR ENVIRONMENTAL STATEMENT FOR DUANE ARNOLD ENERGY CENTER

Plant Name: Duane Arnold Energy Center
Licensing Stage: OL
Docket Number: 50-331
Responsible Branch: Environmental Projects Branch #2
Project Leader: L. Werner
Requested Completion Date: September 20, 1972
Description of Response: Radwaste Section & Source Terms for ES
Review Status: Complete

In response to your request, we have prepared and attached to this memorandum the Radwaste Section and Source Terms for Duane Arnold Energy Center. The liquid and gaseous source terms were transmitted informally to the Radiological Assessment Branch on September 6, 1972.

Original signed by:
R. L. Tedesco

R. L. Tedesco, Assistant Director
for Containment Safety
Directorate of Licensing

Enclosures:
As stated

cc: w/o enclosures
A. Giambusso
W. McDonald

w/enclosures
S. Hanauer
J. Hendrie
TR Assistant Directors
TR Branch Chiefs
R. Boyd
W. Butler
G. Dicker
G. Lear
L. Werner
B. Mann

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DATE ▶	9/12/72	9/15/72	9/15/72			

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Waste Treatment Section for Environmental Statement

Duane Arnold Energy Center

3.5 Radioactive Waste Systems

During the operation of nuclear power reactors, radioactive material will be produced by fission and by neutron activation reactions in metals and other material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes may enter the waste streams, which will be processed and monitored within the station to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into the Cedar River. Releases of radioactivity during operation of the station will be in accordance with the Commission's regulations, as set forth in 10 CFR Part 20 and 10 CFR Part 50. The applicant will utilize the equipment described in this section to meet the "as low as practical" discharge criteria as delineated in the appropriate Technical Specifications.

The waste handling and treatment systems to be installed at the station are discussed in detail in the Final Safety Analysis Report and in the Applicant's Environmental Report. In these documents, the applicant has provided the results of his analysis of the proposed treatment systems including estimates of the annual effluents.

The following analysis is based on our model, adjusted to apply to this plant and uses somewhat different operating conditions. Our calculated radwastes will be classified, collected, and treated as high purity, low purity, chemical, detergent, sludge or spent resins. The terms high purity and low purity refer to the conductivity and not radioactivity. Table 3.5.1 lists the principal assumptions used in evaluating the waste treatment systems. Figure 3.5.1 is a simplified liquid radwaste system flow diagram.

High purity (low conductivity) liquid wastes will be collected in the waste collector tank (10,000 gal.), principally from the piping and equipment drains but also liquid decanted from the resin backwash phase separators. These wastes will be processed by filtration and ion exchange through the waste filter and waste demineralizer. After processing, the liquid will be received in one of two waste sample tanks (10,000 gal. each) where it will be sampled. Then, if it is satisfactory for reuse, it will be transferred to the condensate storage tank as makeup water.

Our analysis assumed a daily input into this system of 21,000 gallons of high purity wastes at about .28 percent of primary coolant activity. We further considered that 90% of this water would be recycled and that 10% would be discharged. The annual release from this source was calculated to be 0.5 Ci.

Low purity (moderate conductivity) liquid wastes will be collected in the floor drain collector tank (10,000 gal), principally from the various floor drain sumps. These wastes will generally have low concentrations of radioactive impurities. Processing will consist of filtration, ion exchange, and subsequent transfer to the floor drain sample tank (10,000 gal.) for sampling and analysis. Normally, treated low purity wastes will meet the specifications of water quality used in the plant and, if the water inventory of the plant permits, they will be returned to the condensate storage tank for reuse. Infrequently, when the water inventory of the plant does not permit return to condensate storage, treated low purity waste will be sampled and discharged.

Our analysis assumed a daily input to this system of 8500 gallons of low purity wastes at about 34 percent of primary coolant activity. About 30% of this water will be discharged after processing. The annual release from this source was calculated to be 1.0 Ci.

Chemical wastes will be collected in the chemical waste tank (4,000 gal.) principally from decontamination, laboratory drains and cask cleaning drains. These chemical wastes will be of such high conductivity as to preclude treatment by ion exchange. These wastes will be neutralized, if required, and then processed by filtration and by evaporation. Excess waste will be discharged to the cooling tower blowdown stream. Evaporator bottoms (concentrates) will be drummed and disposed of as solid radwaste. The distillate from the evaporator will be collected in a sample tank for sampling and analysis.

Our analysis considered a daily input to this system of 500 gallons of chemical wastes at an estimated 10% of primary coolant activity with 100% of the condensate discharged. The annual release from this source was calculated to be less than 0.5 Ci.

Detergent wastes will be collected in one of two detergent drain tanks (1000 gal. each). The source of these wastes are shop regulated drain, personnel decontamination, cask cleaning drains, and turbine washdown area drains. Detergent wastes will be of low radioactivity concentration, but they will be treated in the same manner as chemical wastes to the maximum extent practicable, taking into account the tendency of these wastes to adversely affect evaporator performance. Plant laundry will be done offsite by an outside contractor.

We assumed a daily input of 300 gallons of detergent waste at a negligible activity. In our calculations we have combined the chemical and detergent wastes.

Our estimated annual liquid waste releases are shown in Table 3.5.2. Based on evaluation of the liquid waste treatment system and the assumptions summarized in Table 3.5.1 we have calculated these releases to be a fraction of the values shown in Table 3.5.2. However, to compensate for equipment downtime and expected operational occurrences the values have been normalized to 4 curies per year excluding tritium. Based on operating experience with other BWR's we estimate the annual tritium release to be approximately 20 curies. In comparison the applicant estimates a yearly liquid waste release of 0.4 curie excluding tritium, based on an off-gas rate of 100,000 microcuries per second, and a yearly tritium release of 20 curies. The liquid effluent will be discharged into the cooling tower blowdown stream which has a flow rate ranging from 6,000 to 24,000 gpm.

3.5.2 Gaseous Wastes

During power operation of the plant, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission-product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material including both fission products and activated corrosion products. A simplified schematic of the various systems for processing of radioactive gaseous waste and ventilation paths is shown in Figure 3.5.2.

The primary source of gaseous radioactive waste will be the non-condensible gases removed from the primary coolant through the main condenser by the air ejector. These gases will consist of a small amount of air which has leaked into the condenser (approximately 20 cfm), and approximately 5 times as much hydrogen and oxygen produced by the radiolytic decomposition of water, with very small volumes of radioactive gases, primarily krypton and xenon. Other sources of airborne radioactivity include the non-condensible radioactive gases removed from the turbine gland seal condenser and those from the reactor building, turbine building, and radwaste building ventilation systems. Additional potentially radioactive gases include the off-gas removed from the main condenser during startup by the mechanical vacuum pump, and the off-gas from purging the drywell and suppression chamber during shutdowns.

The gases removed from the main condenser by the air ejectors will be processed in a gas delay system consisting of two redundant catalytic H_2-O_2 recombiners to convert these gases to water in order to reduce the volume of gases to be treated; a condenser to remove the water vapor; a 30-min holdup pipe to permit the decay of short-lived radioactive gases; and 12 beds each containing 3 tons of activated charcoal wherein xenons and kryptons will be adsorbed and delayed selectively, thereby permitting a significant reduction by radioactive decay. The residual gases will be released through a HEPA filter to the environs through the 100-meter, main off-gas stack.

According to our calculations, the expected delay for krypton will be 18.2 hours and for xenon 13.6 days. The gases are expected to be dried to a 45°F dew point and the beds to be maintained at 77°F. The applicant has calculated delay periods of 19 hours for krypton and 15 days for xenon.

Primary system steam will be used in the turbine gland seal system; hence, the gases released from the turbine gland seal condenser can be radioactive.

These gases will be held up approximately 1.8 minutes before being exhausted into the off-gas stack without further treatment.

During unit startup, air and any radioactive gases present will be removed from the main condenser by a mechanical vacuum pump. It is assumed that the pump will operate about 10 hours per year, and while the composition of the exhaust gases will vary depending upon shutdown time, the quantity expected will not exceed 1% of the normal amount of gas released to the stack. These gases will be discharged through the same holdup pipe into which the turbine gland seal condenser exhausts. The gases will be released through the main stack without further treatment.

The ventilation air from the reactor building will normally be discharged through the reactor building vent without treatment. The flow will be monitored, and the building will be isolated if the activity exceeds a preset level. During building isolation, air flow will be reduced to 4,000 cfm and directed through the Standby Gas Treatment System (SGTS) before release through the main stack. The SGTS will consist of a pre-filter, a HEPA filter, a charcoal adsorber, and another HEPA filter in series.

The drywell and suppression chambers will be isolated during normal reactor operation. However, during shutdowns and startups associated with refueling maintenance these areas will be purged, with the gases exhausting through the Standby Gas Treatment System, or directly to the main stack if the activity is low. The expected release from this operation is insignificant. A requirement for a quarterly test of the High Pressure Coolant Injection Pump necessitates the use of primary steam as the turbine power source. As shown on the drawing, this gland seal steam is condensed and the vented gases directed through the STGS system. As an additional source of radioactivity release, this is considered to be negligible.

The ventilation air flow rate through the Turbine Building will vary from approximately 41,000 cfm in the winter to approximately 112,000 cfm in the summer. Approximately 41,000 cfm of potentially contaminated air will be constantly exhausted from the lower areas of the turbine building to the reactor building vent. The balance of the air flow through the upper turbine building for heat removal in summer will be exhausted unfiltered through roof outlets. The exhaust air from the Radwaste Building will pass through prefilters and HEPA filters before discharging to the reactor building drywell where it is exhausted to the reactor building vent. All of the ventilation systems will be designed to operate at negative pressure and air will flow from clean regions to areas of higher contamination potential.

Table 3.5.3 lists the results of our calculations of annual gaseous effluents based upon the conditions listed in Table 3.5.1. This table indicates an expected annual release of noble gases of about 33,000 Ci.

Based on use of the charcoal delay system and an off-gas rate of 25,000 microcuries/second, the applicant has estimated an annual release of about 17,000 Ci. of noble gases. In addition we estimate an annual release of 0.6 curie of I-131 coming mainly from expected steam leaks in the turbine building. No similar estimate has been made by the applicant.

3.5.3 Solid Radwaste System

The solid waste handling system is designed to collect, monitor, process, package and provide temporary storage for radioactive solid wastes prior to offsite shipment and disposal in accordance with applicable regulations. Solid wastes will be grouped under two categories, wet and dry.

Wet wastes will consist of spent demineralizer resins, filter sludges and evaporator bottoms. Because of differences in radioactivity or contamination levels of the many wastes, various methods will be employed for processing and packaging. The waste from the evaporator bottoms will be solidified and drummed.

Standard 55-gallon steel drums will be used for packaging solid wastes because of their ready availability, ease of handling, and conformance with present shipping practices. Spent resins and filter sludges will be held for radioactive decay in the phase separators or sludge tanks and will then be transferred to one of two centrifuges where the excess water will be removed. The solids will be discharged by gravity to a hopper below each centrifuge. Drums will be filled from the hoppers. The excess back wash water from the phase separators, sludge tanks and centrifuges will be transferred to the liquid radwaste system for processing.

After filling, the drums will be moved to the capping station where lids will be remotely placed on the drums and secured in place under manual control of an operator. After capping, decontamination and monitoring the drums will be moved to the storage area to await shipment by a licensed carrier to a licensed disposal site in accordance with applicable regulations. Loading of drums for offsite shipment will be done within the confines of the radwaste building.

Typical dry solid wastes will include air filters, miscellaneous paper, rags from contaminated areas, contaminated clothing, tools, and equipment parts, and solid laboratory wastes. The disposition of a particular item of waste will be determined by its radiation level, type and the availability of disposal space. Material which can be compressed will be compacted into 55-gallon drums by a hydraulic press. Some solid wastes will be handled manually because of low radioactivity content or minimal contamination levels. Except for used reactor components, generally, solid wastes need to be held on site only until quantities large enough for economical shipment are accumulated.

The applicant estimates the weight and volume of waste, concentrates exclusive of evaporator bottoms, to be respectively about 63,000 pounds and

2,200 cubic feet per year. The applicant expects the total isotopic inventory of these solids to be about 1000 curies per year. We estimate that approximately 500 drums of spent resins, filter sludges and evaporator bottoms and 250 drums of dry and compacted waste will be shipped offsite at a total activity of approximately 1500 curies per year after 180 days of storage.

TABLE 3.5.1

PRINCIPAL CONDITIONS AND ASSUMPTIONS USED IN ESTIMATING
RADIOACTIVE RELEASES FROM DUANE ARNOLD ENERGY CENTER

Power	1658 MWt
Plant Capacity Factor	0.8
Operating Power Fission Source Term	Equivalent to 100,000 μCi/sec with 30 min holdup for a 3400 MWt reactor
Total Steam Flow	7,150,000 lb/hr
Weight of Liquid in the System	1,538,000 lb
Weight of Steam in the System	28,320 lb
Cleanup Demineralizer Flow	77,000 lb/hr
Containment Purges	4 per year
Leaks	
Reactor Bldg.	480 lb/hr
Turbine Bldg.	1,700 lb/hr
Condenser Air Inleakage	20 cfm
Gland Seal Flow	7,150 lb/hr
Iodine Partition Coefficients	
Steam/Liquid in Reactor	0.012
Reactor Bldg. Liquid Leak	0.001
Turbine Bldg. Steam Leak	1
Gland Seal	1
Air Ejector	0.005
Air Ejector Recombiner System	0.01
Condensate Demineralizer	0.0016
Cleanup Demineralizer	0.1
Gland Seal Condenser	0.01
Holdup Times	
Gland Seal Gas	0.03 hr
Air Ejector Gas	0.5 hr

TABLE 3.5.1 (Continued)

Charcoal Delay Holdup Time for	
Kryptons	0.76 days
Xenons	13.6 days

Decontamination Factors

	I	Cs,Rb	Y	Mo,Tc	Others
High Purity Waste	10^2	10	10	10^2	10^2
Low Purity Waste	10^2	1	10	10^2	10^2
Chemical Waste	10^2	10^3	10^4	10^5	10^3

TABLE 3.5.2

ESTIMATED ANNUAL RELEASES OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS FROM DUANE ARNOLD ENERGY CENTER

Nuclide	Curies/yr	Nuclide	Curies/yr
Rb-86	0.00096	I-130	0.0020
Sr-89	0.075	I-131	0.132
Sr-90	0.0046	I-132	0.027
Sr-91	0.0765	I-133	0.318
Y-90	0.027	I-135	0.093
Y-91m	0.050	Cs-134	0.555
Y-91	0.163	Cs-136	0.225
Y-92	0.142	Cs-137	0.450
Y-93	0.451	Ba-137m	0.43
Zr-95	0.00096	Ba-140	0.140
Zr-97	0.00096	La-140	0.062
Nb-95	0.00088	La-141	0.004
Nb-97m	0.00088	Ce-141	0.0026
Nb-97	0.00096	Ce-143	0.0027
Mo-99	0.093	Ce-144	0.00056
Tc-99m	0.085	Pr-143	0.00096
Ru-103	0.00074	Pr-144	0.00056
Ru-106	0.00030	Nd-147	0.00034
Rh-103m	0.00074	Pm-147	0.00008
Rh-105	0.001	Pm-151	0.0001
Rh-106	0.00030	Sm-153	0.0002
Sb-127	0.000062	Cr-51	0.018
Te-125m	0.000039	Mn-54	0.0015
Te-127m	0.00022	Fe-55	0.074
Te-127	0.00022	Fe-59	0.0030
Te-129m	0.00088	Co-58	0.178
Te-129	0.00059	Co-60	0.018
Te-131m	0.0025	Zn-65	0.000037
Te-131	0.00049	Zn-69	0.00027
Te-132	0.022	W-187	0.053
		Na-24	0.018
		P-32	0.00074
		Np-239	0.0144

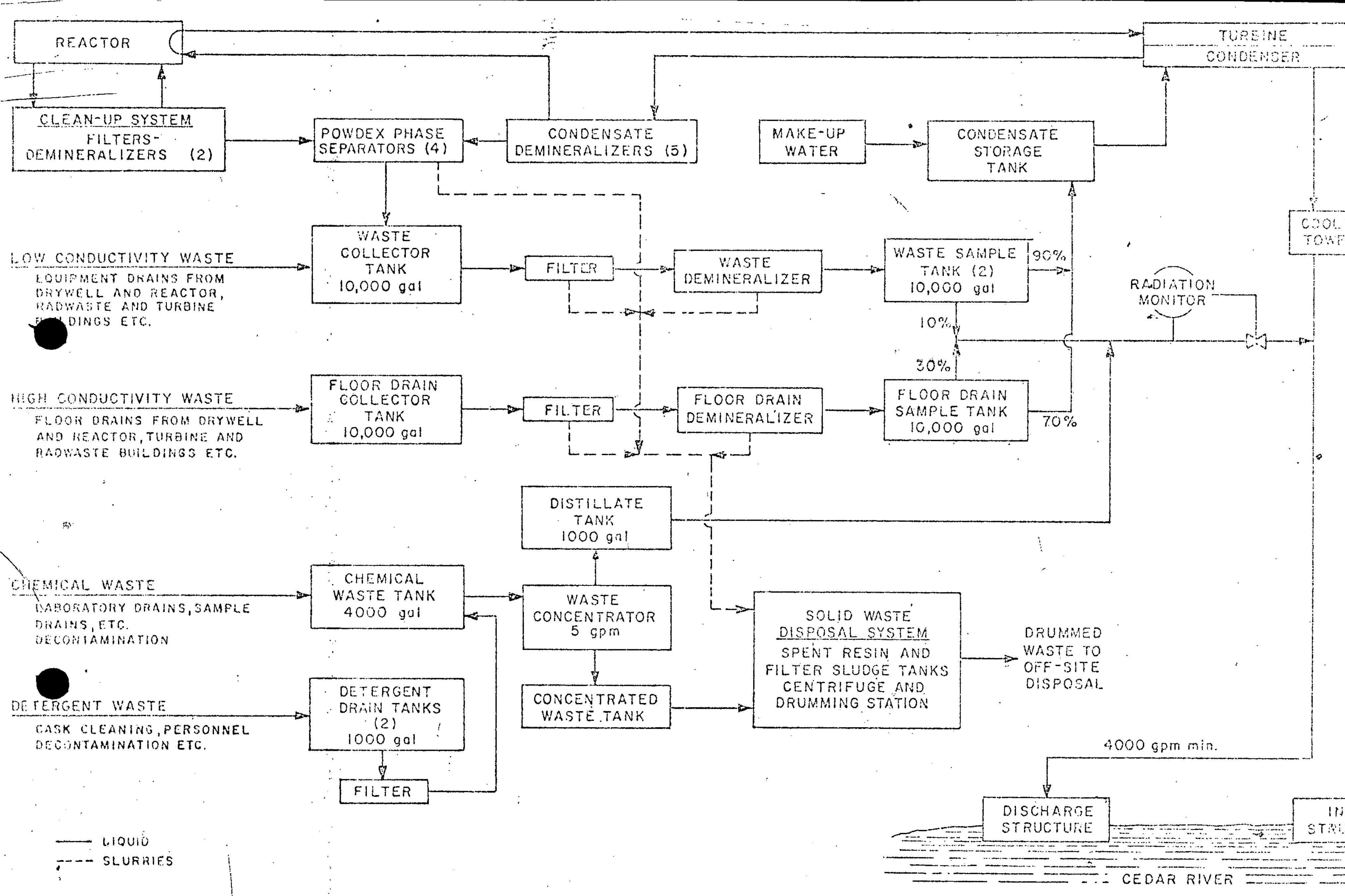
Total (excluding tritium)	4.0 curies
Tritium	20 curies

Note: Isotopes having an estimated release of less than 10^{-5} curies/yr. have not been included.

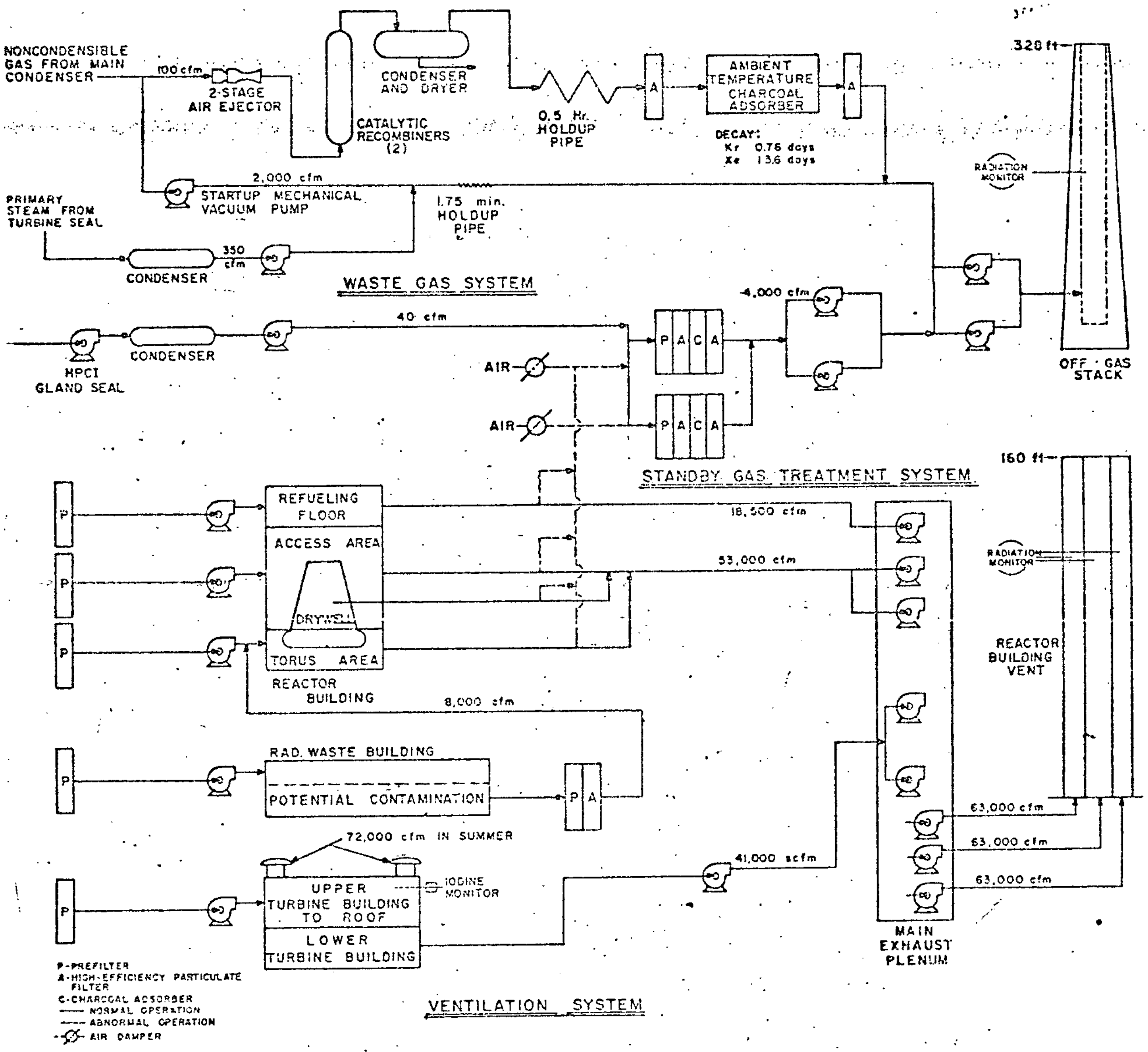
TABLE 3.5.3

Calculated Annual Release of Radioactive Gaseous Effluents from the Duane Arnold Energy Center Reactor

Nuclide	Curies per year					
	Mechanical Vacuum Pump	Reactor Bldg.	Turbine Bldg.	Gland Seal	Air Ejector	Total
Kr-83m	--	--	10	41	39	90
Kr-85m	--	--	16	69	3,600	3,600
Kr-85	--	--	--	--	360	360
Kr-87	--	--	49	200	7	260
Kr-88	--	--	53	220	2,200	2,500
Kr-89	--	--	17	490	--	500
Xe-131m	--	--	--	--	140	140
Xe-133m	--	--	1	4	68	70
Xe-133	1,445	--	29	120	20,600	22,000
Xe-135m	--	--	82	320	--	400
Xe-135	215	--	84	350	--	650
Xe-137	--	--	290	900	--	1,200
Xe-138	--	--	260	1,020	--	1,300
Total Noble Gases						33,160
I-131	--	0.012	0.547	0.041	--	0.6
I-133	--	0.041	2.54	0.214	--	2.8



LIQUID RADIOACTIVE WASTE
DUANE ARNOLD ENERGY CENTER



DUANE ARNOLD ENERGY CENTER
NUCLEAR POWER PLANT