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11.0 RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

General Electric has evaluated radioactive material sources (activation products and fission product release from fuel) in operating boiling water reactors (BWRs) over the past decade. These source terms are reviewed and periodically revised to incorporate up-to-date information. Release of radioactive material from operating BWRs has resulted in doses to offsite persons which have been only a small fraction of 10 CFR 20, or of natural background dose.

The information provided in this section defines the design basis radioactive material levels in the reactor water, steam and off-gas. The various radioisotopes listed have been grouped as coolant activation products, non-coolant activation products, and fission products. The fission product levels are based on measurements of BWR reactor water and off-gas at several stations through mid-1971. Emphasis was placed on observations made at KRB and Dresden 2. The design basis radioactive material levels do not necessarily include all the radioisotopes observed or predicted theoretically to be present. The radioisotopes included are considered significant to one or more of the following criteria:

a. Plant equipment design.

b. Shielding design.

c. Understanding system operation and performance.

d. Measurement practicability.

e. Evaluation of radioactive material releases to the environment.

For halogens, radioisotopes with half-lives of less than three minutes were omitted. For other fission product radioisotopes in reactor water, radioisotopes with half-lives of less than 10 minutes were not considered.

11.1.1 FISSION PRODUCTS

11.1.1.1 Noble Radiogas Fission Products

The noble radiogas fission product source terms observed in operating BWRs are generally complex mixtures; the sources of which vary from miniscule defects in cladding to "tramp" uranium on external cladding surfaces. The relative concentrations or amounts of noble radiogas isotopes can be described as follows:

$$\text{Equilibrium:} \quad R_g \approx k_1 y \tag{11.1-1}$$

$$\text{Recoil:} \quad R_g \approx k_2 y \lambda \tag{11.1-2}$$

The nomenclature in Section 11.1.1.4 defines the terms in these and succeeding equations. The constants k_1 and k_2 describe the fractions of the total fissions that are involved in each of the releases. The equilibrium and recoil mixtures are the two extremes of the mixture spectrum that are physically possible. When a sufficient time delay occurs between the fission event and the time of release of the radiogases from the fuel to the coolant, the radiogases approach equilibrium levels in the fuel and the equilibrium mixture results. When there is no delay or impedance between the fission event and the release of the radiogases, the recoil mixture is observed.

Prior to Vallecitos Boiling Water Reactor (VBWR) and Dresden 1 experience, it was assumed that noble radiogas leakage from the fuel would be the equilibrium mixture of the noble radiogases present in the fuel.

VBWR and early Dresden 1 experience indicated that the actual mixture most often observed approached a distribution which was intermediate in character to the two extremes[1]. This intermediate decay mixture was termed the "diffusion" mixture. It must be emphasized that this "diffusion" mixture is merely one possible point on the mixture spectrum ranging from the equilibrium to the recoil mixture and does not have the absolute mathematical and mechanistic basis for the calculational methods possible for equilibrium and recoil mixtures. However, the "diffusion" distribution pattern which has been described is as follows:

$$\text{Diffusion:} \quad R_g \approx k_3 y \lambda^{0.5} \qquad (11.1\text{-}3)$$

The constant, k_3, describes the fraction of total fissions that are involved in the release. The value of the exponent of the decay constant, λ, is midway between the values for equilibrium, 0, and recoil, 1. The "diffusion" pattern value of 0.5 was originally derived from diffusion theory.

Although the previously described "diffusion" mixture has been used by GE as a basis for design since 1963, the design basis release magnitude used has varied from 0.5 Ci/sec to 0.1 Ci/sec as measured after 30 minute decay (t = 30 min). The noble radiogas source term rate after 30 minute decay has been used as a conventional measure of the design basis fuel leakage rate since it is conveniently measurable and was consistent with the nominal design basis 30 minute off-gas holdup system used on a number of plants. Since about 1967, the design basis release magnitude used (including the 1971 source terms) has been established at an annual average of 0.1 Ci/sec (t = 30 min). This design basis is considered as an annual average with some time above and some time below this value. This design value was selected on the basis of operating experience rather than predictive assumptions. Several judgment factors, including the significance of environmental release, reactor water radioisotope concentrations, liquid waste handling and effluent disposal criteria, building air contamination, shielding design and other component contamination affecting maintenance, have been considered in establishing this level.

Noble radiogas source terms from fuel above 0.1 Ci/sec (t = 30 min) can be tolerated for reasonable periods of time. Continual assessment of these values is made on the basis of actual operating experience in BWRs.[2]

While the noble radiogas source term magnitude was established at 0.1 Ci/sec (t = 30 min), it was recognized that there may be a more statistically applicable distribution for the noble radiogas mixture. Sufficient data were available from KRB operations from 1967 to mid-1971 along with Dresden 2 data from operation in 1970 and several months in 1971 to more accurately characterize the noble radiogas mixture pattern for an operating BWR.

The basic equation for each radioisotope used to analyze the collected data is:

$$R_g = K_g y \lambda^m \left(1 - e^{-\lambda T}\right) \left(e^{-\lambda t}\right) \qquad (11.1\text{-}4)$$

With the exception of Kr-85 with a half-life of 10.74 years, the noble radiogas fission products in the fuel are essentially at an equilibrium condition after an irradiation period of several months (rate of formation is equal to the rate of decay). So for practical purposes the term $(1 - e^{-\lambda T})$ approaches 1 and can be neglected when the reactor has been operating at a steady-state for long periods of time. The term $(e^{-\lambda t})$ is used to adjust the releases from the fuel (t = 0) to the decay time for which values are needed. Historically, t equal to 30 minutes has been used. When discussing long steady-state operation and leakage from the fuel (t = 0), the following simplified form of Equation 11.1-4 can be used to describe the leakage of each noble radiogas:

$$R_g = K_g y \lambda^m \qquad (11.1\text{-}5)$$

The constant, K_g, describes the magnitude of leakage. The relative rates of leakage of the different noble radiogas isotopes is accounted for by the variable, m, the exponent of the decay constant, λ.

Dividing both sides of Equation 11.1-5 by y, the fission yield, and taking the logarithm of both sides results in the following equation:

$$\log (R_g/y) = m \log (\lambda) + \log (K_g) \qquad (11.1\text{-}6)$$

Equation 11.1-6 represents a straight line when log R_g/y is plotted versus log (λ); m is the slope of the line. This straight line is obtained by plotting (R_g/y) versus (λ) on logarithmic graph paper.

By fitting actual data from KRB and Dresden 2 (using least squares techniques) to the equation, the slope, m, can be obtained. This can be estimated on the plotted graph. With radiogas leakage at KRB over the nearly 5 year period varying from 0.001 to 0.056 Ci/sec (t = 30 min) and with radiogas leakage at Dresden 2 varying from 0.001 to 0.169 Ci/sec (t = 30 min), the average value of m was determined. The value for $\bar{m}$ is 0.4 with a standard deviation of ±0.07. This is illustrated in Figure 11.1-1 as a frequency histogram. As can be seen from this figure, variations in m were observed in the range m equal to 0.1 to m equal to 0.6. After establishing the value of m equal to 0.4, the value of K_g can be calculated by selecting a value for R_g, or as has been done historically, the design basis is set by the total design basis source term magnitude at t equal to 30 minutes. With ΣR_g at 30 minutes equal to 100,000 μCi/sec, K_g can be calculated as being 2.6×10^7 and Equation 11.1-4 becomes:

$$R_g = 2.6 \times 10^7 \ y\lambda^{0.4}(1 - e^{-\lambda T}) \ (e^{-\lambda t}) \qquad (11.1\text{-}7)$$

This updated noble radiogas source term mixture has been termed the "1971 Mixture" to differentiate it from the "diffusion mixture". The noble gas source term for each radioisotope can be calculated from Equation 11.1-7. The resultant source terms are presented in Table 11.1-1 as leakage from fuel (t = 0) and after 30 minute decay. While Kr-85 can be calculated using Equation 11.1-7, the number of confirming experimental observations was limited by the difficulty of measuring very low release rates of this isotope. Therefore, the table provides an estimated range for Kr-85 based on a few actual measurements.

Normal operational releases to the primary coolant are expected to be approximately 25,000 μCi/sec of the thirteen commonly considered noble gases, as evaluated at 30 minutes, and 100 μCi/sec of I-131. These values can be compared to the design base value of 100,000 μCi/sec for the summation of the same thirteen and 700 μCi/sec for I-131. Table 11.1-2 presents the source terms released to the reactor pressure vessel as a consequence of a power isolation event, which is the only anticipated operational occurrence in which significant activity is expected to be released.

11.1.1.2 Radiohalogen Fission Products

Historically, the radiohalogen design basis source term was established by the same equation as that used for noble radiogases. In a fashion similar to that used with gases, a simplified equation can be shown to describe the release of each halogen radioisotope:

$$R_h = K_h y \lambda^n \qquad (11.1\text{-}8)$$

The constant, K_h, describes the magnitude of leakage from fuel. The relative rates of halogen radioisotope leakage are expressed in terms of n, the exponent of the decay constant, λ. As was done with the noble radiogases, the average value was determined for n. The value for $\bar{n}$ is 0.5 with a standard deviation of ±0.19. This is illustrated in Figure 11.1-2 as a frequency histogram. As can be seen from this figure, variations in n were observed in the range of n equal to 0.1 to n equal to 0.9.

It appeared that the use of the previous method of calculating radiohalogen leakage from fuel was overly conservative. Figure 11.1-3 relates KRB and Dresden 2 noble radiogas versus I-131 leakage. While it can be seen from Dresden 2 data during the period August 1970 to January 1971 that there is a relationship between noble radiogas and I-131 leakage under one fuel condition, there was no simple relationship for all fuel conditions experienced. Also, it can be seen that during this period, high radiogas leakages were not accompanied by high radioiodine leakage from the fuel. Except for one KRB datum point, all steady-state I-131 leakages observed at KRB or Dresden 2 were equal to or less than 505 μCi/sec. Even at Dresden 1 in

March 1965, when severe defects were experienced in stainless-steel-clad fuel, I-131 leakages greater than 500 μCi/sec were not experienced. Figure 11.1-3 shows that these higher radioiodine leakages from the fuel were related to noble radiogas source terms of less than the design basis value of 0.1 Ci/sec (t = 30 min). This may be partially explained by inherent limitations due to internal plant operational problems that caused plant derating.

In general, it would not be anticipated that operation at full power would continue for any significant time period with fuel cladding defects which would be indicated by I-131 leakage from the fuel in excess of 700 μCi/sec. When high radiohalogen leakages are observed, other fission products will be present in greater amounts.

Using these judgment factors and experience to date, the design basis radiohalogen source terms from fuel were established based on I-131 leakage of 700 μCi/sec. This value, as seen in Figure 11.1-3, accommodates the experience data and the design basis noble radiogas source term of 0.1 Ci/sec (t = 30 min). With the I-131 design basis source term established, K_h can be calculated as being 2.4×10^7 and halogen radioisotope release can be expressed by the following equation:

$$R_h = 2.4 \times 10^7 \ y\lambda^{0.5} \ (1 - e^{-\lambda T}) \ (e^{-\lambda t}) \qquad (11.1\text{-}9)$$

Concentrations of radiohalogens in reactor water can be calculated using the following equation:

$$C_h = \frac{R_h}{(\lambda+\beta+\gamma)M} \qquad (11.1\text{-}10)$$

Although carryover of most soluble radioisotopes from reactor water to steam is observed to be less than 0.1 percent (<0.001 fraction), the observed "carryover" for radiohalogens has varied from 0.1 percent to about 2 percent on newer plants. The average of observed radiohalogen carryover measurements has been 1.2 percent by weight of reactor water in steam, with a standard deviation of ±0.9. In the present source term definition, a radiohalogen carryover of 2 percent (0.02 fraction) was used.

The halogen release rate from the fuel can be calculated from Equation 11.1-9. Concentrations in reactor water can be calculated from Equation 11.1-10. The resultant concentrations are presented in Table 11.1-3.

11.1.1.3 Other Fission Products

The observations of other fission products (and transuranic nuclides, including Np-239) in operating BWRs are not adequately correlated by simple equations. For these radioisotopes, design basis concentrations in reactor water have been estimated conservatively from experience data and are presented in Table 11.1-4. Carryover of these radioisotopes from the reactor water to the steam is estimated to be less than 0.1 percent (<0.001 fraction). In addition to carryover, however, decay of noble radiogases in the steam leaving the reactor results in production of noble gas daughter radioisotopes in the steam and condensate systems.

Some daughter radioisotopes (e.g., yttrium and lanthanum), were not listed as being in reactor water. Their independent leakage to the coolant is negligible; however, these radioisotopes may be observed in some samples in equilibrium or approaching equilibrium with the parent radioisotope.

Except for Np-239, trace concentrations of transuranic isotopes have been observed in only a few samples where extensive and complex analyses were carried out. The predominant alpha emitter present in reactor water is Cm-242 at an estimated concentration of 10^{-6} μCi/g or less, which is below the maximum permissible concentration in drinking water applicable to continuous use by the general public. The concentration of alpha emitting plutonium radioisotopes is more than one order of magnitude lower than that of Cm-242.

Plutonium-241 (a beta emitter) may also be present in concentrations comparable to the Cm-242 level.

11.1.1.4 Nomenclature

The following list of nomenclature defines the terms used in equations for source term calculations:

R_g = Leakage rate of a noble gas radioisotope (μCi/sec).

R_h = Leakage rate of a halogen radioisotope (μCi/sec).

y = Fission yield of a radioisotope (atoms/fission).

λ = Decay constant of a radioisotope (sec^{-1}).

T = Fuel irradiation time (sec).

t = Decay time following leakage from fuel (sec).

m = Noble radiogas decay constant exponent (dimensionless).

n = Radiohalogen decay constant exponent (dimensionless).

K_g = A constant establishing the level of noble radiogas leakage from fuel.

K_h = A constant establishing the level of radiohalogen leakage from fuel.

C_h = Concentration of a halogen radioisotope in reactor water (μCi/g).

M = Mass of water in the operating reactor (g).

B = Cleanup system removal constant (sec^{-1}), defined as follows:

$$B = \frac{\text{cleanup system flowrate (g/sec)}}{M(g)}$$

g = Grams mass.

γ = Halogen steam carryover removal constant (sec^{-1}), defined as follows:

$$\gamma = \frac{\left[\dfrac{\text{concentration of halogen radioisotope in steam } (\mu Ci/g)}{C_h \ (\mu Ci/g)}\right]\left[\text{steam flow (g/sec)}\right]}{M(g)}$$

11.1.2 ACTIVATION PRODUCTS

11.1.2.1 Coolant Activation Products

The coolant activation products are not adequately correlated by simple equations. Design basis concentrations in reactor water and steam have been estimated conservatively from experience data. The resultant concentrations are presented in Table 11.1-5.

11.1.2.2 Noncoolant Activation Products

The activation products formed by activation of impurities in the coolant or by corrosion of irradiated system materials are not adequately correlated by simple equations. The design basis source terms of noncoolant activation products have been estimated conservatively from experience data. The resultant concentrations are presented in Table 11.1-6. Carryover of these isotopes from the reactor water to the steam is estimated to be less than 1 percent (<0.01 fraction).

11.1.2.3 Steam and Power Conversion System N-16 Inventory

Steam and power conversion system N-16 inventories are given in Section 12.2.1.

11.1.3 TRITIUM

In a BWR, tritium is produced by three principal methods:

a. Activation of naturally occurring deuterium in the primary coolant.

b. Nuclear fission of UO_2 fuel.

c. Neutron reactions with boron used in reactivity control rods.

The tritium, formed in control rods, which may be released from a BWR in liquid or gaseous effluents, is believed to be negligible. A prime source of tritium available for release from a BWR is that produced from activation of deuterium in the primary coolant. Some fission product tritium may also transfer from fuel to primary coolant. This discussion is limited to the uncertainties associated with estimating the amounts of tritium generated in a BWR which are available for release.

All of the tritium produced by activation of deuterium in the primary coolant is available for release in liquid or gaseous effluents. The tritium formed in a BWR from deuterium activation can be calculated using the equation:

$$R_{act} = \frac{\Sigma \phi V \lambda}{3.7 \times 10^4 P} \qquad (11.1\text{-}11)$$

Where:

R_{act} = Tritium formation rate by deuterium activation (μCi/sec/MWt)
Σ = Macroscopic thermal neutron cross section (cm^{-1})
ϕ = Thermal neutron flux (neutrons/(cm^2) (sec))
V = Coolant volume in core (cm^3)
λ = Tritium radioactive decay constant (1.78×10^{-9} sec^{-1})
P = Reactor power level (MWt)

For recent BWR designs, R_{act} is calculated to be $1.3 \pm 0.4 \times 10^{-4}$ μCi/sec/MWt. The uncertainty indicated is derived from the estimated errors in selecting values for the coolant volume in the core, coolant density in the core, abundance of deuterium in light water (some additional deuterium is present due to the H(n,γ) D reaction), thermal neutron flux, and microscopic cross section for deuterium.

The fraction of tritium produced by fission which may transfer from fuel to the coolant (which is then available for release in liquid and gaseous effluents) is more difficult to estimate. However, since zircaloy-clad fuel rods are used in BWRs, essentially all fission product tritium remains in the fuel rods unless defects are present in the cladding material (Reference 3).

The study made at Dresden 1 in 1968 by the U.S. Public Health Service (USPHS) suggests that essentially all of the tritium released from the plant could be accounted for by the deuterium activation source.[4] For purposes of estimating the leakage of tritium from defective fuel, it can be assumed that it leaks in a manner similar to the leakage of noble radiogases. Thus, use can be made of the empirical relationship described as the "diffusion mixture," used for predicting the source term of individual noble gas radioisotopes as a function of the total noble gas source term. The equation which describes this relationship is:

$$R_{dif} = Ky\lambda^{0.5} \qquad (11.1\text{-}12)$$

Where:

R_{dif} = Leakage rate of tritium from fuel (μCi/sec)
y = Fission yield fraction (atoms/fission)
λ = Radioactive decay constant (sec^{-1})
K = A constant related to total tritium leakage rate

If the total noble radiogas source term is 10^5 μCi/sec after 30 minute decay, leakage from fuel can be calculated to be about 0.24 μCi/sec of tritium. To place this value in perspective in the USPHS study, the observed rate of Kr-85 (which has a half-life similar to that of tritium) was 0.06 to 0.4 times that calculated using the "diffusion mixture" relationship. This would suggest that the actual tritium leakage rate might range from 0.015 to 0.10 μCi/sec. Since the annual average noble radiogas leakage from a BWR is expected to be less than 0.1 Ci/sec (t = 30 min), the annual average tritium release rate from the fission source can be conservatively estimated at 0.12 ± 0.12 μCi/sec, or 0.0 to 0.24 μCi/sec.

Based on this approach, the estimated total tritium appearance rate in reactor coolant and release rate in the effluent is about 20 Ci/yr.

Tritium formed in the reactor is generally present as tritiated oxide (HTO) and to a lesser degree as tritiated gas (HT). Tritium concentration (on a weight basis) in the steam formed in the reactor is the same as in the reactor water at any given time. This tritium concentration is also present in condensate and feedwater. Since radioactive effluents generally originate from the reactor and power cycle equipment, radioactive effluents also have this tritium concentration. The condensate storage tanks receive treated water from the liquid waste management system and reject water from the condensate system. Thus, all plant process water has a common tritium concentration.

Off-gases released from the plant contain tritium, which is present as tritiated gas (HT) resulting from reactor water radiolysis, as well as HTO. In addition, water vapor from the turbine gland seal steam packing exhauster and a lesser amount present in ventilation air due to process steam leaks or evaporation from sumps, tanks, and spills on floors also contain tritium. The remainder of the tritium leaves the plant in liquid effluents or with solid wastes.

Recombination of radiolysis gases in the air ejector off-gas system forms water, which is condensed and returned to the main condenser. This tends to reduce the amount of tritium leaving in gaseous effluents. Reducing the gaseous tritium release results in a slightly higher tritium concentration in the plant process water. Reducing the amount of liquid effluent discharged also results in a higher process coolant equilibrium tritium concentration.

Essentially, all tritium in the primary coolant is eventually released to the environs, either as water vapor and gas to the atmosphere, or as liquid effluent to the plant discharge or as solid waste. Reduction due to radioactive decay is negligible due to the 12 year half-life of tritium.

The USPHS study at Dresden 1 estimated that approximately 90 percent of the tritium release was observed in liquid effluent, with the remaining 10 percent leaving as gaseous effluent (Reference 4). Efforts to reduce the volume of liquid effluent discharges may change this distribution so that a greater amount of tritium leaves as gaseous effluent. From a practical standpoint, the fraction of tritium leaving as liquid effluent may vary between 60 and 90 percent, with the remainder leaving in gaseous effluent.

11.1.4 FUEL FISSION PRODUCTION INVENTORY AND FUEL EXPERIENCE

11.1.4.1 Fuel Fission Product Inventory

Fuel fission product inventory information is used in establishing fission product source terms for accident analysis and is, therefore, discussed in Chapter 15.

11.1.4.2 Fuel Experience

A discussion of BWR fuel experience, including fuel failure experience, burnup experience, and thermal conditions under which the experience was gained, is presented in References 5, 6, 7, and 8.

11.1.5 PROCESS LEAKAGE SOURCES

Process leakage results in potential release paths for noble gases and other volatile fission products through ventilation systems. Liquid from process leaks is collected and routed to the liquid-solid radwaste system. Radionuclide releases through ventilation paths are at extremely low levels and have been insignificant compared to process off-gas from operating BWR plants. However, because the implementation of improved process off-gas treatment systems makes the ventilation release relatively significant, GE has conducted measurements to identify and qualify these low level release paths. GE has maintained an awareness of other measurements by the Electric Power Research Institute and other organizations and routine measurements by utilities with operating BWRs.

Leakage of fluids from the process system results in the release of radionuclides into plant buildings. In general, the noble radiogases remain airborne and are released to the atmosphere with little delay through the building ventilation exhaust ducts. The radionuclides partition between air and water, and airborne radioiodines may "plate out" on metal surfaces, concrete, and paint. A significant amount of radioiodine remains in air or is desorbed from surfaces. Radioiodines are found in ventilation air as methyl iodide and as inorganic iodine which is here defined as particulate, elemental, and hypoiodous acid forms of iodine. Particulates are also present in the ventilation exhaust air.

The estimated release rate of radioactive materials in gaseous effluents is presented in Section 11.3.3.

11.1.6 LIQUID RADWASTE SYSTEM

Radioactive sources for the liquid radwaste system are described in Section 11.2.3 and are based on information contained in NUREG-0016[9].

11.1.7 RADIOACTIVE SOURCES IN THE GAS TREATMENT SYSTEM

Radioactive sources for the gas treatment system are described in Section 11.3.2.1.2.

11.1.8 SOURCE TERMS FOR COMPONENT FAILURES

11.1.8.1 Off-Gas System Failure

Source terms for evaluation of the radiological consequences of component failures within the off-gas system are described in Appendix 12A.

11.1.8.2 Liquid Radwaste System

Radiation sources used for component failures are consistent with an off-gas release rate of 100,000 μCi/sec after 30 minutes decay. This results in maximum inventories of radioisotopes in the system and is not anticipated to occur during operation of the plant. The isotopic breakdown of the inventory in each significant component of the liquid radwaste system is presented in Table 15.7-12.

11.1.9 REFERENCES FOR SECTION 11.1

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TABLE 11.1-1

NOBLE RADIOGAS SOURCE TERMS

Isotope	Half-Life	Source Term t=0 (μCi/sec)	Source Term t=30 (μCi/sec)
K-83	1.86	3.4 +3	2.9 +3
Kr-85m	4.4 Hr	6.1 +3	5.6 +3
Kr-85	10.74 Yr	10 to 20 (1)	10 to 20 (1)
Kr-87	76 Min	2.0 +4	1.5 +4
Kr-88	2.79 Hr	2.0 +4	1.8 +4
Kr-89	3.18 Min	1.3 +5	1.8 +2
Kr-90	32.3 Sec	2.8 +5	-
Kr-91	8.6 Sec	3.3 +5	-
Kr-92	1.84 Sec	3.3 +5	-
Kr-93	1.29 Sec	9.3 +4	-
Kr-94	1.0 Sec	2.3 +4	-
Kr-95	0.5 Sec	2.1 +3	-
Kr-97	1.0 Sec	1.4 +1	-
Xe-131m	11.96 Day	1.5 +1	1.5 +1
Xe-133m	2.26 Day	2.9 +2	2.8 +2
Xe-133	5.27 Day	8.2 +3	8.2 +3
Xe-135m	15.7 Min	2.6 +4	6.9 +3
Xe-137	3.82 Min	1.5 +5	6.7 +2
Xe-138	14.2 Min	8.9 +4	2.1 +4
Xe-139	40 Sec	2.8 +5	-

TABLE 11.1-1 (Continued)

Isotope	Half-Life	Source Term t=0 (μCi/sec)	Source Term t=30 (μCi/sec)
Xe-140	13.6 Sec	3.0 +5	-
Xe-141	1.72 Sec	2.4 +5	-
Xe-142	1.22 Sec	7.3 +4	-
Xe-143	0.96 Sec	1.2 +4	-
Xe-144	9.0 Sec	5.6 +2	-
Total		Approx. 2.5 +6	Approx. 1.0 +6

NOTE:

1. Estimated from experimental observations.

TABLE 11.1-2

POWER ISOLATION EVENT - ANTICIPATED OCCURRENCE

Isotope	Isotopic Spiking Activity (Ci)/Bundle
I-131	2.1
132	3.2
133	5.0
134	5.4
135	4.8
Kr-83m	0.9
85m	2.2
85	0.5
87	4.3
88	6.1
89	8.0
Xe-131m	0.1
133m	0.3
133	11.6
135m	1.8
135	11.0
137	10.5
138	10.6

TABLE 11.1-3

HALOGEN RADIOISOTOPES IN REACTOR WATER

Isotope	Half-Life	Concentration (μCi/g)
Br-83	2.40 hr	2.8×10^{-2}
Br-84	31.8 min	6.1×10^{-2}
Br-85	3.0 min	6.5×10^{-2}
I-131	8.065 day	2.0×10^{-2}
I-132	2.284 hr	2.6×10^{-1}
I-133	20.8 hr	1.5×10^{-1}
I-134	52.3 min	4.8×10^{-1}
I-135	6.7 hr	2.4×10^{-1}

TABLE 11.1-4

OTHER FISSION PRODUCT RADIOISOTOPES IN REACTOR WATER

Isotope	Half-Life		Concentration (μCi/g)
Sr-89	50.8	day	2.1×10^{-3}
Sr-90	28.9	yr	1.2×10^{-4}
Sr-91	9.67	hr	5.6×10^{-2}
Sr-92	2.69	hr	1.3×10^{-1}
Zr-95	65.5	day	3.0×10^{-5}
Zr-97	16.8	hr	2.7×10^{-4}
Nb-95	35.1	day	3.0×10^{-5}
Mo-99	66.6	hr	2.5×10^{-4}
Tc-99m	6.007	hr	1.5×10^{-1}
Tc-101	14.2	min	1.8×10^{-1}
Ru-103	39.8	day	1.6×10^{-5}
Ru-106	368	day	1.6×10^{-4}
Te-129m	34.1	day	4.5×10^{-6}
Te-132	78.0	hr	1.6×10^{-4}
Cs-134	2.06	yr	1.4×10^{-4}
Cs-136	13.0	day	9.2×10^{-5}
Cs-137	30.2	yr	1.3×10^{-4}
Cs-138	32.3	min	2.7×10^{-2}
Ba-139	83.2	min	8.5×10^{-2}
Ba-140	12.8	day	7.1×10^{-3}

TABLE 11.1-4 (Continued)

Isotope	Half-Life		Concentration (μCi/g)
Ba-141	18.3	min	2.0×10^{-1}
Ba-142	10.7	min	2.0×10^{-1}
Ce-141	32.53	day	3.1×10^{-5}
Ce-143	33.0	hr	1.5×10^{-4}
Ce-144	284.4	day	1.8×10^{-5}
Pr-143	13.58	day	4.0×10^{-5}
Nd-147	11.06	day	1.7×10^{-5}
Np-239	2.35	day	2.1×10^{-1}

TABLE 11.1-5

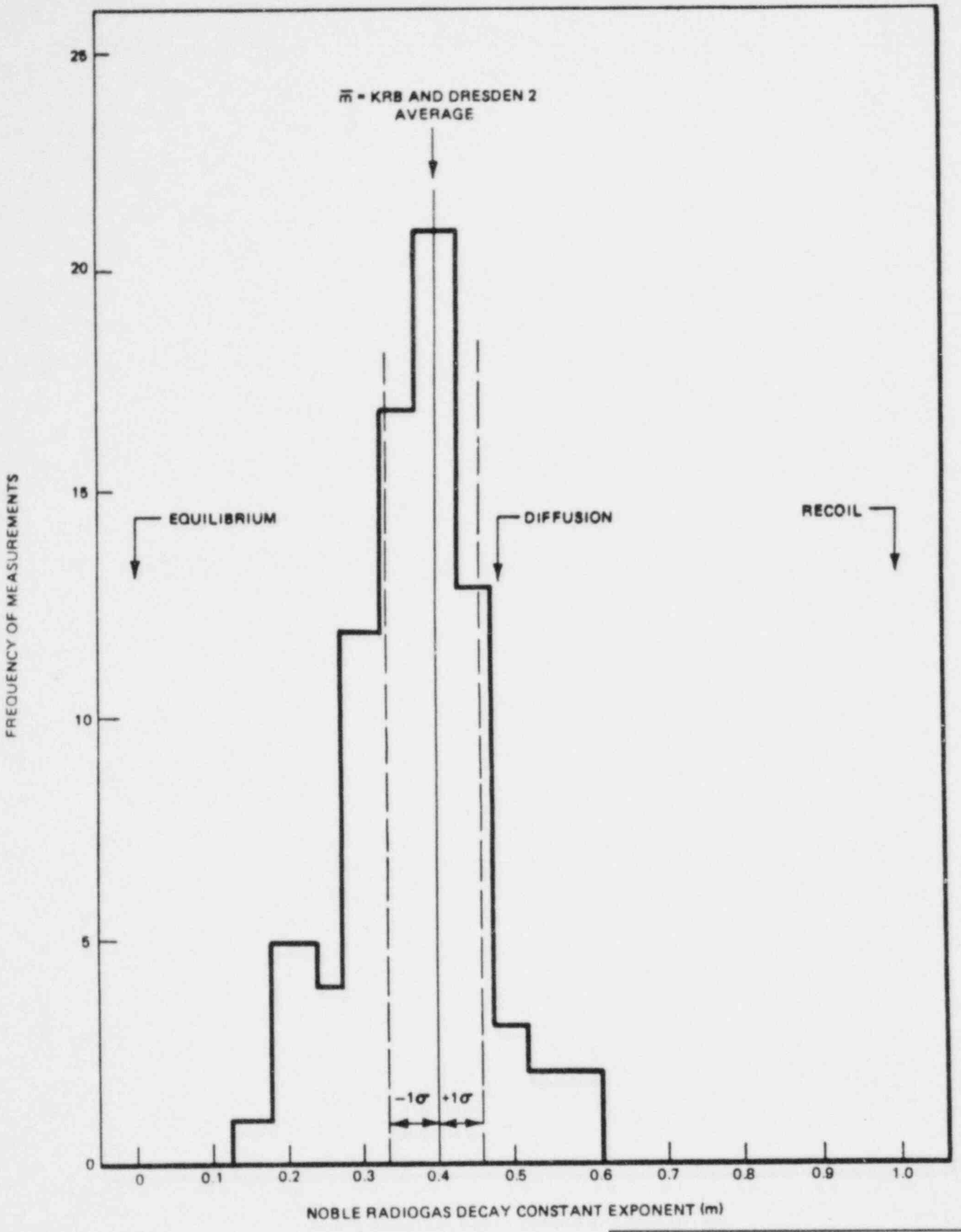
COOLANT ACTIVATION PRODUCTS IN REACTOR WATER AND STEAM

Isotope	Half-Life	Steam Concentration	Reactor Water Concentration
N-13	9.99 Min	1.5 -3	1.0 -1
N-16	7.13 Sec	5.0 -1	3.8 -1
N-17	4.14 Sec	4.0 -2	1.9 -2
O-19	26.8 Sec	6.0 -1	1.4 -0
F-18	109.8 Min	4.4 -4	4.0 -2

TABLE 11.1-6

NONCOOLANT ACTIVATION PRODUCTS IN REACTOR WATER

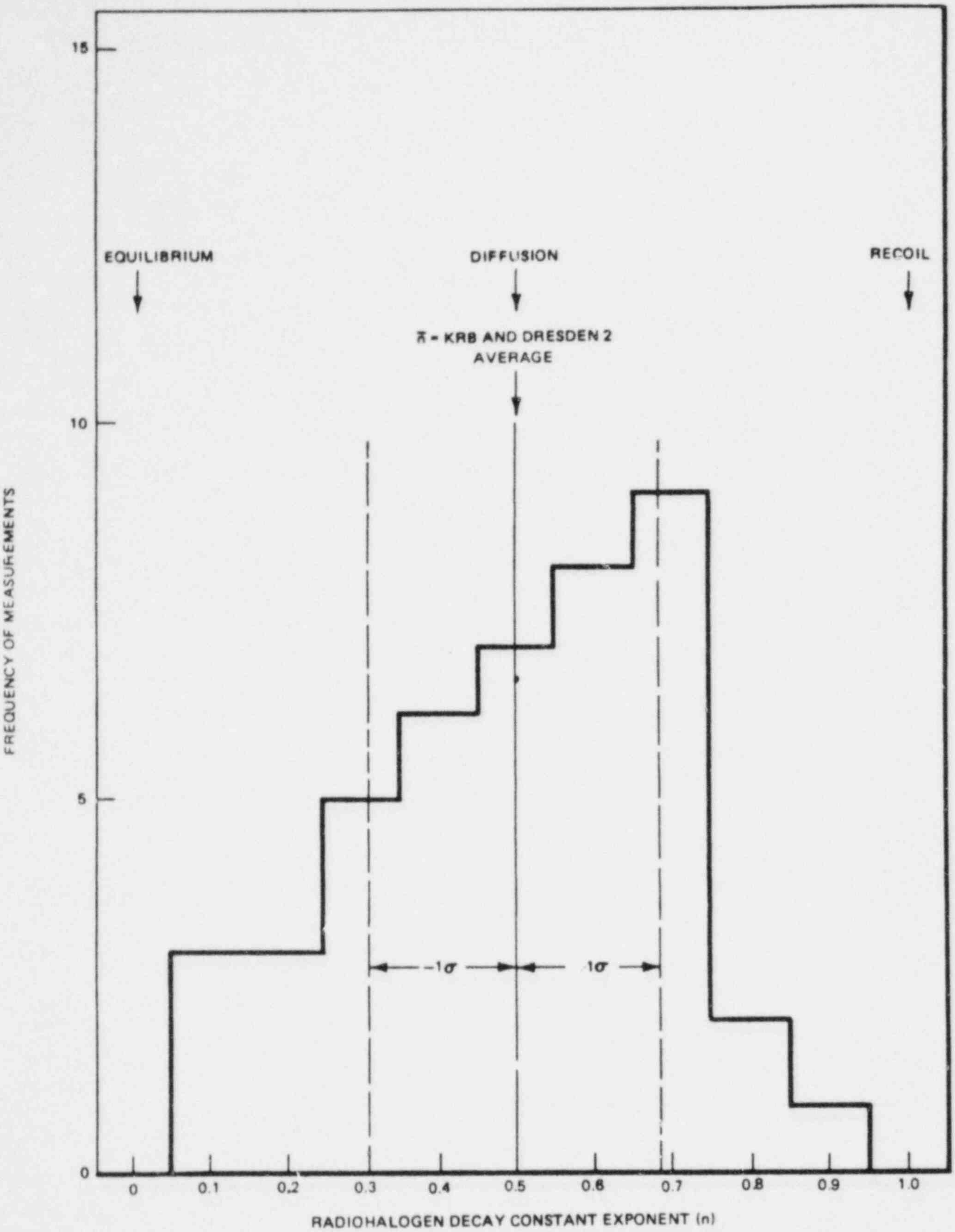
Isotope	Half-Life	Concentration (μCi/g)
Na-24	15.0 Hr	2.0 -3
P-32	14.31 Day	2.0 -5
Cr-51	27.8 Day	5.0 -4
Mn-54	313.0 Day	4.0 -5
Mn-56	2.582 Hr	5.0 -2
Co-58	71.4 Day	5.0 -3
Co-60	5.258 Yr	5.0 -4
Fe-59	45.0 Day	8.0 -5
Ni-65	2.55 Hr	3.0 -4
Zn-65	243.7 Day	2.0 -6
Zn-69m	13.7 Hr	3.0 -5
Aq-110m	253.0 Day	6.0 -5
W-187	23.9 Hr	3.0 -3



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Noble Radiogas Decay Constant Exponent Frequency Histogram

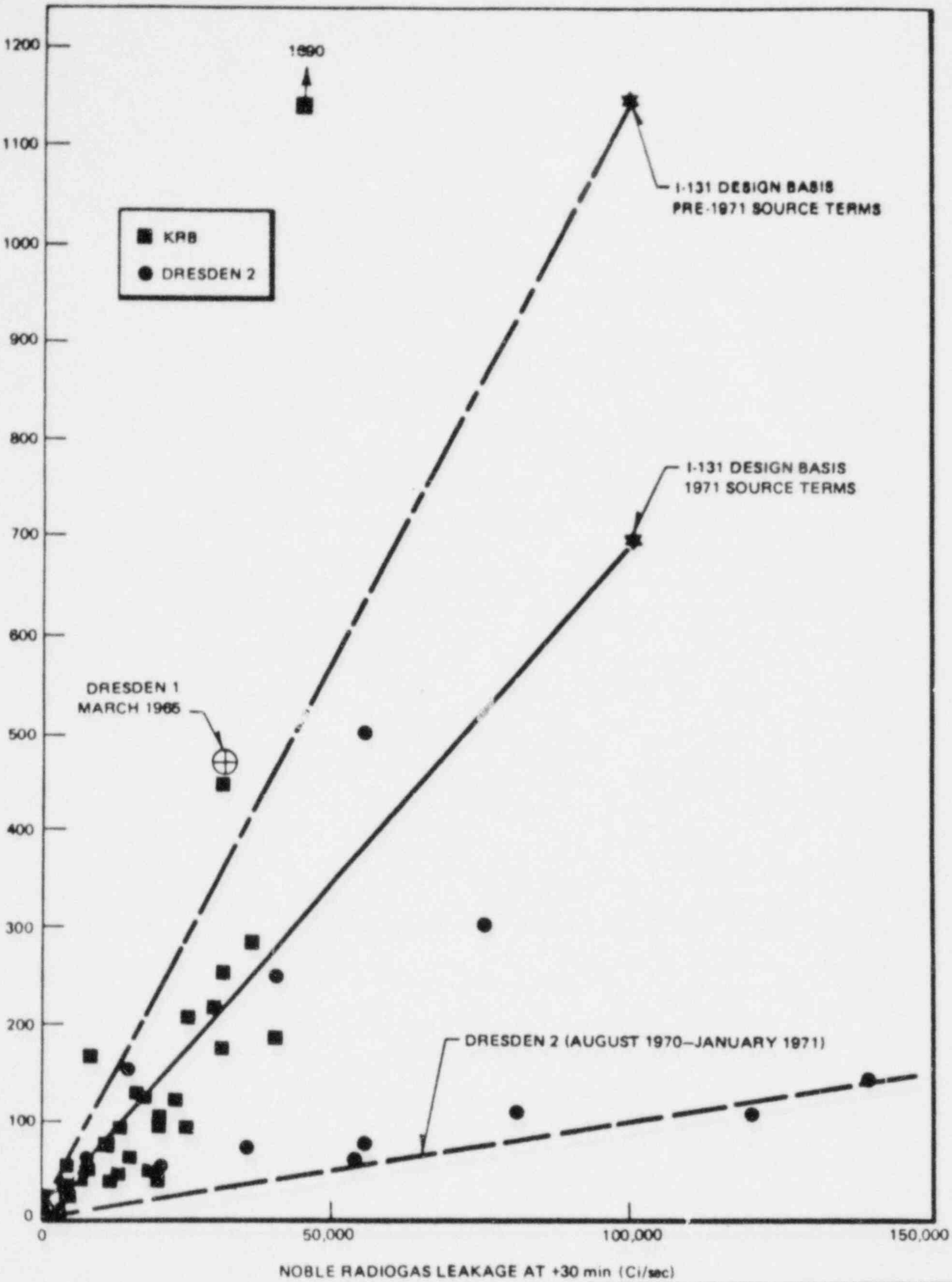
Figure 11.1-1



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Radiohalogen Decay Constant
Exponent Frequency Histogram

Figure 11.1-2



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Noble Radiogas Leakage vs. I-131 Leakage

Figure 11.1-3

11.2 LIQUID WASTE MANAGEMENT SYSTEMS

11.2.1 DESIGN BASES

11.2.1.1 Power Generation Design Objectives

The liquid radioactive waste (LRW) system is designed to collect and treat, for reuse or disposal, all radioactive (or potentially radioactive) liquid wastes produced in the plant. This is done in such a manner that, for all anticipated quantities of waste produced, the availability of the plant for power generation is not adversely affected.

11.2.1.2 Radiological Design Objectives

The LRW system is designed to restrict releases of radioactive material to the environment and exposures to both operating personnel and the general public to "as low as reasonably achievable" (ALARA) in accordance with the guidelines given in Appendix I to 10 CFR 50.

11.2.1.3 Design Criteria

The LRW system is designed in accordance with the following design criteria:

a. For each reactor at the site, the estimated annual total quantity of radioactive material (excluding tritium) above background in the liquid effluents released to unrestricted areas is less than 5 curies.

b. For the total radioactive liquid effluents of Units 1 and 2, the resultant whole body dose to any individual offsite is less than 5 m Rem/yr.

c. Design and construction of all LRW system components satisfies or exceeds the intent of all applicable criteria set forth in Regulatory Guide 1.143 and ANSI N197-1976.

d. All LRW system components and the structure in which they are housed are designed and constructed in accordance with the codes, standards, seismic classifications, and safety classifications listed in Table 3.2-1.

11.2.1.4 Cost-Benefit Analysis

Section 11.2.3 includes an analysis that shows that the LRW system, as designed, is capable of controlling releases of radioactive material within the numerical design objectives of Appendix I to 10 CFR 50. Under the rules of Section II, Paragraph D of Appendix I to 10 CFR 50, a cost-benefit analysis is not required for this system because the design satisfies the "Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors", proposed in the "Concluding Statement of Position of the Regulatory Staff", in Docket-RM-50-2.

11.2.1.5 Accident Analysis

An analysis is included in Chapter 15 to determine the radiological consequences for case situations in which equipment malfunctions and/or operator errors are hypothesized during periods of operation at design basis fuel leakage. Design provisions are included to prevent the uncontrolled release of radioactive material to the environment as a result of any single equipment malfunction or operator error. An evaluation of failures of single pieces of equipment is provided by Table 11.2-1.

11.2.1.6 Component Design Parameters

With the exception of normal wearing parts, such as seals and bearings, all pumps, valves, piping, tanks, pressure vessels and other components in the LRW system are fabricated from materials which are intended to provide a minimum service life of 40 years without replacement. In selecting materials to satisfy this criterion, due consideration is given to the following:

a. The corrosive nat re of both the process fluid and the external envi· nment.

b. Decontaminability of the material.

c. Wall thickness requirements dictated by design pressures, temperatures, flow rates, and corrosion rates.

Tabulations of LRW system components and design parameters are presented by Tables 11.2-2 through 11.2-7.

11.2.1.7 Surge Input Collection Capabilities

Redundancy of equipment for collecting and processing inputs to the LRW system is described in detail in Section 11.2.2 and summarized by Table 11.2-8. Considerable excess capacity is built into the collecting and processing equipment of each subsystem to handle all anticipated normal and maximum input quantities. An evaluation of this capability is presented by Table 11.2-9 which shows that only when the suppression pool is drained for maintenance does the LRW system fall short of needed capacity. This occurrence is satisfactorily handled by reducing the rate at which the suppression pool is drained. This method adds, at most, three days to the outage and results in no increase in radiation exposures to operating personnel or the general public.

11.2.1.8 Control of Tank Leakage and Overflows

With the exception of the condensate storage tank, all tanks containing radioactive material are housed inside reinforced, concrete structures with floor drains for routing tank leakage to the LRW system. A seismically qualified retaining structure (dike) surrounds each condensate storage tank to contain any leakage from this source. Further information on these dikes is provided in Section 9.2.6.

All tanks in the LRW and solid radioactive waste (SRW) systems have closed tops with overflow lines piped up solid to embedded drain piping that is routed to sumps. Any water collected in these sumps is pumped back to the LRW collection tanks.

For each tank in the LRW and SRW systems, level indication and high level alarms are provided on a remote control panel. On reaching high level in any tank, further inputs are automatically diverted to another tank or stopped. These monitoring and control features significantly reduce the possibility of overflowing any tanks.

11.2.1.9 ALARA Design Features

Numerous features have been incorporated into the design of both the LRW system and the building housing this system to insure that exposures of operating personnel to radiation will be kept within ALARA guidelines. The following is a listing of the most significant ALARA design features:

1. All floors and wall areas subject to contamination with radioactive material are coated with nuclear grade epoxy coatings to aid in decontamination.

2. With the exception of the detergent drains tanks and chemical waste distillate tanks, which are low in activity content, all redundant tanks are located in separate, shielded cubicles. This allows one tank to be repaired or inspected with minimal personnel exposure while the second tank is being used to process waste.

3. Most redundant pumps and process equipment are located in separate, shielded cubicles similar to those for the tanks as described above.

4. All normal operations are performed from a remote, centralized control panel. Normal operations are performed semi-automatically using a solid state, programmable logic controller to control valves and pumps. This eliminates exposures to operating personnel during normal operation and minimizes operating errors that could indirectly result in greater exposures to both operating and maintenance personnel.

5. Pipe lines containing radioactive fluids are routed through shielded chases. There is no instrumentation, valves or other equipment located in these chases, eliminating the need to enter them for any reason other than to maintain the piping itself.

6. As much as possible, pipes containing filter backwash slurries, spent resins, or evaporator concentrate make use of bends rather than standard elbow fittings to reduce the chances of plugging. As another precaution against sludge buildup, these lines are automatically backflushed after every use.

7. Backflush connections are provided on all process piping in pump cubicles to permit this piping to be decontaminated before entering the cubicles for maintenance purposes.

8. All pumps seals are mechanical type to minimize seal leakage and to eliminate the need for periodic adjustment of the seals. Rotating element facing material is tungsten carbide to maximize seal operating life.

9. The majority of valves are top-entry, diaphragm type with ethylene propylene terpolymer (EPT) elastomer diaphragms. This type of valve has the advantages of: a) no crud traps; b) no leakage unless the diaphragm fails; and c) quick, simple procedures for replacement of worn seals (diaphragm).

10. Materials of construction for all pumps, valves, piping, tanks and process equipment are selected to provide long-term corrosion resistance and improved decontamination capability. Most pumps, tanks and other process equipment are constructed of austenitic stainless steels. Alloy 20 stainless steel or Incoloy are used where protection against chloride stress corrosion is needed. Depending on the service, piping and valves are either austenitic stainless steel, Alloy 20 stainless steel, Incoloy, polypropylene lined, or Yoloy (a nickel copper alloy steel with increased corrosion resistance over carbon steel). Valves in Yoloy portions of piping are carbon steel with nuclear grade epoxy coatings.

11.2.1.10 Control of Inadvertent Releases

Releases as a result of equipment failures or malfunctions are discussed in Section 11.2.1.5. Another way in which unintentional releases could occur would be as a result of operator errors either allowing a tank to overflow or pumping the contents of the wrong tank to the discharge canal. Provisions for control of tank overflows are discussed in Section 11.2.1.8. Provisions for preventing the contents of the wrong tank from being discharged are discussed below.

All LRW system discharges, other than detergent wastes, are directed to the Unit 1 emergency service water discharge pipe. Detergent wastes are discharged to the sanitary waste system. All pipe lines going to the discharge point are routed through one central discharge flow control station, where the liquid can be directed through a low flow or parallel high flow control valve station. Both the low and high flow control valves are remote-manually adjusted from the LRW system control panel. Between the control valve station and each sample tank that can be discharged is a power operated shutoff valve that must be opened before a tank can actually be drained to the discharge point. During normal operation, these valves are controlled by a programmable logic controller. When an operator selects a tank to be discharged, the logic controller automatically checks the discharge shutoff valves of all other sample tanks. If any of these other valves are open, the discharge shutoff valve for the selected sample tank cannot be opened without overriding the logic controller. If, during transfer of the contents of one sample tank to the discharge point, the operator opens the discharge shutoff valve for another sample tank, a valve misalignment alarm is set off on the control panel and the sample pump is automatically stopped. As further protection against inadvertent discharges, an administratively controlled, manual, normally locked closed valve with position indicating limit switches is provided in series with each discharge isolation valve. Each of these manual valves is also checked by the logic controller for proper position before the discharge isolation valve for any sample tank can be opened or before the sample transfer pump can be started.

11.2.2 SYSTEM DESCRIPTION

11.2.2.1 Input Streams

The LRW system is designed and sized to simultaneously handle all radioactive liquid wastes for both units of the Perry Nuclear Power Plant, based on each unit having a condensate polishing treatment system as discussed in Section 10.4.6.

The input streams for the system are shown on the detailed process flow diagram in Figure 11.2-1 (Sheets 1 through 15). For these streams, normal and expected maximum quantities of significant radioactive nuclides and total flow quantities are given in Table 11.2-10.

11.2.2.2 Separation of Inputs

Incoming streams of liquid waste are collected and treated in one of four separate process streams according to their composition. These four subdivisions are high purity/low conductivity wastes (primarily equipment drains), medium-to-low purity/medium conductivity wastes (primarily floor drains), high conductivity chemical wastes, and detergent drains.

In addition to handling these four categories of liquid waste, the LRW system collects spent resin slurries and filter backwash slurries prior to being sent to the SRW disposal system.

11.2.2.3 Previous Experience

The type of process equipment used in the system described herein has been used effectively in many previous BWR units, including Dresden Units 1, 2 and 3, Quad Cities Units 1 and 2, Oyster Creek, and Nine Mile Point. Justification for the decontamination factors used for this equipment is based on available data from several operating units, equipment manufacturer's data, topical reports and standards given in References 1 through 25.

11.2.2.4 Treatment of High Purity/Low Conductivity Wastes

Input streams to this subsystem consist of equipment drains, cask pit drawdown, suppression pool water (normally diverted to suppression pool cleanup system) blowdown of reactor water (normally directed to hotwell), rinse water from condensate demineralizers and residual heat removal system flush/test. These inputs are collected in one of two waste collector tanks, each sized to hold one day's maximum normal input. With the exception of equipment drains, these waste streams can be diverted to the floor drain collector tanks if water quality or flow conditions warrant. After a batch of waste is collected, it is sent through a travelling belt filter to remove suspended solids, and then a mixed-bed demineralizer to remove dissolved solids. Alternate flow paths for treatment of these wastes are discussed in Section 11.2.2.13. Two waste sample tanks, each sized to hold one batch of waste, are provided for sampling, mixing, and temporary storage of the treated effluent. After a batch is sampled, it may be recycled to the waste collector tank for further treatment, sent to the condensate storage system (normal path) or discharged. The system is completely redundant, either through backup equipment or cross-ties with identical equipment in one of the other subsystems.

The major inputs to the high purity subsystem are equipment drains. The embedded drainage piping system for collecting this waste water is described in Section 9.3.3. The equipment drain piping in each structure housing radioactive (or potentially radioactive) fluid systems is routed to a sump located at the lowest elevation of the building. After one of these sumps is filled, one of two redundant, vertical sump pumps automatically pumps the contents to either the waste collector tanks in the LRW system or to the main condenser, depending on conductivity. If the conductivity is approximately 1.0 μmho/cm or less, the water is clean enough to be sent to the condenser. Higher conductivity water is sent to the LRW system.

11.2.2.5 Treatment of Medium-to-Low Purity/Medium Conductivity Wastes

Input streams to this subsystem consist of floor drains, decantate from the backwash settling tanks, decantate from the solid radwaste disposal system and backwash from the radwaste demineralizers. These inputs are collected in one of two floor drain collector tanks, each sized to hold approximately three days' maximum normal input. With the exception of floor drains, these waste streams can be diverted to the waste collector tanks if water quality or flow conditions warrant. After a batch is collected, it is normally filtered, demineralized and re-used. Alternate flow paths for treatment of these wastes are discussed in Section 11.2.2.13. Two floor drain sample tanks, each sized to hold one batch of waste, are provided for sampling and temporary storage of treated effluent. After sampling, a batch is either recycled for further treatment, sent to condensate storage (normal path) or discharged. The system is completely redundant, either through backup equipment or cross-ties with identical equipment in one of the other subsystems.

The major inputs to the medium-to-low purity subsystem are floor drains, which consist of miscellaneous unidentified equipment leakage and floor washdown. The embedded drainage piping system for collecting this waste water is described in Section 9.3.3. The floor drain piping in each structure housing radioactive (or potentially radioactive) fluid systems is routed to a sump located at the lowest elevation of the building. After one of these sumps is filled, one of two redundant, vertical sump pumps automatically sends the contents to the floor drain collector tanks in the LRW system. In the same manner as for the equipment drain sumps, drains collected in the drywell or containment floor drains sumps are routed to either the LRW system or main condenser, depending on conductivity.

11.2.2.6 Treatment of High Conductivity Chemical Wastes

These wastes consist primarily of laboratory drains and chemical regeneration solutions from the mixed-bed condensate polishing demineralizers. They are collected in two chemical waste tanks, each sized to hold the regeneration solutions from one mixed-bed demineralizer. Miscellaneous leakage and

maintenance drains from the condensate polishing demineralizer regeneration equipment is collected in a chemical waste sump located at the lowest elevation of the structure housing the regeneration equipment. When this sump is filled, one of two redundant sump pumps automatically transfers the contents to the chemical waste tanks. After a chemical waste tank is filled, the contents are concentrated in one of two horizontal type waste evaporators. The evaporators are set up so that one normally handles chemical wastes and the other handles floor drains only. However, cross connections are provided so that either evaporator can handle equipment drains, floor drains or chemical wastes. Prior to entering the evaporator, the wastes are sampled and the pH level monitored. For optimum evaporator performance, chemicals are added to maintain the pH between 7 and 10. Bottoms from the evaporator are pumped to two concentrated waste tanks sized to hold seven batches each. Bottoms are periodically transferred from these tanks to the SRW disposal system. Distillate from the evaporators is temporarily stored in two chemical waste distillate tanks, each of which is sized to hold the distillate from one batch of waste. After sampling, the distillate may be sent through either the floor drains demineralizer or waste demineralizer for further treatment, sent to the condensate storage system (normal path) or discharged.

Alternate flow paths for treatment of these wastes are discussed in Section 11.2.2.13.

11.2.2.7 Treatment of Detergent Drains

Inputs to this subsystem consist of personnel decontamination solutions and floor drains from nonradioactive areas of the control complex. Dry cleaning machines are being installed at the plant for cleaning protective clothing. All waste inputs are collected in the laundry and floor drains sump located at the lowest elevation of the control complex. When this sump is filled, one of two redundant sump pumps automatically transfers the contents to the LRW system detergent drains tanks. After sampling, this waste is filtered and discharged to the sanitary waste treatment system because it normally contains negligible levels of radioactivity. If significant activity levels should occur in the detergent drains, these drains can be sent to the waste evaporator after defoaming agents have been added.

11.2.2.8 Treatment of Spent Resins

Spent resins from the mixed-bed condensate demineralizers, waste demineralizer, floor drains demineralizer and suppression pool demineralizer are collected in two spent resin storage tanks. Each tank is sized to hold the resins for six months. The spent resins are transferred to the SRW disposal system as a water slurry.

11.2.2.9 Treatment of Filter/Demineralizer Backwash

Backwash slurries from the condensate filter fuel pool filter/demineralizer and RWCU filter/demineralizer backwash receiving tanks are pumped to settling tanks located in the radwaste building. The sludge is allowed to settle to the bottom of these tanks while relatively clean water is drawn off the top and pumped to the floor drain collector tanks or waste collector tanks for further treatment. Periodically, the sludge is transferred to the SRW disposal system as a water slurry.

11.2.2.10 Detailed Component Design

Piping and instrumentation for the LRW system are shown in Figure 11.2-1. For a definition of symbols used on this system diagram, see Figure 1.2-22. Design data for all LRW system components is given in Tables 11.2-2 through 11.2-7. The safety class for equipment and piping in the system is given in Table 3.2-1. Also shown in this table are the seismic classifications and principal construction codes for LRW system components and for the radwaste building.

a. Collection Tank Design

All collection tanks are either horizontal or vertical, atmospheric, cylindrical, stainless steel tanks. Vertical tanks have closed tops and dished bottoms for easy drainage. Vent, overflow, recycle and drain lines are provided for each tank. A level sensor is provided on each tank for remote level indication, level recording, and alarm/control functions.

The liquid radwaste system is non-seismic. However, collection tanks containing significant amounts of radioactive liquids are Seismic Category I tanks up to, and including, the first tank isolation valve on each pipe line that could drain the tanks upon rupture. Tanks in this category are the chemical waste tanks, concentrated waste tanks, spent resin tanks, and RWCU backwash settling tanks. These tanks and the piping out to the first isolation valve on lines that could drain the tanks, are designed in accordance with Quality Group C requirements, less material traceability and N stamp.

b. Pump Design

All pumps other than sump pumps are horizontal, centrifugal type, driven by 460 volt drip proof motors. Each pump is provided with inlet and outlet shutoff valves for maintenance and a discharge pressure sensor with readout in the RWBCR. All pump seals are single or double mechanical type.

c. Waste Collector Filter/Floor Drains Filter

Each filter is a flatbed, continuous belt type, precoat filter unit rated at 100 to 150 gpm when used to filter waste water. Each unit can also be used to dewater resin or filter backwash slurries, for which case the process rate is 50 gpm.

For improved filtration efficiency, provisions are made for body feed of precoat material to the filter influent. During periods of non-use, water is continuously recirculated through the filter to prevent deterioration of the filter precoat.

Upon completion of a filtration run, the precoat material and accumulated crud is partially dried by air and the filter belt is indexed, causing the semi-dry cake to fall off the end of the belt and down a stainless steel chute into a waste mixing/dewatering tank in the SRW disposal system.

Each filter has a filtration surface area of 68 square feet. Operating differential pressure varies from 2 to 14 psi. Design differential pressure is 15 psi.

d. Waste Demineralizer/Floor Drains Demineralizer

These demineralizers are identical 200 gpm mixed bed units, using a cation to anion resin ratio of one to one (by volume). Each demineralizer is designed for a process flow rate of 6 to 8 gpm per square foot. They are cross-tied by manual valves to achieve redundancy in both subsystems.

Maximum pressure differential at rated flow is 10 psi. A demineralizer run may be terminated on a high differential pressure or a high conductivity signal. The spent resin is then sluiced to one of the spent resin tanks.

e. Chemical Waste Evaporator/Condensers

Two 30 gpm horizontal evaporator/condensers are provided, each designed to operate on a batch basis. Normally, only one unit is used, but the design is such that they can be operated simultaneously. Each evaporator is designed to concentrate a solution of Na_2SO_4 from 0.7 w/o to 25.0 w/o.

Each evaporator is designed to operate under slight positive pressure. Water vapor is condensed and cooled to a temperature of 120°F prior to being pumped from the unit to distillate tanks.

f. Detergent Drains Filters

Two 50 gpm cartride type filters are provided for detergent drains. Each filter operates at a normal differential pressure varying from 5 to 25 psi with a maximum design of 75 psig. Filtration is terminated on high differential pressure.

The cartridge elements are epoxy impregnated cellulose with a filtration efficiency of 98 percent at 3 μm and 100 percent at 23 μm. Spent cartridges are taken to the SRW disposal system for packaging and shipment to offsite burial grounds.

g. Settling Tanks

All settling tanks are vertical, atmospheric, cylindrical, stainless steel tanks with closed tops and dished bottoms. Each tank is provided with vent, overflow, drain, blowdown, recycle and decant lines. Connections for flushing water and sparging air or condensate are also provided.

Four ultrasonic level indicators are provided on each tank to indicate in the radwaste building control room (RWBCR) when the sludge level is at 25, 50, 75 or 100 percent of the maximum permissible level. The tanks are designed so that this maximum level is below the elevation of the decant lines. Each tank is also provided with a liquid level sensor for remote level indication and alarm control functions.

h. Spent Resin Tanks

Two vertical, atmospheric, cylindrical, stainless steel spent resin tanks are provided. Each tank has a closed top and dished bottom and is provided with vent, drain, overflow, and flushing lines. The entrance to the overflow line is provided with a wire mesh screen to prevent resins from entering the overflow.

Level instrumentation for these tanks is the same as for the settling tanks.

i. Concentrated Waste Tanks

Two vertical, atmospheric, cylindrical, Incoloy concentrated waste tanks are provided. Each tank has a closed top, dished bottom, and vent, overflow, drain and recycle lines. All lines normally containing

concentrated waste are heat traced and insulated to prevent solidification of the concentrate. Each tank is provided with a heating element to maintain the tank temperature between 120°F and 150°F. A level sensor is provided for remote indication and alarm/control functions. Temperature elements are provided to monitor and record temperature in the tanks and activate an alarm in the RWBCR if the temperature exceeds 150°F or falls below 120°F.

j. Sample Tanks

The waste sample tanks and floor drains sample tanks are vertical, atmospheric, cylindrical, stainless steel tanks. The chemical waste distillate tanks are horizontal, atmospheric, cylindrical, stainless steel tanks. All tanks have vent, overflow, drain, and recycle lines. Each tank has a level sensor for remote level indication, level recording, and alarm/control functions.

k. Sumps

Radioactive floor and equipment drains are collected in sumps located in the basemat of all structures housing radioactive fluid systems. These sumps range in size from 50 to 1000 gallons. With the exception of those sumps that are normally non-radioactive, all sumps are lined with stainless steel for leakage control and to facilitate decontamination.

Many sumps are provided with a small recessed "boot" in the area of the bottom from which the sump pump takes suction. This ensures that the pump suction is submerged at all times while allowing most of the sump to be drained completely to minimize buildup of radioactive sludge and to facilitate decontamination.

All sumps are covered with grating or solid plates. Solid plates are used where shielding is needed, or if the sump is in an open area where litter could end up in the sump.

Each sump is provided with level switches for alarm and control functions. Sumps inside containment have additional level instrumentation for leak rate detection as discussed in Section 7.6. The quantity of waste water sent to the LRW system from each sump is monitored on the RWBCR panel using digital, sump pump elapsed running time counters.

1. Sump Pumps

Except for the annulus sump, which is expected to be used very infrequently, all sumps have redundant, duplex sump pumps. Vertical turbine pumps are used in sumps containing relatively clean water. Standard vertical, open impeller, centrifugal sump pumps are used in sumps where trash could accumulate. All sump pumps are provided with suction strainers to prevent refuse from clogging or damaging the pump impeller.

Pump motors are totally enclosed and fan cooled to prevent contamination of the motor internals.

11.2.2.11 Field Routed Pipe

Routing of piping and tubing in the LRW system that normally carry radioactive fluids is shown on piping drawings to ensure proper protection of operating personnel against exposure to radiation. Therefore, there will be no field routed radioactive piping or tubing for which shielding design criteria or controls will be necessary.

11.2.2.12 System Control and Operating Procedures

a. General

All pumps and normally used valves are controlled from a control panel in the RWBCR. A semi-graphic mimic is provided on this panel showing the operating status (off/on) of all system pumps and the position

(open/closed) of all power operated valves. Important system parameters such as tank levels, pump discharge pressures, etc. are also indicated and/or recorded on this control panel. An annunciator on the panel sounds an alarm if abnormal conditions such as high tank level or high discharge activity should occur. Alarms on the LRW control panel are retransmitted to the control complex control room, where a single radwaste system trouble alarm is activated.

Additional control panels are located near the radwaste filters and demineralizer for use when reconditioning this equipment. After a filter has received a fresh precoat or a demineralizer has been refilled with new resins, control of this equipment is returned to the main LRW system control panel.

b. Programmable Logic Controller

To facilitate operation and to minimize human errors, the LRW system is controlled by a programmable logic controller (PLC) during normal operation. Once the operator has selected a mode of operation for one of the LRW subsystems, the PLC automatically controls the operating sequences. For any operating mode, the PLC first checks that all valves are in the predetermined alignment. An improper valve alignment is annunciated and the PLC either discontinues the program or delays further steps in the program until the situation is corrected. Following this step, the PLC signals the correct valves to open and the subsystem pump to start. At the end of the program (signaled by low tank level, a timer running out, loss of a permissive signal, etc.), the PLC stops the subsystem pump, closes all valves, and indicates the end of the cycle.

The PLC is only used for normal modes of operation. For abnormal occurrences such as bypassing equipment or cross-tying shared equipment, the operator can override the PLC and operate the system remote - manually from the control panel. If necessary, the PLC can also be reprogrammed from a computer input/output terminal located in the radwaste building control room.

c. Normal Control of Discharges

Except for detergent wastes, all liquid effluents from the LRW system are normally routed to the condensate storage system or main condenser for reuse in the plant. This is done on a batch basis after a sample of the effluent is taken to determine if it is suitable for reuse. If the sample does not meet the water quality standards for condensate makeup given in Table 11.2-11 the batch is either recycled for further treatment or discharged through the discharge tunnel entrance structure, depending on the chemical content and activity level.

All streams to be discharged are routed through one central flow control station, where either a low flow or parallel high flow control valve is used. These valves are modulated remote-manually from the radwaste building control room to achieve the desired flow rate. The stream is then monitored for gross beta-gamma activity and routed to the discharge tunnel entrance structure, which discharges to the environment at the point shown in Figure 1.2-18.

For each batch discharged, the activity monitor is set to actuate an alarm in the RWBCR if the activity level exceeds a preselected value. This value is calculated for each batch based on the activity level of a sample taken from the batch and on the flow rate of the circulating water blowdown at the time that it is desired to discharge the batch. The value is set so that after dilution in the circulating water, the concentration will be substantially below the MPC level of 10 CFR 20.

11.2.2.13 Selection of Normal and Alternate Flow Paths

Normal flow paths for all input streams to the liquid radwaste system are described in Sections 11.2.2.4 through 11.2.2.9. However, because of the variable nature of these input streams, alternate flow paths for their treatment may sometimes be necessary. In Figure 11.2-2, the normal and alternate flow paths for each input stream are summarized. For each flow

path, the percentages of total flow are given for expected normal operation, design and sizing of equipment, and calculation of quantities of radioactivity discharged. Explanation of each flow path used is given in Table 11.2-12.

11.2.2.14 Performance Tests

Prior to plant startup, all equipment in the radwaste system will be tested for operability. After startup, when radioactive liquids are in the system, the filters, demineralizers and evaporators will periodically be tested for performance by taking samples of the liquid wastes before and after treatment and analyzing for isotopic content.

Reports in the literature on performance tests for this equipment are given in References 1 through 25.

11.2.3 RADIOACTIVE RELEASES

11.2.3.1 Description

The criteria for recycle, treatment and discharge of radioactive wastes is discussed in Section 11.2.2. In calculating the radioactive releases to the environment it was assumed that 10 percent of the high purity, chemical and regenerant waste streams and 25 percent of the low purity waste stream are discharged.

11.2.3.2 Dilution Factors

The liquid waste discharged to the environment is diluted by the cooling tower blowdown and excess service water of Units 1 and 2. After Unit 2 is placed in operation, the normal dilution flow will be between 44,500 and 61,500 gpm. When both the emergency service water and normal service water are discharging into the discharge tunnel the dilution flow may temporarily increase to approximately 100,000 gpm.

Values in Table 11.2-13 were calculated using the normal minimum dilution flow of 44,500 gpm. During certain operating conditions or certain seasons, flows may be less than the normal minimum flows indicated. However, flows will exceed the normal minimum flow a substantial portion of the year, thus the values in Table 11.2-13 are a valid conservative estimate of annual discharges. In no case will flows go below 10,000 gpm during normal operating conditions, and this is ample to insure that actual releases do not exceed allowable releases.

11.2.3.3 Release Points

Releases to the environment, with the exception of detergent drains, are by way of the discharge tunnel entrance structure. This release point is shown on the process flow diagram in Figure 11.2-1, and the site plot plan in Figure 1.2-18. The detergent drains filter discharge is sent to the sanitary waste treatment system. After tertiary treatment it is discharged to the lake.

11.2.3.4 Estimated Releases

The release rate of radioactive materials in liquid effluents is presented in Tables 11.2-13 and 11.2-14. These values were calculated with the GALE Code and are based on the assumptions and parameters provided in NUREG-0016 (BWR-GALE Code) and Table 11.2-15. As shown in Table 11.2-14 the estimated releases are a small fraction of the limits of 10 CFR 20, Table II, Column 2 and are considered as low as reasonably achievable. The estimated offsite doses for the Perry site and a comparison with the design objectives of Appendix I to 10 CFR 50 and the dose limits of 10 CFR 20 is presented in Section 5.1.4 of the PNPP Environmental Report.

11.2.4 REFERENCES FOR SECTION 11.2

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4. "Experience With Precoat Filters in Nuclear Power Plants", C. H. Becker and J. S. Brown, presented at 34th Annual American Power Conference, Chicago, Illinois, April 18 - 20, 1972.

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18. "Studies on Radioisotope Removal by Water Treatment Process"; "Discussion", Arthur E. Gorman, Op. Cit., Volume 43, August, 1951, p. 633.

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TABLE 11.2-1

SINGLE EQUIPMENT ITEM MALFUNCTION EVALUATION

Equipment Item	Malfunction	Consequences	Design Precautions
Discharge flow control valve	Does not respond to signal to throttle flow	Radioactive isotope concentration in discharge could exceed limits of 10 CFR 20.	Radiation monitor downstream of control valve signals power operated isolation valve in series with flow control valve to close.
Discharge radiation monitor	Improperly calibrated or power failure	Activity of liquid discharged to environment is not monitored or recorded.	Monitor has down scale alarm to warn operator in control room of loss of power. Recycle line is provided on sample tank to permit each batch of waste being discharged to be sampled for isotopic content prior to release.
Discharge flow monitor	Improperly calibrated or power failure	Quantity of liquid being discharged to environment is not monitored or recorded.	Level recorder on sample tank provides indirect record of quantity of liquid released.
Cooling tower blowdown line	Flow through line is blocked or lost.	Radioactive isotope concentration in discharge could exceed limits of 10 CFR 20.	Flow sensor on weir of discharge structure signals power operated valve in LRW discharge line to close on loss of dilution water flow.

TABLE 11.2-1 (Continued)

Equipment Item	Malfunction	Consequences	Design Precautions
Waste evaporator	Tube leak in steam tube bundle	Possible contamination of auxiliary steam system when evaporator is not in operation and process concentrate is left in shell of unit.	When starting evaporator after a period of non-use, steam condensate return is routed to the LRW system until, or unless, a conductivity switch in the return line signals that the conductivity (which is an indirect measure of radioactivity) is below a predetermined setpoint.

TABLE 11.2-2

DESIGN DATA FOR LIQUID RADWASTE SYSTEM SUMPS

Sump Description	Number per Unit of PNPP	Operating Capacity (gal)	Type of Cover Plate	Stainless Steel Liner Provided
Drywell Equipment Drains	1	500	Shielding Plate	Yes
Containment Equipment Drains	1	440	Checkered Plate	Yes
Radwaste Building Equipment Drains	1(1)	500	Checkered Plate	Yes
Intermediate Building Equipment Drains	1(1)	500	Grating	Yes
Turbine Power Complex Equipment Drains	1	1000	Checkered Plate	Yes
Control Complex Equipment Drains	1(1)	500	Checkered Plate	Yes
Drywell Floor Drains	1	255	Shielding Plate	Yes
Containment Floor Drains	1	390	Checkered Plate	Yes
Annulus Floor Drains	1	50	Grating	No
Intermediate Building Floor Drains	1(1)	500	Grating	Yes
Auxiliary Building Floor/Equipment Drains	1	345/675	Checkered Plate	Yes
Turbine Power Complex Floor Drains	1	1000	Checkered Plate	Yes
Turbine Laydown Area Floor Drains	1	450	Checkered Plate	No

TABLE 11.2-2 (Continued)

Sump Description	Number per Unit of PNPP	Operating Capacity (gal)	Type of Cover Plate	Stainless Steel Liner Provided
Radwaste Building Floor Drains	1 (1)	500	Checkered Plate	Y[illegible]
Turbine Lube Oil Area Floor Drains	1	750	Checkered Plate	No
Heater Bay Floor Drains	1	270	Checkered Plate	Yes
Turbine Power Complex Chemical Drains	1	270	Grating	Yes
Control Complex Laundry and Floor Drains	1 (1)	500	Checkered Plate	Yes

NOTE:

1. Common sump serves both Unit 1 and Unit 2.

TABLE 11.2-3

DESIGN DATA FOR LIQUID RADWASTE SYSTEM SUMP PUMPS

Sump Pump	Type	Quantity (2 Units)	Design Press. (psig)	Design Temp. (°F)	Design Flow Rate (gpm)	TDH @ Design Pt. (ft)	Shutoff Head (ft)	Max. Fluid Temp. (°F)	Material	Tag Number
Drywell Equip. Drain Sump Pumps	Duplex V.T.(1)	4	100	200	50	60	80	150	CI	1G61C001A 1G61C001B 2G61C001A 2G61C001B
Containment Equip. Drain Sump Pumps	Duplex V.T.(1)	4	100	200	50	60	80	150	CI	1G61C002A 1G61C002B 2G61C002A 2G61C002B
Radwaste Bldg. Equip. Drain Sump Pumps	Duplex V.T.(1)	2	100	150	50	65	85	100	CI	G61C003A G61C003B
Intermediate Bldg. Equip. Drain Sump Pumps	Duplex V.T.(1)	2	100	150	50	65	85	100	CI	G61C004A G61C004B
Turb. Power Complex Equip. Drain Sump Pumps	Duplex V.T.(1)	4	100	150	50	110	142	100	CI	1G61C007A 1G61C007B 2G61C007A 2G61C007B
Drywell Floor Drain Sump Pumps	Duplex V.T.(1)	4	100	150	50	65	85	100	CI	1G61C008A 1G61C008B 2G61C008A 2G61C008B
Containment Floor Drain Sump Pumps	Duplex	4	100	150	50	65	90	100	CI	1G61C009A 1G61C009B 2G61C009A 2G61C009B
Annulus Floor Drain Sump Pumps	Single	2	100	150	25	55	60	100	CI	1G61C010 2G61C010
Intermediate Bldg. Floor Drain Sump Pumps	Duplex	2	100	150	50	60	84	100	CI	G61C011A G61C011B
Auxiliary Bldg. Floor Drain Sump Pumps	Duplex	4	100	150	100	70	80	100	CI	1G61C012A 1G61C012B 2G61C012A 2C61C012B

TABLE 11.2-3 (Continued)

Sump Pump	Type	Quantity (2 Units)	Design Press. (psig)	Design Temp. (°F)	Design Flow Rate (gpm)	TDH @ Design Pt. (ft)	Shutoff Head (ft)	Max. Fluid Temp. (°F)	Material	Tag Number
Turb. Power Complex Floor Drain Sump Pumps	Duplex	4	100	150	100	85	115	100	CI	1G61C014A 1G61C014B 2G61C014A 2G61C014B
Turb. Power Complex Floor Drain Sump Pumps	Single	2	100	150	750	130	185	100	CI	1G61C014C 1G61C014C
Turb. Laydown Area Floor Drain Sump Pumps	Duplex	4	100	150	50	25	32	100	CI	1G61C015A 1G61C015B 2G61C015A 2G61C015B
Radwaste Bldg. Floor Drain Sump Pumps	Duplex	2	100	150	50	60	84	100	CI	G61C016A G61C016B
Turb. Lube Oil Area Floor Drain Sump Pumps	Duplex	4	100	150	50	50	74	100	CI	1G61C005A 1G61C005B 2G61C005A 2G61C005B
Heater Bay Floor Drain Sump Pumps	Duplex	4	100	150	25	95	95	100	CI	1G61C019A 1G61C019B 2G61C019A 2G61C019B
Control Complex Equip. Drain Sump Pumps	Duplex V.T.(1)	2	100	150	50	65	85	100	CI	G61C013A G61C013B
Turb. Power Complex Chemical Drain Sump Pumps	Duplex	4	100	150	25	60	64	100	SS	1G61C017A 1G61C017B 2G61C017A 2G61C017B
Control Complex Laundry and Floor Drain Sump Pumps	Duplex	2	100	175	50	75	95	150	CI	G61C018A G61C018B
Auxiliary Bldg. Equip. Drain Sump Pumps	Duplex	4	100	150	250	70	105	100	CI	G61C020A G61C020B

NOTES

1. V.T. - Abbreviation for "vertical turbine".

TABLE 11.2-4

DESIGN DATA FOR LIQUID RADWASTE SYSTEM TANKS

Tank	Quantity (2 Units)	Type	Head Design	Design Press. (Psig)	Design Temp. (°F)	Mat'l	Operating Capacity(1) (Gal)	Tag Number
Waste Collector Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 SS	36,500	G50-A001A G50-A001B
Waste Sample Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 SS	34,000	G50-A002A G50-A002B
Floor Drain Collector Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos	150	304 SS	36,500	G50-A003A G50-A003B
Floor Drain Sample Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 SS	34,000	G50-A004A G50-A004B
Chemical Waste Tanks	2	Vertical	Flat Top, Elip. Bot.	Atmos.	150	316 SS	19,650	G50-A005A G50-A005B
Concentrated Waste Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	200	Incoloy 825	4,900	G50-A006A G50-A006B
Chemical Waste Distillate Tanks	2	Horiz.	Shallow Dished	Atmos.	150	304 SS	19,100	G50-A007A G50-A007B
Detergent Drains Tanks	2	Horiz.	Shallow Dished	Atmos.	150	304 SS	1,550	G50-A008A G50-A008B
Spent Resin Tanks	2	Vertical	Flat Top, Elip. Bot.	Atmos.	150	304 SS	9,500	G50-A009A G50-A009B
Condensate Filter Backwash Receiving Tanks	2	Horiz.	Shallow Dished	Atmos.	150	304 SS	9,900	1G50-A010 2G50-A010
Condensate Filter Backwash Settling Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 SS	17,600	G50-A011A G50-A011B
RWCU F/D Backwash Settling Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 L SS	4,400	G50-A013A G50-A013B
Fuel Pool F/D Backwash Settling Tanks	2	Vertical	Flat Top, Dish. Bot.	Atmos.	150	304 SS	17,600	G50-A014A G50-A014B
LRW Filter Precoat Tank	1	Vertical	Flat Top, Dish. Bot.	Atmos.	100	CS (Plasite lined)	1,475	G50-A015

TABLE 11.2-4 (Continued)

Tank	Quantity (2 Units)	Type	Head Design	Design Press. (Psig)	Design Temp. (°F)	Mat'l	Operating Capacity(1) (Gal)	Tag Number
LRW Demineralizer Resin Feed Tank	1	Vertical	Flat Top, Cone Bot.	Atmos.	100	CS (Koroscal lined)	825	G50-A016
LRW Filter Aid Tank	1	Vertical	Flat Top, Dish. Bot.	Atmos.	100	304 SS	1,000	G50-A017
Fuel Pool F/D Backwash Receiving Tank	1	Horiz.	Shallow Dished	Atmos.	150	304 SS	9,400	G50-A022
LRW Phosphate Tank	1	Vertical	Flat Top, Flat Bot.	Atmos.	100	304 SS	250	G50-A023
LRW Hot Water Heater	1	Vertical	ASME Dished	130	200	CS (Phenolic Lining)	500	G50-B003

NOTE:

1. Operating capacity is arbitrarily defined herein to be the volume of that portion of the tank up to 6 inches below the lowest point in the overflow line.

TABLE 11.2-5

DESIGN DATA FOR LIQUID RADWASTE SYSTEM PUMPS

Pump	Type	Quantity (2 Units)	Design Press. (psig)	Design Temp. (°F)	Design Flow Rate (gpm)	TDH @ Design Pt. (ft)	Shutoff Head (ft)	Max. Fluid Temp. (°F)	Material	Tag Number
Waste Collector Transfer Pumps	Horz. Cent.	2	125	150	150	175	210	140	316 SS	G50-C001A G50-C001B
Waste Sample Pumps	Horz. Cent.	2	125	150	200	110	120	100	316 SS	G50-C002A G50-C002B
Floor Drains Collector Transfer Pumps	Horz. Cent.	2	125	150	150	175	210	100	316 SS	G50-C003A G50-C003B
Floor Drains Sample Pumps	Horz. Cent.	2	125	150	200	110	120	100	316 SS	G50-C004A G50-C004B
Chemical Waste Pumps	Horz. Cent.	2	125	150	120	95	125	100	Alloy 20 SS	G50-C005A G50-C005B
Chemical Waste Distillate Pumps	Horz. Cent.	2	125	150	200	110	120	120	316 SS	G50-C006A G50-C006B
Detergent Drains Pumps	Horz. Cent.	2	125	175	50	110	115	150	316 SS	G50-C007A G50-C007B
Spent Resin Pumps	Horz. Cent.	2	125	150	400	135	160	100	316 SS	G50-C008A G50-C008B
Condensate Backwash Transfer Pumps	Horz. Cent.	4	125	150	450	80	90	100	316 SS	1G50-C009A 1G50-C009B 2G50-C009A 2G50-C009B
Cond. Sludge Discharge Mixing Pumps	Horz. Cent.	2	125	150	400	180	205	100	316 SS	G50-C010A G50-C010B
Condensate Sludge Decant Pumps	Horz. Cent.	2	125	150	450	75	85	100	316 SS	G50-C011A G5C-C011B
RWCU Backwash Transfer Pumps	Horz. Cent.	2	125	150	350	95	105	120	316 SS	1G50-C012 2G50-C012
RWCU Sludge Discharge Mixing Pumps	Horz. Cent.	2	125	150	200	175	185	120	316 SS	G50-C013A G50-C013B

TABLE 11.2-5 (Continued)

Pump	Type	Quantity (2 Units)	Design Press. (psig)	Design Temp. (°F)	Design Flow Rate (gpm)	TDH @ Design Pt. (ft)	Shutoff Head (ft)	Max. Fluid Temp. (°F)	Material	Tag Number
RWCU Sludge Decant Pumps	Horz. Cent.	2	125	150	50	55	60	120	316 SS	G50-C014A G50-C014B
Fuel Pool Sludge Discharge Mixing Pumps	Horz. Cent.	2	125	150	400	180	205	100	316 SS	G50-C015A G50-C015B
Fuel Pool Sludge Decant Pumps	Horz. Cent.	2	125	150	450	75	85	100	316 SS	G50-C016A G50-C016B
Waste Collector Filtrate Pump	Horz. Cent.	1	125	150	150	100	~120	140	CI	G50-C017
Floor Drains Filtrate Pump	Horz. Cent.	1	125	150	150	100	~120	100	CI	G50-C018
Waste Collector Filter Aid Pump	Positive Displnt.	1	125	150	0.12 to 1.2	134	-	100	316 SS	G50-C019
Floor Drains Filter Aid Pump	Positive Displnt.	1	125	150	0.12 to 1.2	134	-	100	316 SS	G50-C020
Radwaste Precoat Pumps	Horz. Cent.	2	125	150	350	51	~60	100	CI	G50-C021A G50-C021B
Spent Resin Transfer Pumps	Horz. Cent.	2	125	150	200	175	185	100	316 SS	1G50-C022 2G50-C022
WEC Concentrate Pumps	Horz. Cent.	4	125	250	45			220	Alloy 20 SS	G50-C023A G50-C023B G50-C023C G50-C023D
WEC Distillate Pumps	Canned	2	125	150	31.2			120	316 SS	G50-C024A G50-C024B
Concentrated Waste Transfer Pumps	Horz. Cent.	2	125	175	150	150	180	150	Alloy 20 SS	G50-C026A G50-C026B
Fuel Pool F/D Backwash Transfer Pump	Horz. Cent.	1	125	150	450	120	135	100	316 SS	G50-C027

TABLE 11.2-6

DESIGN DATA FOR LIQUID RADWASTE SYSTEM PIPING

Pipe Line Specification	Design Code	Material	Schedule or Wall
G18-4	ANSI B31.1	Stainless steel tubing; ASTM A213, Gr TP316	0.065" wall
L1-3	ASME Code, Section III, Class 3	Carbon steel; ASTM A106 Gr B	Sch. 80 (2" and less) Sch. 40 (2-1/2" thru 10")
L1-4	ANSI B31.1	Carbon steel; ASTM A106 Gr B	Sch. 80 (2" and less) Sch. 40 (2-1/2" thru 10")
L2-3	ASME Code Section III, Class 3	Stainless steel; ASTM SA 312 or SA 376 TP 304	Sch. 40S
L2-4	ANSI B31.1	Stainless steel; ASTM SA 312 or SA 376 TP 304	Sch. 40S
L6-4	ANSI B31.1	Yoloy (nickel/ copper alloy steel); ASTM A53	Sch. 80 (2" and less) Sch. 40 (2-1/2" to 20")
L7-3	ASME Code, Section III, Class 3	Alloy 20 stainless steel, ASTM B-464	Sch. 40S
L7-4	ANSI B31.1	Alloy 20 stainless steel; ASTM B-464	Sch. 40S
N13-4	ANSI B31.1	Polypropylene lined carbon steel pipe per ASTM A53	Std. wall

TABLE 11.2-7

DESIGN DATA FOR LIQUID RADWASTE SYSTEM PROCESS EQUIPMENT

Equipment	Type	Quantity (2 units)	Design Press. (psig)	Design Temp. (°F)	Design Flow Rate (gpm)	Material	Tag Number
Waste Demineralizer	Mixed bed	1	125	150	150 to 200	304 and 316 SS	G50-D003
Floor Drains Demineralizer	Mixed bed	1	125	150	150 to 200	304 and 316 SS	G50-D004
Waste Collector Filter	Precoat; Flat bed	1	15	150	100 to 150	304 SS	G50-D001
Floor Drains Filter	Precoat; Flat bed	1	15	150	100 to 150	304 SS	G50-D002
Waste Evaporator/ Condensers	Horizontal; bowed tube; waste on shell side; forced recirculation	2	50	300	30	Incoloy 825 (evaporator section); 304 SS (condenser section)	G50-B001A G50-B001B (evaporator) G50-B002A G50-B002B (condenser)
Detergent Drains Filters	Cartridged	2	125	175	50	304 SS (vessel) Epoxy impregnated cellulose (element)	G50-D005A G50-D005B

TABLE 11.2-8

SUMMARY OF LIQUID RADWASTE SYSTEM EQUIPMENT REDUNDANCY

Equipment	Degree of Redundancy	Normal Collecting or Processing Capacity	Maximum Collecting or Processing Capacity
Equipment Drain Sump	None	Varies (500 to 1000 gal)	Varies (500 to 1000 gal)
Equipment Drain Sump Pump	100%	Varies (50 to 250 gpm)	Varies (100 to 500 gpm)
Waste Collector Tank	100%	36,500 gal	73,000 gal
Waste Sample Tank	100%	34,000 gal	68,000 gal
Waste Collector Transfer Pump	100%	150 gpm	150 gpm
Waste Sample Pump	100%	200 gpm	200 gpm
Waste Demineralizer	100%(1)	Varies (150 to 200 gpm)	Varies (150 to 200 gpm)
Waste Collector Filter	100%(2)	150 gpm	150 gpm
Floor Drains Sump	None	Varies (50 to 1000 gal)	Varies (50 to 1000 gal)
Floor Drains Sump Pump	100%(3)	Varies (25 to 750 gpm)	Varies (50 to 750 gpm)
Floor Drains Collector Tank	100%	36,500 gal	73,000 gal
Floor Drains Sample Tank	100%	34,000 gal	68,000 gal
Floor Drain Transfer Pump	100%	150 gpm	150 gpm
Floor Drains Sample Pump	100%	150 gpm	150 gpm
Floor Drains Demineralizer	100%(1)	Varies (150 to 200 gpm)	Varies (150 to 200 gpm)

TABLE 11.2-8 (Continued)

Equipment	Degree of Redundancy	Normal Collecting or Processing Capacity	Maximum Collecting or Processing Capacity
Floor Drains Filter	100%(2)	150 gpm	150 gpm
Chemical Drains Sump	None	270 gal	270 gal
Chemical Drains Sump Pump	100%	25 gpm	50 gpm
Chemical Waste Tank	100%	19,650 gal	39,300 gal
Waste Evaporator	100%	30 gpm	60 gpm
Chemical Waste Distillate Tank	100%	19,100 gal	38,200 gal
Chemical Waste Distillate Pump	100%	200 gpm	400 gpm
Laundry and Floor Drains Sump	None	500 gal	500 gal
Laundry and Floor Drains Sump Pump	100%	50 gpm	100 gpm
Detergent Drains Tank	100%	1,550 gal	3,100 gal
Detergent Drains Pump	100%	50 gpm	100 gpm
Detergent Drains Filter	100%	50 gpm	100 gpm

NOTES:

1. Waste demineralizer and floor drains demineralizer can be cross tied.
2. Water collector filter and floor drains filter can be cross tied.
3. Except for turbine building fire water sump pump.

TABLE 11.2-9

EVALUATION OF LIQUID RADWASTE SYSTEM CAPACITY FOR HANDLING LARGE WASTE INPUT VOLUMES

Waste Input Description	Input Rate, (gpm)	Input Duration, (Minutes)	Total per Occurrence (Gal/day)	Frequency of Occurrence	Disposition of Waste Input
1. High purity (equipment drains) subsystem:					
a. Max. normal quantity of miscellaneous equipment leakage	50 to 500	Inter-mittent	33,000	158 days per year	Collect in one waste collector tank and process. Total process time is approximately 8 hours per occurrence.
b. Maximum quantity of miscellaneous equipment leakage (estimated quantity taken from ANSI N197-1976)[1]	50 to 500	Inter-mittent	73,100	14 days per year	Collect in both waste collector tanks and process. Total process time is approximately 16 hours per occurrence.
c. Condensate polishing demineralizer rinse during condenser tube leak period or plant startup.[3]	200	207	41,500	60 days per year	Collect in two waste collector tanks (or FDCT) and process. Total process time is approximately 10 hours per occurrence.
d. Reactor blowdown via reactor water cleanup system during startup (normally directed to main condenser)[3]	300	180	54,000	Rare	Collect in both waste collector tanks and process. Total process time is approximately 12 hours per occurrence.
e. Suppression pool drain (for decontamination, inspection, and maintenance of pool)[2,3]	1000	1000 (Inter-mittently)	1,000,000	Once every 10 years	Collect in one waste collector tank and one floor drain collector tank in 34,000 gallon batches as these tanks become available. Total process time is approximately 150 hours per occurrence

TABLE 11.2-9 (Continued)

Waste Input Description	Input Rate, (gpm)	Input Duration, (Minutes)	Total per Occurrence (Gal/day)	Frequency of Occurrence	Disposition of Waste Input
f. Spent fuel shipping cask pit drawdown(3)	200	235	47,000	18 days per year	Collect in two waste collector tanks and process. Total process time is approximately 10 hours.
g. RHR flush/test(3)	2000	20.4	40,800	24 days per year	Collect in two waste collector tanks and process. Total process time is approximately 10 hours.
2. Low purity (floor drains) subsystem:					
a. Max. normal quantity of miscellaneous floor drainage	25 to 750	Inter-mittent	13,000	158 days per year	Collect in one floor drain collector tank and process. Total process time is approximately 3 hours per occurrence.
b. Maximum quantity of miscellaneous drainage (Estimated quantity taken from ANSI N197-1976)(1)	25 to 750	Inter-mittent	67,600	14 days per year	Collect in both floor drain collector tanks and process. Total process time is approximately 15 hours.
c. Decant from backwash settling tanks for reactor waster cleanup filter/demineralizers and condensate polishing filters during startup or condenser tube leak period.	450	90 (Inter-mittently)	39,200	60 days per year	Collect in both floor drains collector tanks in 8,000 gallon batches and process. Total process time is approximately 9 hours.
3. Chemical waste subsystem:					
a. Condensate polishing demineralizer regeneration solutions during startup or condenser tube leak period.	200	65	13,000	60 days per year	Collect in one chemical waste tank and process. Total process time is approximately 8 hours.

TABLE 11.2-9 (Continued)

NOTES:

1. The maximum leak rate used here is for the drywell. It is assumed to occur in both drywells simultaneously, even though the probability of this happening is very low. This maximum leak rate could also occur in the containment, turbine power complex, auxiliary bldg., radwaste bldg., control complex, or intermediate bldg. However, the probability of simultaneous leakage in these areas while the maximum leakage rate is assumed in both drywells is extremely low. Since these areas are accessible, it is assumed that repairs could be made quickly enough to avoid such multiple failures.

2. The total volume of water in the suppression pool is approximately 1,000,000 gallons. Since the reactor will be completely shut down while the pool is being inspected, the condenser hotwell can be used to store a portion of this volume (approximately 500,000 gallons). The remaining portion of the pool inventory will be pumped to the LRW system as tankage in this system becomes available to collect and process this waste. (It is assumed that one reactor will still be operating, requiring half of the LRW system processing capacity to be available for handling waste from the operating unit).

3. These inputs can be diverted to the low purity (floor drains) subsystem if processing conditions warrant.

TABLE 11.2-10

PROCESS FLOW DATA FOR LIQUID RADWASTE SYSTEM

Stream Number	Stream Description	Normal Batches/Day	Maximum Batches/Day	Gallons/ Batch	Solids/ Batch (Pounds)	Normal Gal/Yr (Both Units)	Isotopic Activity[1]
1-a	Drywell Floor Drains (each unit)	2.82	113.3	255	N/A	525,000	M
1-b	Containment Floor Drains (each unit)	2.56	38.5	390	N/A	729,000	M
1-c	Turbine Building Floor Drains (each unit)	2.0	2.0	1,000	N/A	1,460,000	S
1-d	Radwaste Building Floor Drains (common)	2.0	2.0	500	N/A	365,000	R
1-e	Auxiliary Building Floor Drains (each unit)	1/1.72	43.5	345	N/A	146,000	M
1-f	Heater Bay Floor Drains (each unit)	-	1.0	270	N/A	-	S
1-g	Annulus Floor Drains (each unit)	-	1/5.0	50	N/A	-	(S+M)/2
1-h	Intermediate Building Floor Drains (common)	3.2	20.0	500	N/A	584,000	M
2	Decantate from SRW Disposal System	1.0	-	250	N/A	91,000	S/4
3	RHR Flush/Test (each unit)	1/30	2.0	40,800	N/A	993,000	Negligible

TABLE 11.2-10 (Continued)

Stream Number	Stream Description	Normal Batches/Day	Maximum Batches/Day	Gallons/ Batch	Solids/ Batch (Pounds)	Normal Gal/Hr (Both Units)	Isotopic Activity[1]
7	Floor Drains Effluent to Condenser	1/2.65	-	35,000	N/A	4,821,000	
8	Floor Drains Effluent Design Discharge	-	1/5.3	35,000	N/A	2,410,000 (max)	See Table 11.2-15
9-a	Recirc. Pumps & Valves in Drywell (each unit)	8.6	57.8	360	N/A	2,260,000	M
9-b	Drywell Steam Valves and Coolers in Drywell (each unit)	8.6	57.8	140	N/A	879,000	S
9-c	Misc. Pumps, Valves, and RCIC Equip. in Containment (each unit)	9.64	35.86	265	N/A	1,865,000	M
9-d	Steam Valves in Containment (each unit)	9.64	35.86	50	N/A	352,000	S
9-e	RWCU Sample Drains in Containment (each unit)	9.64	35.86	125	N/A	880,000	M
9-f	Radwaste Building Equipment Drains (common)	1.0	1.0	500	N/A	182,000	R
9-g	Turbine Building Equipment Drains (each unit)	5.76	5.76	1,000	N/A	4,205,000	S
9-h	Auxiliary Building Equipment Drains (each unit)	1/11.2	1/3.0	675	N/A	44,000	M x 10^2
9-j	Intermediate Building Equipment Drains (common)	1/10.0	1/5.0	500	N/A	18,000	R

TABLE 11.2-10 (Continued)

Stream Number	Stream Description	Normal Batches/Day	Maximum Batches/Day	Gallons/ Batch	Solids/ Batch (Pounds)	Normal Gal/Yr (Both Units)	Isotopic Activity[1]
9-k	Control Complex Equipment Drains (common)	1/5.0	1.0	500	N/A	37,000	Negligible
10	Cond. Demin. Rinse (each unit)	1/14.6	1/2.0	41,500	N/A	2,075,000	S/4
11	Reactor Blowdown via RWCU (each unit)	-	Rare	-	-	-	-
13-g	W.D. Effluent Design Discharge	-	1/4.5	35,000	N/A	2,839,000 (max)	See Table 11.2-15
13-h	W.D. Effluent to Condenser	1.12	-	35,000	N/A	14,308,000	
14	Cond. Mixed Bed Demin. Regeneration Solutions (each unit)	1/14.6	1/2.0	13,000	N/A	650,000	See Note 3
15	Chemical Drains (each unit)	1.1	1.1	500	N/A	401,000	M/4
17	Evaporator Bottoms (both units)						
	a. Radioactive Regen. Solutions	1/7.3	1/2.0	480	N/A	24,000	Regen. Solution Concentrates
	b. Chemical Drains	1/7.3	1/2.0	160	N/A	8,000	
23-a	Radioactive Chemical Waste Distillate	1/7.3	1/2.0	15,360	N/A	768,000	Regen. Sol. Distillate

TABLE 11.2-10 (Continued)

Stream Number	Stream Description	Normal Batches/Day	Maximum Batches/Day	Gallons/ Batch	Solids/ Batch (Pounds)	Normal Gal/Yr (Both Units)	Isotopic Activity(1)
24	Radioactive Chemical Waste Effluent Design Discharge	-	1/36.5	15,360	N/A	154,000 (max)	See Table 11.2-15
25	Hot Shower and Detergent Drains	3.0	3.0	500	-	547,000	Negligible
27	Detergent Waste Effluent	1.48	2.65	1,600	-	864,000	Negligible
29	Radioactive Evap. Bottoms to SRW	1/51	1/14	5,000	-	36,000	See Table 11.4-2
30	Floor Drains Demin. Spent Resins Transfer	1/30.5	1/22.35	1,455	1,970	17,000	Buildup on F.D. Demin.
31	Waste Demineralizer Spent Resins Transfer	1/35	1/15.35	1,455	1,970	15,000	Buildup on Waste Demineralizer
34-a	Cond. Demin. Spent Resins to SRW Disposal (both units)	6/3.6 yrs	6/3.6 yrs	9,970	12,090	17,000	See Table 11.4-2
34-b	W.D., F.D. and S.P.D. Spent Resins to SRW Disposal	1/83.5	1/31.6	9,980	11,700	44,000	See Table 11.4-2
35	Condensate Filter Backwash (each unit)	1/3.0	8.0	5,200	360	1,265,000	See Note 5
40	Cond. Filter Sludge to SRW Disposal	2/36.0	1/2	7,000	4,350	142,000	See Note 6
43	Avg. CBST Decantate	1/1.5	8.0	4,610	N/A	1,122,000	S/6

TABLE 11.2-10 (Continued)

Stream Number	Stream Description	Normal Batches/Day	Maximum Batches/Day	Gallons/ Batch	Solids/ Batch (Pounds)	Normal Gal/Yr (Both Units)	Isotopic Activity(1)
45	RWCU F/D Backwash (each unit)	1/6.5	1.0	2,400	70	270,000	See Note 7
48	RWCU F/D Sludge to SRW Disposal	2/97.5	5/30	2,150	1,040	16,000	See Note 8
51	Avg. RBST Decantate	1/3.25	1.0	2,300	N/A	258,000	M/4
53	Fuel Pool F/D Backwash	1/5.2	1/5.2	2,160	65	152,000	See Note 2
62	Fuel Pool F/D Sludge to SRW Disposal	1/348	1/30	7,000	4,350	7,000	See Note 9
65	Decantate from Fuel Pool Filter Backwash	1/5.2	1/5.2	2,055	N/A	144,000	Negligible
81	Cask Pit Draw-Down	1/20.3	-	47,000	N/A	845,000	Negligible
84	Suppression Pool Maintenance Drain (each unit)	-	1/10 yrs	1,000,000	N/A	-	Negligible
86	Cond. Mixed Bed Demin. Spent Resins Transfer (each unit)	6/3.6 yrs	6/3.6 yrs	4,950	5,750	16,000	See Note 4
87	Suppression Pool Cleanup Demin. Spent Resins Transfer	1/30	1/15	1,750	2,365	21,000	Buildup on Suppression Pool Cleanup Demin.

TABLE 11.2-10 (Continued)

NOTES:

1. M = maximum concentration in reactor water.

   S = maximum concentration in condensate.

   R = maximum concentration in radwaste sump.

2. Activity for this stream is 1.0 Curie/year, based on operating data from Nine Mile Point Nuclear Station, Unit No. 1.

3. Activity is calculated on basis of 1.38×10^8 gallons of water treated by the condensate demineralizers every 90 days.

4. Activity is calculated on basis of 1.38×10^8 gallons of water treated by the condensate demineralizers every 90 days plus M/4 times the demineralizer backwash volume.

5. Activity is calculated on the basis of the filter/demineralizer buildup per batch (0.98 curies) plus S/6 times the backwash volume.

6. Activity is calculated on the basis of the filter/demineralizer buildup for 8 days at the normal condensate flow rate (6.5 curies), a fill time of 4 days, and a decay time of 2 days.

7. Activity is calculated on the basis of the filter/demineralizer buildup per batch (355 curies) plus M/4 times the backwash volume.

8. Activity is calculated on the basis of the RWCU buildup per batch (355 curies) plus M/4 times the backwash volume, a fill time of 60 days, and a decay time of 60 days.

9. Activity is calculated on the basis of the filter buildup per batch, a fill time of 100 days and a decay time of 100 days.

TABLE 11.2-11

QUALITY REQUIREMENTS FOR CONDENSATE MAKEUP

a.	Specific Conductivity at 25°C	< 1.0 μmho/cm
b.	pH at 25°C	5.3 to 7.5
c.	Chloride (as Cl^-)	< 0.05 ppm

TABLE 11.2-12

CRITERIA FOR SELECTION OF PROCESS FLOW PATH FOR LIQUID RADWASTE SYSTEM INPUTS

Subsystem		Description Process Flow Path[(1)]		Criteria for Selecting Process Flow Path[(1)]
High purity/ low conductivity	a.	Collect, Sample, and Reuse.	a.	Batch is within the limits for condensate makeup given in Table 11.2-11.
	b.	Collect, Sample, Body Feed, Filter, Demineralize, and Reuse.	b.	Batch is above any limit given in Table 11.2-11. Conductivity <100 μmho/cm
	c.	Collect, Sample, Body Feed, Filter, Evaporate/Condense, Demineralize, and Discharge or Reuse.	c.	Batch is above any limit given in Table 11.2-11. Conductivity > 100 μmho/cm
Medium-to-low purity/medium conductivity	a.	Collect, Body Feed, Filter, Demineralize, and Reuse.	a.	Conductivity <100 μmho/cm
	b.	Collect, Body Feed, Filter, Evaporate/Condense, Demineralize, and Reuse or Discharge.	b.	Conductivity >100 μmho/cm
Detergent Drains	a.	Collect, Sample, Filter and send to Sanitary Waste Disposal.	a.	Less than limit of 10 CFR 20.303
	b.	Collect, Sample, Filter, Evaporate/ Condense, Demineralize, and Discharge.	b.	Greater than limits of 10 CFR 20.303

NOTE:

1. Depending on actual processing conditions, these flow paths and processing criteria may change.

TABLE 11.2-13

SIGNIFICANT NUCLIDE
ANNUAL RELEASE TO DISCHARGE CANAL

Nuclide	Annual Release to Discharge Tunnel (Ci/yr/unit)	Concentration In Plant Discharge (μCi/cc)	MPC (μCi/cc)	Fraction of MPC
Na-24	.00004	4.5-13	3-5	1.5-8
P-32	.00017	1.9-12	2-5	9.6-8
Cr-51	.0059	6.7-11	2-3	3.3-8
Mn-54	.0001	1.1-12	1-4	1.1-8
Co-58	.0003	3.4-12	9-5	3.8-8
Co-60	.00071	8.0-12	3-5	2.7-7
Fe-55	.0018	2.0-11	2-3	1.0-8
Fe-59	.00004	4.5-13	5-5	9.0-9
Cu-64	.00011	1.2-12	2-4	6.2-9
Zn-65	.00034	3.8-12	1-4	3.8-8
Np-239	.00049	5.5-12	1-4	5.5-8
Sr-89	.00014	1.6-12	3-6	5.3-7
Sr-90	.00001	1.1-13	3-7	3.8-7
Y-91	.0001	1.1-12	3-5	3.8-8
Nb-95	.00001	1.1-13	1-4	1.1-9
Mo-99	.00016	1.8-12	4-5	4.5-8
Tc-99m	.00017	1.9-12	3-3	6.4-10
Ru-103	.00003	3.4-13	8-5	4.2-9
Rh-103m	.00003	3.4-13	1-2	3.4-11
Ru-106	.00001	1.1-13	1-5	1.1-8

TABLE 11.2-13 (Continued)

Nuclide	Annual Release to Discharge Tunnel (Ci/yr/unit)	Concentration In Plant Discharge (μCi/cc)	MPC (μCi/cc)	Fraction of MPC
Te-129m	.00005	5.6-13	2-5	2.8-8
Te-129	.00003	3.4-13	8-4	4.2-10
I-131	.13	1.5-9	3-7	4.9-3
I-133	.0011	1.2-11	1-6	1.2-5
Cs-134	.0015	1.7-11	9-6	1.9-6
I-135	.00006	6.8-13	4-6	1.7-7
Cs-136	.00043	4.9-12	6-5	8.1-8
Cs-137	.0034	3.8-11	2-5	1.9-6
Ba-137m	.0032	3.6-11	3-6	1.2-5
Ba-140	.0003	3.4-12	2-5	1.7-7
La-140	.00034	3.8-12	2-5	1.9-7
Ce-141	.00004	4.5-13	9-5	5.0-9
Pr-143	.00003	3.4-13	5-5	6.8-9
Ce-144	.00001	1.1-13	1-5	1.1-8
All others (except H-3)	.0001	1.1-12	-	-
Total (except H-3)	.15	1.7-9	-	4.9-3
H-3	47	5.3-7	3-3	1.8-4

TABLE 11.2-14

ANNUAL RELEASE BY STREAM TO DISCHARGE CANAL[(1)]

Nuclide	Annual Releases to Discharge Canal: High Purity (Curies)	Low Purity (Curies)	Chemical (Curies)	Total LWS (Curies)	Adjusted Total (Ci/yr)
Na24	*	*	*	*	0.00004
P32	*	*	*	*	0.00017
Cr51	*	*	0.00014	0.00014	0.0059
Mn54	*	*	*	*	0.00010
Fe55	*	*	0.00004	0.00004	0.0018
Fe59	*	*	*	*	0.00004
Co58	*	*	0.00001	0.00001	0.0003
Co60	*	*	0.00002	0.00002	0.00071
Cu64	*	*	*	*	0.00011
Zn65	*	*	0.00001	0.00001	0.00034
Zr95	*	*	*	*	*
Nb95	*	*	*	*	*
Np239	*	*	0.00001	0.00001	0.00039
Sr89	*	*	*	*	0.00014
Sr90	*	*	*	*	0.00001
Y91	*	*	*	*	0.00010
Nb95	*	*	*	*	0.00001
Mo99	*	*	*	*	0.00016
Tc99m	*	*	*	*	0.00017
Ru103	*	*	*	*	0.00003
Rh103m	*	*	*	*	0.00003
Ru106	*	*	*	*	0.00001
Ag110m	*	*	*	*	*
Te129m	*	*	*	*	0.00005
Te129	*	*	*	*	0.00003
I131	*	*	0.00307	0.00308	0.13
I133	0.00001	*	0.00002	0.00003	0.0011
Cs134	*	*	0.00003	0.00003	0.0015
I135	*	*	*	*	0.00006
Cs13[illegible]	*	*	0.00001	0.00001	0.00043
Cs[illegible]	*	*	0.00008	0.00008	0.0034
Ba[illegible]	*	*	0.00007	0.00008	0.0032
[illegible]	*	*	0.00001	0.00001	0.00030
[illegible]	*	*	0.00001	0.00001	0.00034
[illegible]	*	*	*	*	0.00004
[illegible]	*	*	*	*	0.00003
[illegible]	*	*	*	*	0.00001
[illegible]rs	*	*	*	*	0.00010
Total (Except Tritium)	0.00002	0.00001	0.00354	0.00357	0.15

Tritium Relea[illegible] 47 Curies per year

NOTE:

1. Asterisk indicates less than .00001 Ci.

TABLE 11.2-15

INPUT PARAMETERS FOR CALCULATING LIQUID RELEASES (GALE)

MAXIMUM CORE THERMAL POWER - 3758 Mwt

REACTOR COOLANT CLEANUP SYSTEM

Average flow rate - 1.54×10^5 lb/hr

Demineralizer type - powdered resin

CONDENSATE DEMINERALIZERS

Average flow rate - 10.5×10^6 lb/hr

Demineralizer type - deep bed

Number and size (ft^3) of demineralizers - six condensate demineralizers each containing 260 cubic feet of mixed resin

Regeneration frequency - 3.5 days per demineralizer for a total regeneration time of 21 days

Regenerant volume - 12,000 gallons/batch

TABLE 11.2-15 (Continued)

LIQUID WASTE PROCESSING SYSTEMS

Name	Sources	Flow[1] Rates (gpd)	Fraction of Primary Coolant Activity	Holdup Times Collection/ Discharge (days)	Fraction Assumed Discharge
High Purity Waste	Equipment Drains				
	Drywell	4300	1.0	1.7/.65	0.1
	Containment	2550	.01	1.7/.65	0.1
	Radwaste Building	500	.01	1.7/.65	0.1
	Turbine Building	5760	.01	1.7/.65	0.1
	Auxiliary Building	60	.01	1.7/.65	0.1
	Intermediate Building	25	.01	1.7/.65	0.1
	Control Complex	50	Negligible	1.7/.65	0.1
	Drywell and Containment Steam Valves	1685	.01	1.7/.65	0.1
	Cond. Demin. Rinse	1230	.002	1.7/.65	0.1
	RHR Flush/Test	340	Negligible	1.7/.65	0.1
Low Purity Waste	Floor Drains				
	Drywell	720	1.0	1.7/.65	0.25
	Containment	1000	.01	1.7/.65	0.25
	Turbine Building	2000	.01	1.7/.65	0.25
	Radwaste Building	500	.01	1.7/.65	0.25
	Auxiliary Building	200	.01	1.7/.65	0.25
	Intermediate Building	800	.01	1.7/.65	0.25
	Decantate	2210	.002	1.7/.65	0.25
Chemical Waste	Chemical Drains	275	.02	6.1/.37[2]	0.1
Regenerant Waste	Cond. Mixed Bed Demin. Reg. Sol.	820	(3)	6.1/.37[2]	0.1

TABLE 11.2-15 (Continued)

Name	Component	Capacity	Decontamination Factors Halogens/Cs, Rb/Other Nuclides
High Purity Waste	Waste Collector Tank	35,000 gallons	N/A
	Waste Sample Tank	35,000 gallons	N/A
	Waste Collector Filter	144,000 gpd	1/1/1
	Waste Evaporator	43,200 gpd	$10^3/10^4/10^4$
	Waste Demineralizer	288,000 gpd	$10^2/10/10^2$
Low Purity Waste	Floor Drains Collector Tank	35,000 gallons	N/A
	Floor Drains Sample Tank	35,000 gallons	N/A
	Floor Drains Filter	144,000 gpd	1/1/1
	Waste Evaporator	43,200 gpd	$10^3/10^4/10^4$
	Floor Drains Demineralizer	288,000 gpd	$10^2/2/10^2$
Chemical Waste	Chemical Waste Tank	20,000 gallons	N/A
	Chemical Waste Distillate Tank	20,000 gallons	N/A
	Waste Evaporator	43,200 gpd	$10^3/10^4/10^4$
	Waste or Floor Drains Demineralizer	288,000 gpd	$10^2/2/10^2$
Regenerant(4) Waste			

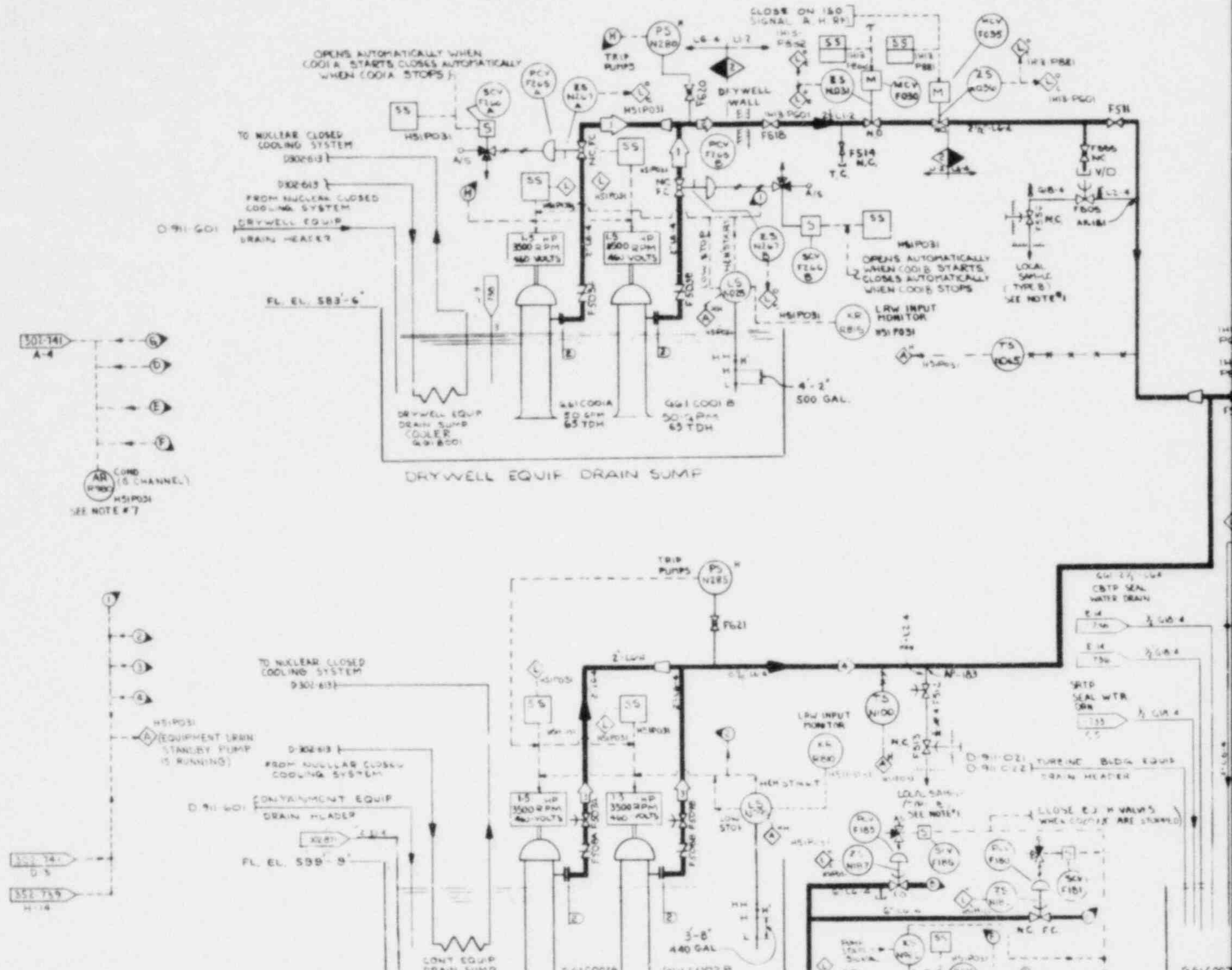
NOTES:

1. Values based on one-half of the total flow for two units.

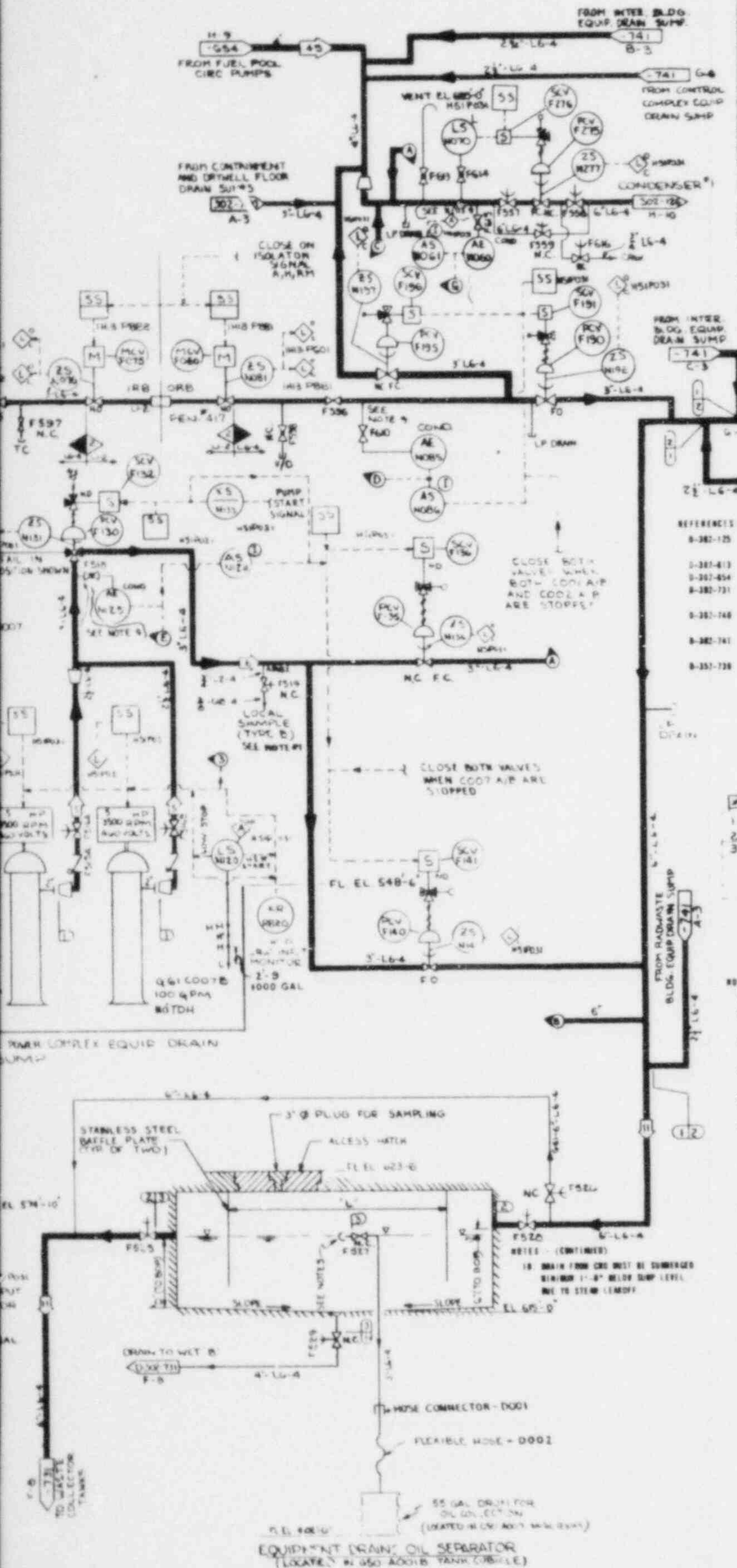
2. Collection time is based on total flow for chemical waste and regenerant waste since they utilize a common tank.

3. Value calculated internally in BWR-GALE Code.

4. Part of chemical waste system.



DRYWELL EQUIP DRAIN SUMP
OPENS AUTOMATICALLY WHEN C001A STARTS CLOSES AUTOMATICALLY WHEN C001A STOPS
TO NUCLEAR CLOSED COOLING SYSTEM
FROM NUCLEAR CLOSED COOLING SYSTEM
DRYWELL EQUIP DRAIN HEADER
FL. EL. 583'-6"
DRYWELL EQUIP DRAIN SUMP COOLER
G61C001A
G61C001B
4'-2"
500 GAL.
TRIP PUMPS
DRYWELL WALL
CLOSE ON ISO SIGNAL
OPENS AUTOMATICALLY WHEN C001B STARTS CLOSES AUTOMATICALLY WHEN C001B STOPS
LRW INPUT MONITOR
LOCAL SAMPLE (TYPE B) SEE NOTE
SEE NOTE #7
CONTAINMENT EQUIP DRAIN SUMP
TO NUCLEAR CLOSED COOLING SYSTEM
FROM NUCLEAR CLOSED COOLING SYSTEM
CONTAINMENT EQUIP DRAIN HEADER
FL. EL. 599'-9"
CONT EQUIP DRAIN SUMP COOLER
3'-8"
440 GAL
EQUIPMENT DRAIN STANDBY PUMP IS RUNNING
TURBINE BLDG EQUIP DRAIN HEADER
CBTP SEAL WATER DRAIN
AUXILARY BLDG EQUIP DRAIN HEADER
AUXILARY BLDG EQUIP DRAIN SUMP
(SEE NOTE 6)
FLOOR DRAINS HEADER
3" Ø PLUG FOR SAMPLING
ACCESS HATCH
STAINLESS STEEL BAFFLE PLATE (TYP OF TWO)
SLOPE
HOSE CONNECTOR-D003
FLEXIBLE HOSE-D004
DRAIN TO FDCT
FLOOR DRAINS OIL SEPARATOR
(LOCATED IN G50-A003B TANK CUBICLE)



	OPERATING DATA				
#	PSIG	GPM	F	BY	REMARKS
1	25	50	150	KWE	
2	25	50-400	150	KWE	
3	25	50	150	KWE	
4	25	50-400	150	KWE	
5	50	100	70	KWE	
6	50	[illegible]-300	70	KWE	
11	5	50-500	70-1[illegible]	KWE	
43	30	250	70	KWE	
44	30	250-500	70	KWE	
45	100	300	120	KWA	INTERMITTENT

REFERENCES

- D-302-125 MAIN REHEAT, EXTRACTION AND MISCELLANEOUS DRAINS N27
- D-302-613 NUCLEAR CLOSED COOLING SYSTEM P43
- D-302-654 FUEL POOL COOLING AND CLEANUP SYSTEM G41
- D-302-731 LRW - FLOOR DRAIN COLLECTOR TANKS AND WASTE COLLECTOR TANKS G50
- D-302-740 LIQUID RADWASTE SUMPS SYSTEM - FLOOR DRAIN SUMPS G61
- D-302-741 LIQUID RADWASTE SUMPS SYSTEM - LAUNDRY, CHEMICAL AND COMMON FLOOR AND EQUIPMENT DRAIN SUMPS G61
- D-352-739 LIQUID RADWASTE SUMPS SYSTEM - EQUIPMENT DRAIN SUMPS G61

DESIGN DATA

#	NORMAL PSIG	NORMAL F	UPSET PSIG	UPSET F	Y	BY	CHKD	REMARKS
1	100	150	NA	NA	NA	KWE	[illegible]	
2	100	200	NA	NA	NA	KWE	[illegible]	
3	15	150	NA	NA	NA	KWE	[illegible]	

NOTES

1. FOR DETAILS OF LOCAL SAMPLES, SEE DWG. D-302-771
2. FOR LEAK DETECTION SYSTEM INSTRUMENTATION, SEE DWG. D-302-864
3. LINE SIDES, TOP, AND BOTTOM OF EACH OIL SEPARATOR WITH STAINLESS STEEL PLATE.
4. MINIMUM DIMENSIONS OF OIL SEPARATION CHAMBER SHALL BE 10'L X 22"-2"W X 5'-4"D
5. CENTER LINE OF ALL SKIMLINE SHALL BE AT NORMAL WATER LEVEL
6. SEE SYSTEM DESCRIPTION G61 FOR DETAILS OF OPERATION FOR AUXILIARY BUILDING EQUIPMENT DRAIN SUMPS
7. CONDUCTIVITY RECORDER PRINTS CONDUCTIVITY ONLY WHEN SUMP PUMP IS IN OPERATION AND ONLY FOR SUMP ASSOCIATED WITH THAT PUMP
8. ALL LOW POINT (L.P.) DRAINS, TEST CONNECTIONS (T.C.'S) AND VENT/DRAIN (V/D) CONNECTIONS SHALL BE 3/4" NOMINAL PIPE SIZE, UNLESS OTHERWISE NOTED
9. ROOT VALVES FOR CONDUCTIVITY CELLS, WHERE NOTED, SHALL BE SUPPLIED WITH CELL AND DESIGNED TO ALLOW REMOVAL OF CELL FROM PROCESS LINE THROUGH BODY OF VALVE. FOR THESE CASES A STAINLESS STEEL 1-1/4" NPT CONNECTION SHALL BE PROVIDED ON THE PROCESS PIPE FOR MATING WITH THE SPECIAL ROOT VALVE

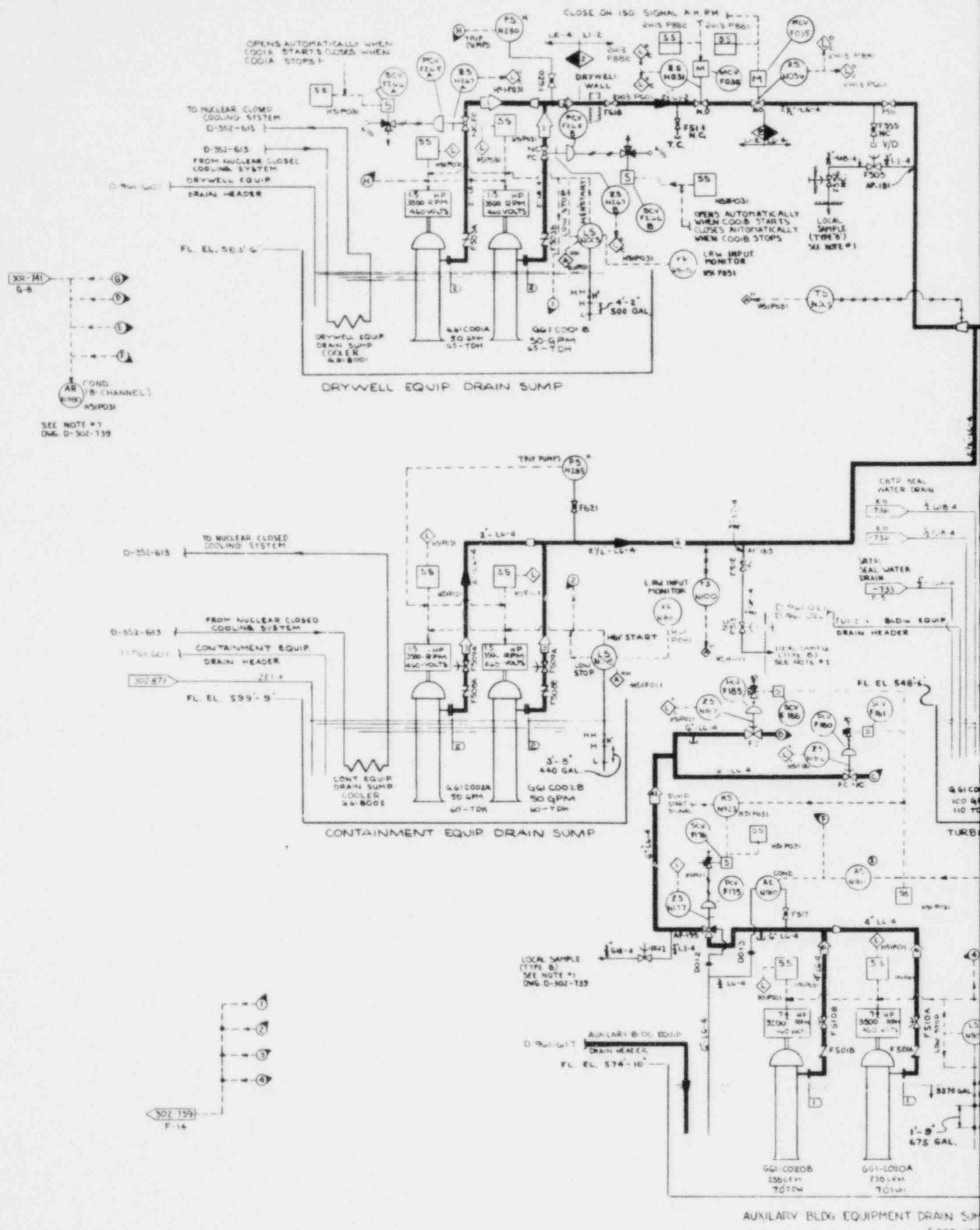
NOTES - (CONTINUED)

10. DRAIN FROM CRD MUST BE SUBMERGED MINIMUM 1'-0" BELOW SUMP LEVEL DUE TO STEAM LEAKOFF.

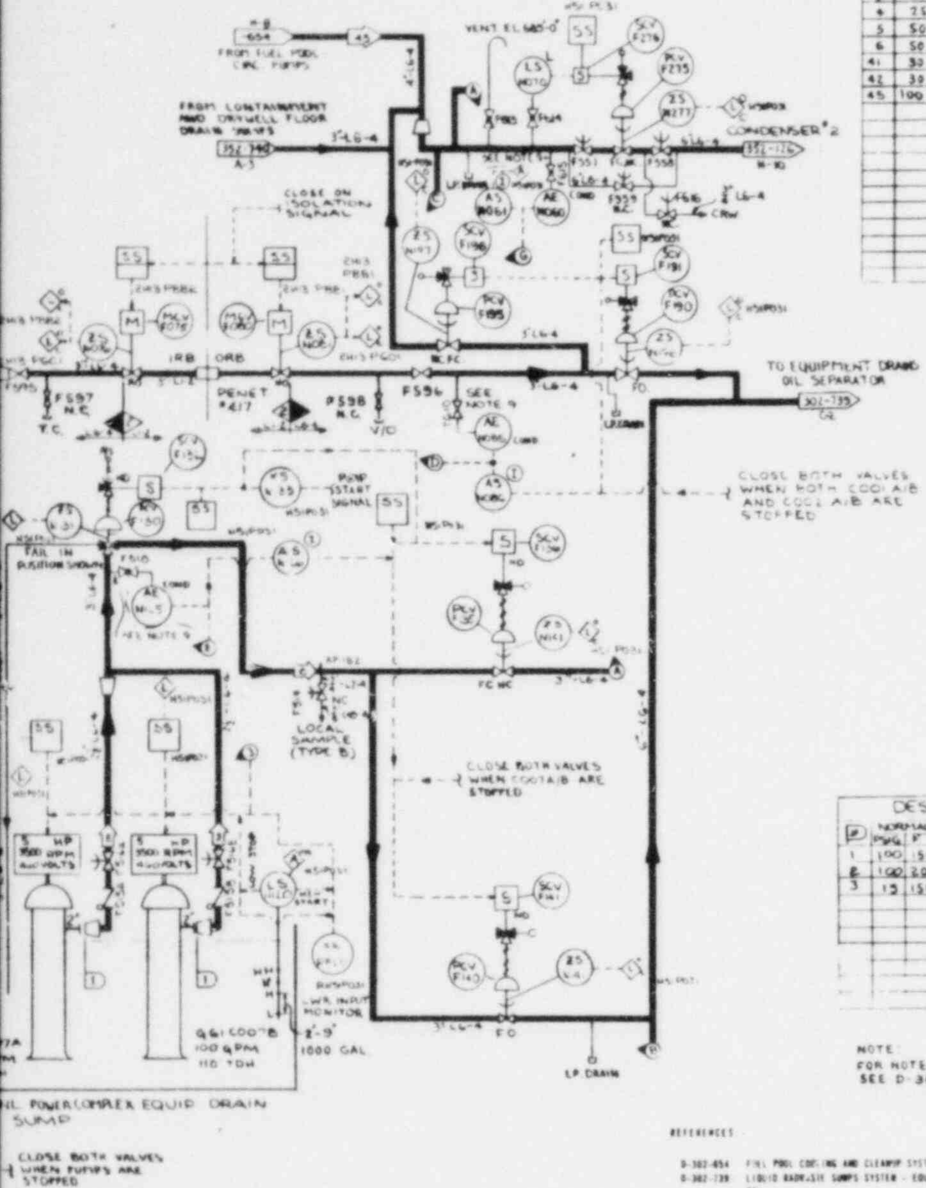
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 1 of 15)
(GAI Dwg. D-302-739)



DRYWELL EQUIP. DRAIN SUMP
CONTAINMENT EQUIP. DRAIN SUMP
AUXILARY BLDG EQUIPMENT DRAIN SUMP
CLOSE ON ISO. SIGNAL A.H.P.M.
OPENS AUTOMATICALLY WHEN C001A STARTS CLOSES WHEN C001A STOPS
TO NUCLEAR CLOSED COOLING SYSTEM
D-352-615
FROM NUCLEAR CLOSED COOLING SYSTEM
DRYWELL EQUIP DRAIN HEADER
FL. EL. 583'-6"
DRYWELL EQUIP DRAIN SUMP COOLER
G61C001A 50 GPM 65-TDH
G61C001B 50 GPM 65-TDH
4'-2" 500 GAL.
LRW INPUT MONITOR
OPENS AUTOMATICALLY WHEN C001B STARTS CLOSES AUTOMATICALLY WHEN C001B STOPS
LOCAL SAMPLE (TYPE B) SEE NOTE #1
DRYWELL WALL
SEE NOTE #7 DWG. D-302-739
CONTAINMENT EQUIP DRAIN HEADER
FL. EL. 599'-9"
CONT EQUIP DRAIN SUMP COOLER G61B002
G61C002A 50 GPM 60-TDH
G61C002B 50 GPM 60-TDH
3'-8" 440 GAL.
TRIP PUMPS
FL. EL. 548'-6"
CBTP SEAL WATER DRAIN
BLDG EQUIP DRAIN HEADER
AUXILARY BLDG EQUIP DRAIN HEADER
FL. EL. 574'-10"
LOCAL SAMPLE (TYPE B) SEE NOTE #1 DWG D-302-739
G61-C020B
G61-C020A
1'-9" 675 GAL.
302-739



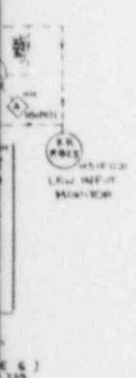
OPERATING DATA					
⟨#⟩	PSIG	GPM	F	BY	REMARKS
1	25	50	150		
2	25	50-100	50		
3	25	50	150		
4	25	50-100	150		
5	50	50	70		
6	50	50-100	70		
41	30	250	70		
42	30	250-500	70		
45	100	300	120		INTERMIT TEST

DESIGN DATA								
⟨#⟩	NORMAL		UPSET			BY		REMARKS
	PSIG	F	PSIG	F	T			
1	100	150	NA	NA	NA	CWE		
2	100	200	NA	NA	NA	CWE		
3	15	150	NA	NA	NA	CWE		

NOTE:
FOR NOTES & REFERENCES
SEE D-302-739

REFERENCES:

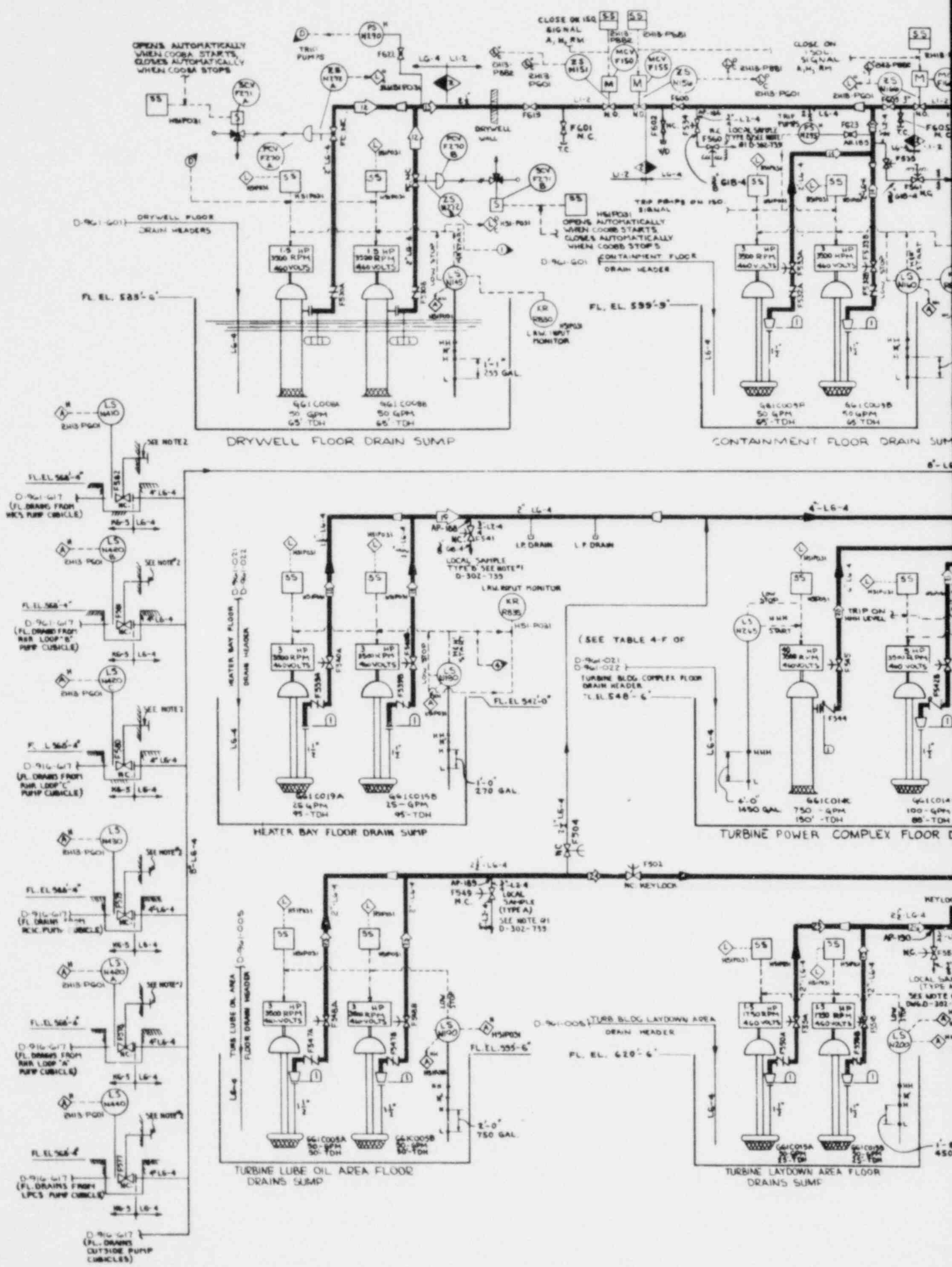
D-302-654 FUEL POOL COOLING AND CLEANUP SYSTEM G41
D-302-739 LIQUID RADWASTE SUMPS SYSTEM - EQUIPMENT DRAIN SUMPS AND OIL SEPARATORS G61
D-352-125 MAIN, REHEAT, EXTRACTION, AND MISCELLANEOUS DRAINS N22
D-352-613 NUCLEAR CLOSED COOLING SYSTEM P43



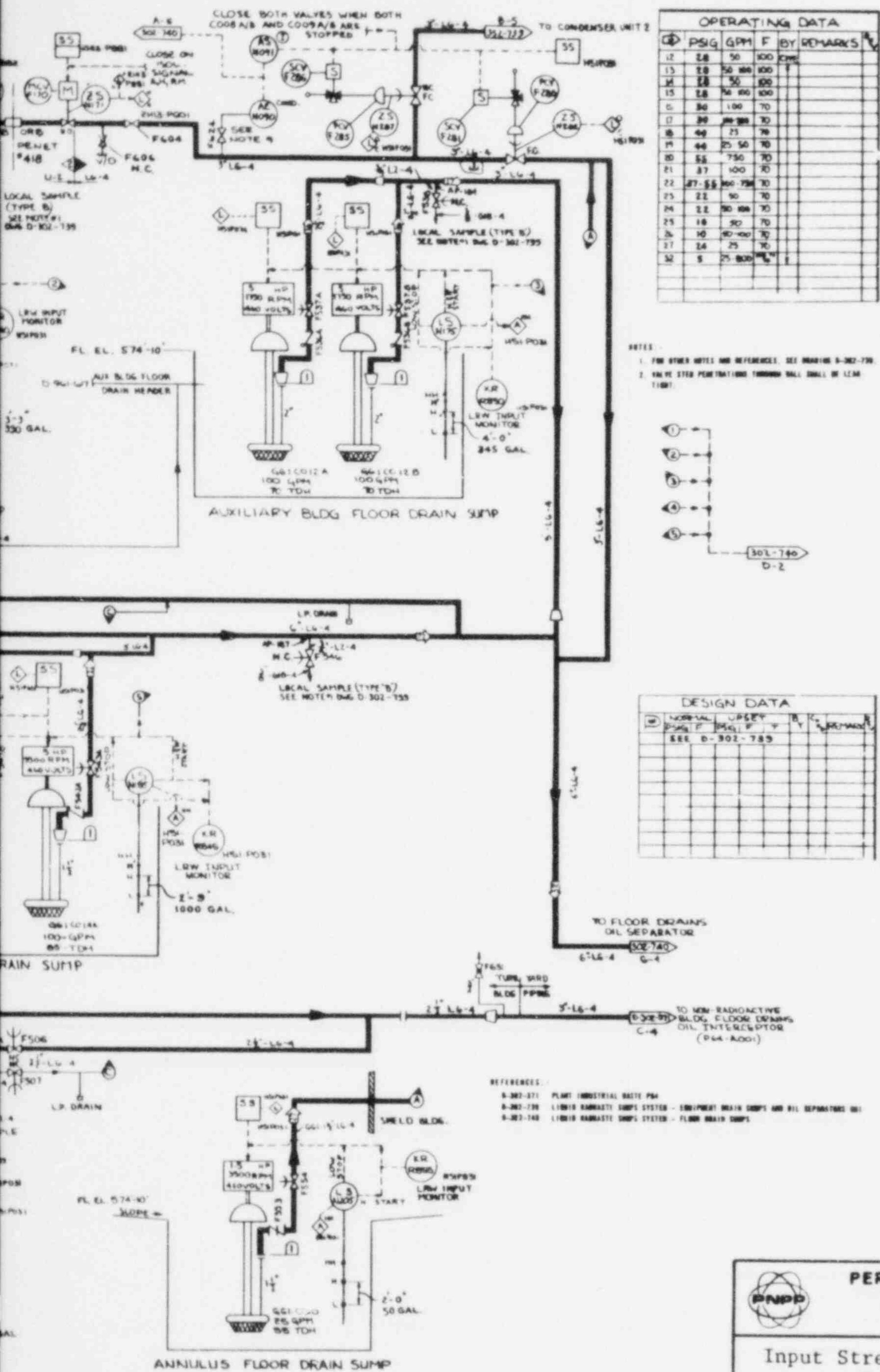
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 2 of 15)
(GAI Dwg. D-352-739)



OPENS AUTOMATICALLY WHEN C008A STARTS, CLOSES AUTOMATICALLY WHEN C008A STOPS
DRYWELL FLOOR DRAIN HEADERS
DRYWELL WALL
OPENS AUTOMATICALLY WHEN C008B STARTS CLOSES AUTOMATICALLY WHEN C008B STOPS
TRIP PUMPS ON ISO SIGNAL
CLOSE ON ISO SIGNAL
CONTAINMENT FLOOR DRAIN HEADER
L.R.W. INPUT MONITOR
DRYWELL FLOOR DRAIN SUMP
CONTAINMENT FLOOR DRAIN SUM
HEATER BAY FLOOR DRAIN HEADER
LOCAL SAMPLE
L.R.W. INPUT MONITOR
(SEE TABLE 4-F OF
TURBINE BLDG COMPLEX FLOOR DRAIN HEADER
TRIP ON HHH LEVEL
HEATER BAY FLOOR DRAIN SUMP
TURBINE POWER COMPLEX FLOOR D
TURB LUBE OIL AREA FLOOR DRAIN HEADER
TURB BLDG LAYDOWN AREA DRAIN HEADER
TURBINE LUBE OIL AREA FLOOR DRAINS SUMP
TURBINE LAYDOWN AREA FLOOR DRAINS SUMP
(FL. DRAINS FROM HPCS PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "B" PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "C" PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "A" PUMP CUBICLE)
(FL. DRAINS FROM LPCS PUMP CUBICLE)
(FL. DRAINS OUTSIDE PUMP CUBICLES)



OPERATING DATA

◇	PSIG	GPM	F	BY	REMARKS
12	28	50	100		
13	28	50-100	100		
14	28	50	100		
15	28	50-100	100		
16	30	100	70		
17	30	100-200	70		
18	44	25	70		
19	44	25-50	70		
20	55	750	70		
21	37	100	70		
22	37-55	100-750	70		
23	22	50	70		
24	22	50-100	70		
25	10	50	70		
26	10	50-100	70		
27	24	25	70		
32	5	25-800	[illegible]		

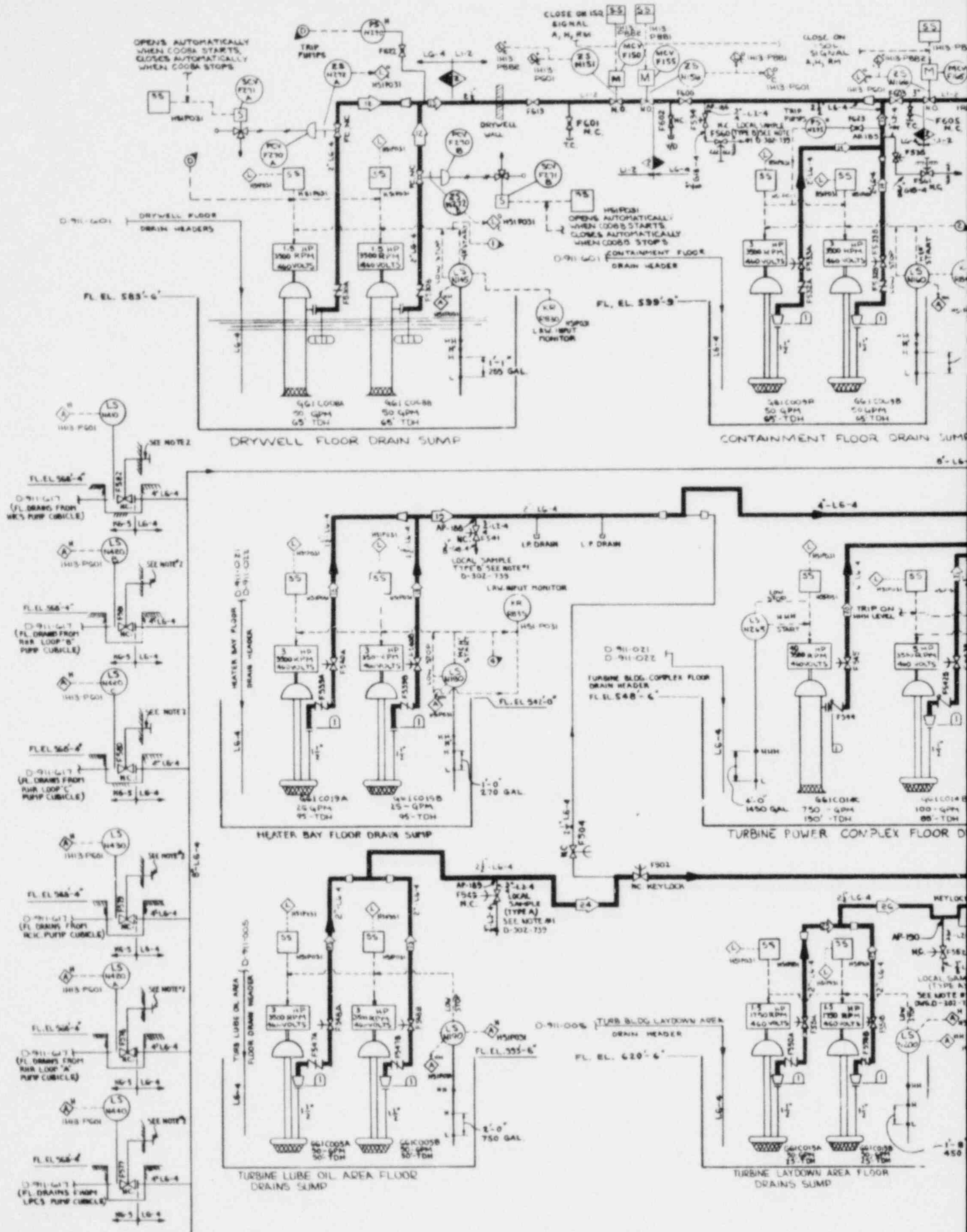
DESIGN DATA

SEE D-302-789

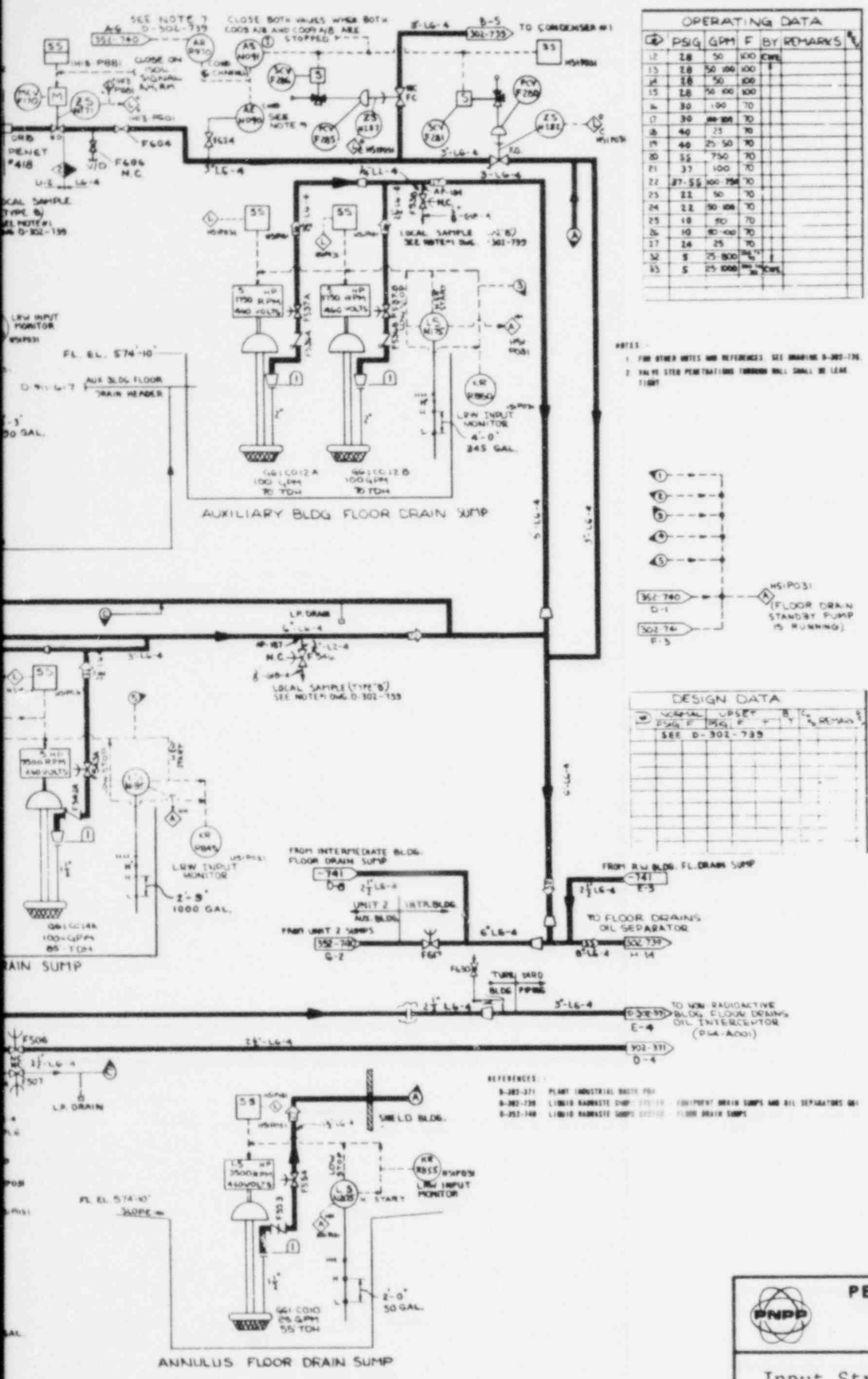
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 3 of 15)
(GAI Dwg. D-302-740)



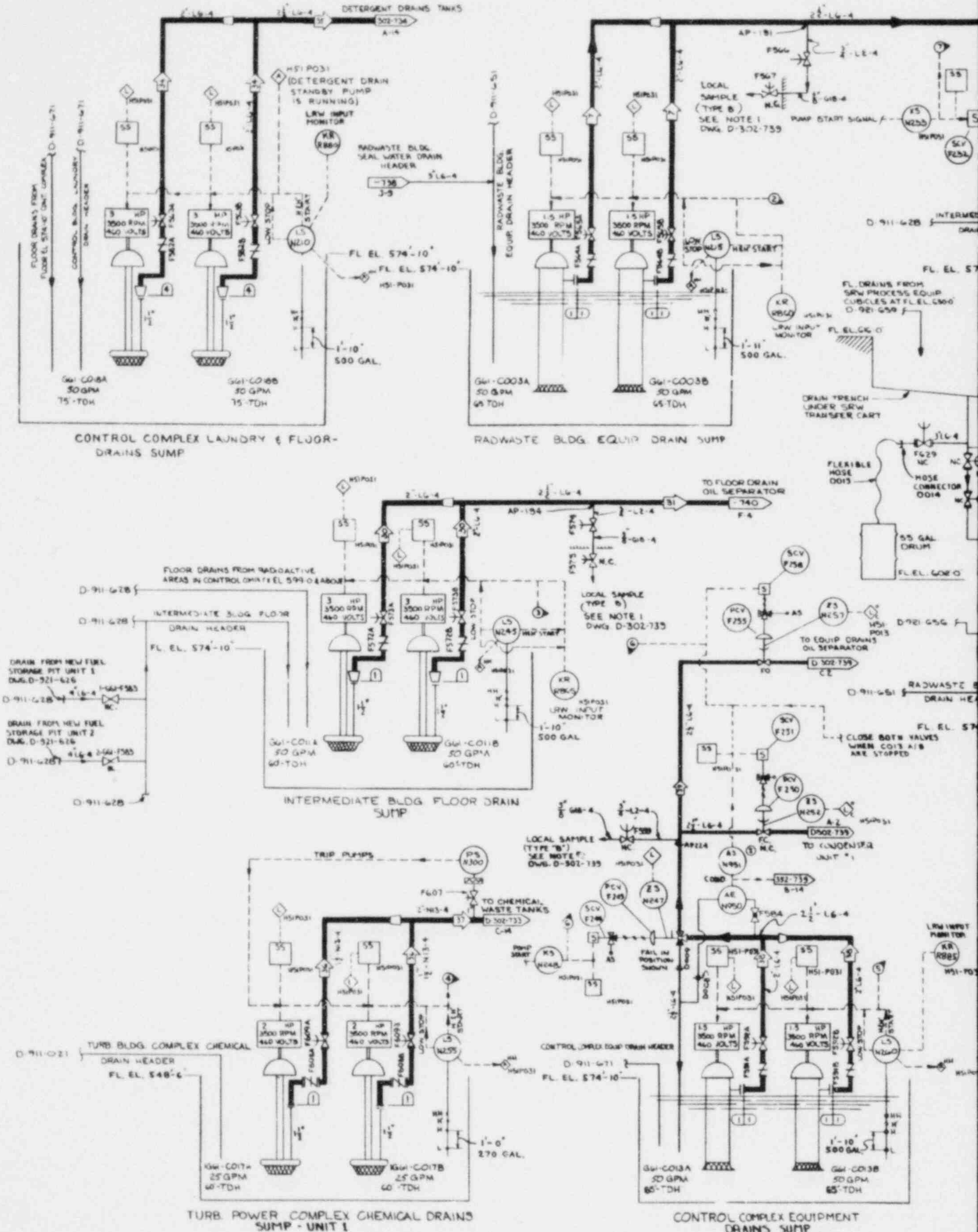
OPENS AUTOMATICALLY WHEN C008A STARTS. CLOSES AUTOMATICALLY WHEN C008A STOPS
TRIP PUMPS
DRYWELL WALL
CLOSE ON ISOL SIGNAL A, H, RM
OPENS AUTOMATICALLY WHEN C008B STARTS. CLOSES AUTOMATICALLY WHEN C008B STOPS
D-911-G01 DRYWELL FLOOR DRAIN HEADERS
D-911-G01 CONTAINMENT FLOOR DRAIN HEADER
FL. EL. 583'-6"
FL. EL. 599'-9"
L&W INPUT MONITOR
1'-1" 285 GAL.
G61-C008A 50 GPM 65' TDH
G61-C008B 50 GPM 65' TDH
G61-C009A 50 GPM 65' TDH
G61-C009B 50 GPM 65' TDH
DRYWELL FLOOR DRAIN SUMP
CONTAINMENT FLOOR DRAIN SUMP
SEE NOTE 2
FL. EL. 568'-4"
D-911-G17 (FL. DRAINS FROM HPCS PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "B" PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "C" PUMP CUBICLE)
(FL. DRAINS FROM RCIC PUMP CUBICLE)
(FL. DRAINS FROM RHR LOOP "A" PUMP CUBICLE)
(FL. DRAINS FROM LPCS PUMP CUBICLE)
D-911-G17 (FL. DRAINS OUTSIDE PUMP CUBICLES)
4"-L6-4
L.P. DRAIN
LOCAL SAMPLE TYPE B SEE NOTE #1 D-302-739
L&W INPUT MONITOR
HEATER BAY FLOOR DRAIN HEADER
FL. EL. 542'-0"
1'-0" 270 GAL.
G61-C019A 25 GPM 95' TDH
G61-C019B 25 GPM 95' TDH
HEATER BAY FLOOR DRAIN SUMP
D-911-021
D-911-022
TURBINE BLDG. COMPLEX FLOOR DRAIN HEADER
FL. EL. 548'-6"
TRIP ON HHH LEVEL
4'-0" 1450 GAL.
G61-C014A 750 GPM 150' TDH
100 GPM 88' TDH
TURBINE POWER COMPLEX FLOOR D
NC KEYLOCK
LOCAL SAMPLE (TYPE A) SEE NOTE #1 D-302-739
TURB LUBE OIL AREA FLOOR DRAIN HEADER
D-911-005
FL. EL. 595'-6"
2'-0" 750 GAL.
G61-C005A 50 GPM 50' TDH
G61-C005B 50 GPM 50' TDH
TURBINE LUBE OIL AREA FLOOR DRAINS SUMP
D-911-006 TURB BLDG LAYDOWN AREA DRAIN HEADER
FL. EL. 620'-6"
TURBINE LAYDOWN AREA FLOOR DRAINS SUMP

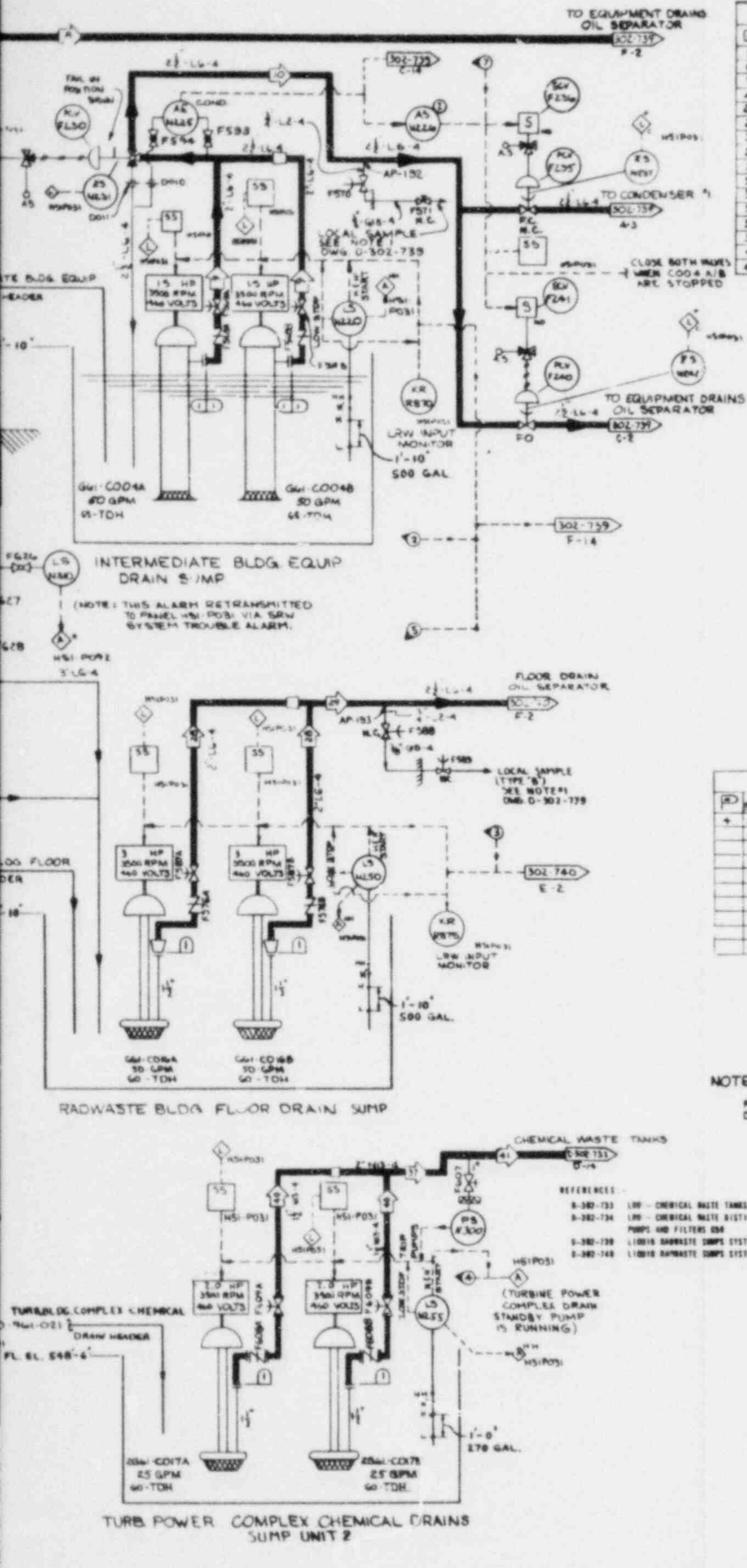


PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 4 of 15)
(GAI Dwg. D-352-740)


DETERGENT DRAINS TANKS
HS1 P031 (DETERGENT DRAIN STANDBY PUMP IS RUNNING)
LRW INPUT MONITOR
RADWASTE BLDG. SEAL WATER DRAIN HEADER
RADWASTE BLDG. EQUIP. DRAIN HEADER
FLOOR DRAINS FROM FLOOR EL. 574'-0" UNIT COMPLEX
CONTROL BLDG. LAUNDRY DRAIN HEADER
3 HP 3500 RPM 460 VOLTS
FL. EL. 574'-10"
1'-10" 500 GAL.
G61-C018A 50 GPM 75'-TDH
G61-C018B 50 GPM 75'-TDH
CONTROL COMPLEX LAUNDRY & FLOOR-DRAINS SUMP
1.5 HP 3500 RPM 460 VOLTS
G61-C003A 50 GPM 65 TDH
G61-C003B 50 GPM 65-TDH
1'-11" 500 GAL.
RADWASTE BLDG. EQUIP. DRAIN SUMP
LOCAL SAMPLE (TYPE B) SEE NOTE 1 DWG. D-302-739
PUMP START SIGNAL
FL. DRAINS FROM SRW PROCESS EQUIP CUBICLES AT FL. EL. 580'-0" D-921-659
DRAIN TRENCH UNDER SRW TRANSFER CART
FLEXIBLE HOSE 0013
HOSE CONNECTOR 0014
55 GAL. DRUM
TO FLOOR DRAIN OIL SEPARATOR
FLOOR DRAINS FROM RADIOACTIVE AREAS IN CONTROL CMPLX EL 599-0 & ABOVE
INTERMEDIATE BLDG. FLOOR DRAIN HEADER
FL. EL. 574'-10"
DRAIN FROM NEW FUEL STORAGE PIT UNIT 1 DWG. D-921-626
DRAIN FROM NEW FUEL STORAGE PIT UNIT 2 DWG. D-921-626
G61-C011A 50 GPM 60-TDH
G61-C011B 50 GPM 60-TDH
1'-10" 500 GAL.
INTERMEDIATE BLDG. FLOOR DRAIN SUMP
TO EQUIP. DRAINS OIL SEPARATOR
CLOSE BOTH VALVES WHEN C013 A/B ARE STOPPED
LOCAL SAMPLE (TYPE "B") SEE NOTE 1 DWG. D-302-735
TO CONDENSER UNIT 1
TRIP PUMPS
TO CHEMICAL WASTE TANKS
FAIL IN POSITION SHOWN
2 HP 3500 RPM 460 VOLTS
TURB. BLDG. COMPLEX CHEMICAL DRAIN HEADER
FL. EL. 548'-6"
1'-0" 270 GAL.
G61-C017A 25 GPM 60'-TDH
G61-C017B 25 GPM 60'-TDH
TURB. POWER COMPLEX CHEMICAL DRAINS SUMP - UNIT 1
CONTROL COMPLEX EQUIP. DRAIN HEADER
FL. EL. 574'-10"
G61-C013A 50 GPM 65'-TDH
G61-C013B 50 GPM 65'-TDH
1'-10" 500 GAL.
CONTROL COMPLEX EQUIPMENT DRAINS SUMP



OPERATING DATA

#	PSIG.	GPM	F	BY	REMARK	R
7	28	50	70			
8	28	50-100	70			
9	28	50	70			
10	28	50-100	70			
28	25	50	70			
29	25	50-100	70			
30	25	50	70			
31	25	50-100	70			
34	28	50	150			
35	28	50-100	150			
36	25	25	70			
37	25	25-50	70			
38	32	50	70			
39	32	50-100	70			
40	25	25-50	70			
41	25	25-50	70			

DESIGN DATA

#	NORMAL PSIG	NORMAL F	UPSET PSIG	UPSET F	UPSET TIME	BY		REMARK	R
+	100	175	NA	NA	NA				
	SEE D-302-739								

NOTES

FOR NOTES SEE DWG. NO. D-302-739.

REFERENCES:-

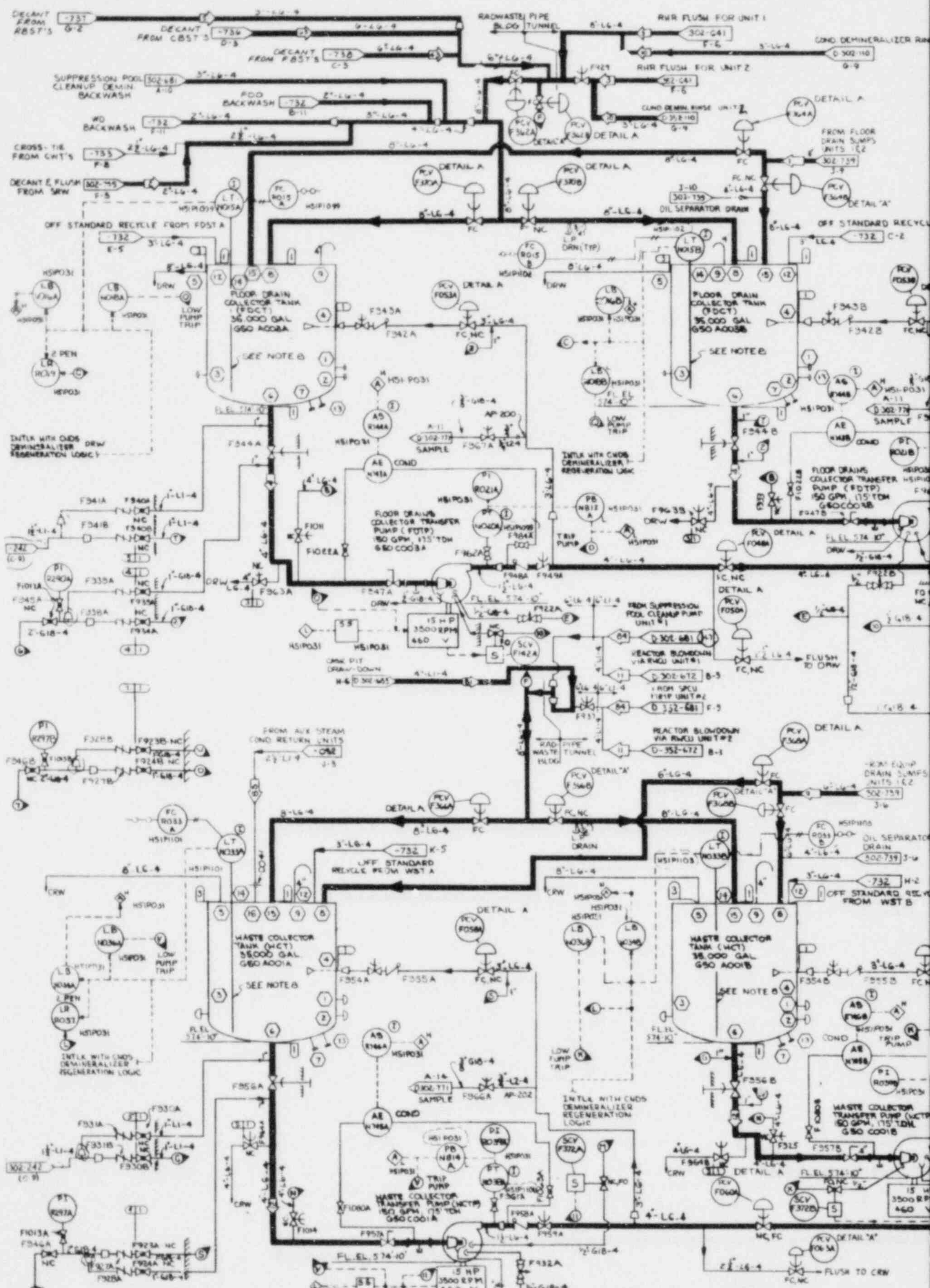
D-302-733 LRW - CHEMICAL WASTE TANKS AND WASTE EVAPORATOR/CONDENSERS G50
D-302-734 LRW - CHEMICAL WASTE DISTILLATE TANKS AND PUMPS AND DETERGENT DRAINS TANKS PUMPS AND FILTERS G50
D-302-739 LIQUID RADWASTE SUMPS SYSTEM - EQUIPMENT DRAIN SUMPS AND OIL SEPARATORS G61
D-302-740 LIQUID RADWASTE SUMPS SYSTEM - FLOOR DRAIN SUMPS G61

PNPP

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

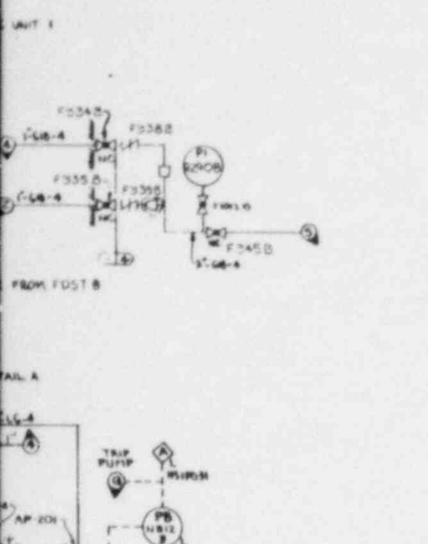
Figure 11.2-1 (Sheet 5 of 15)
(GAI Dwg. D-302-741)

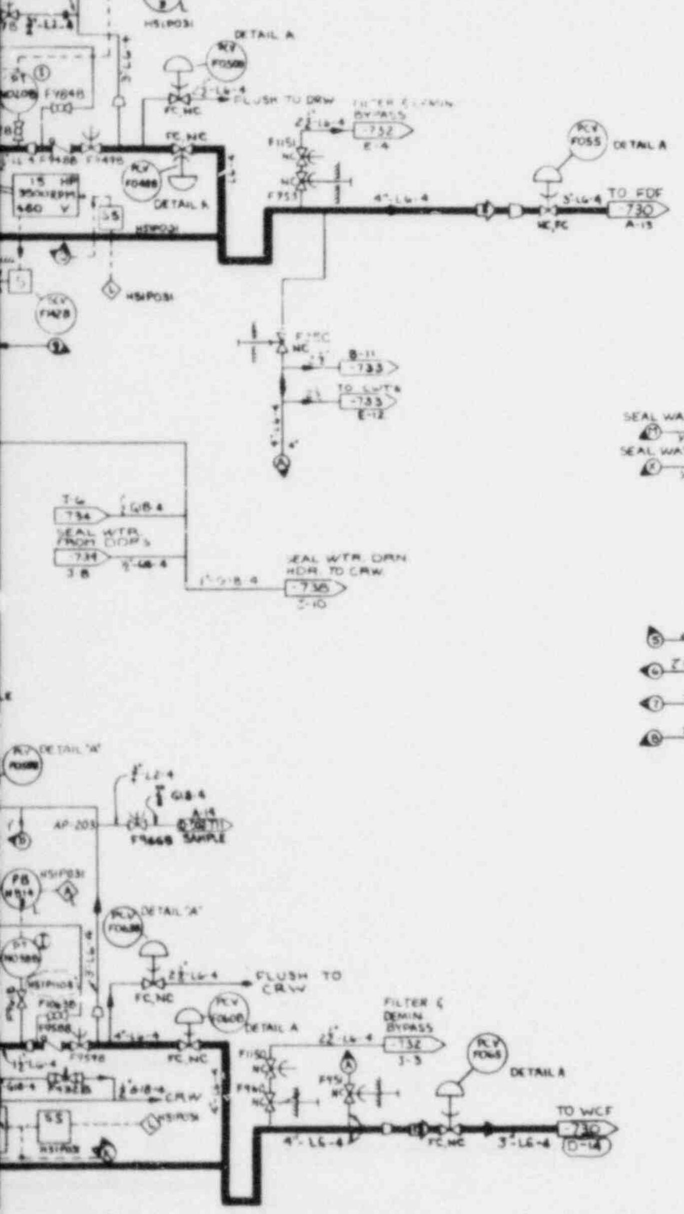


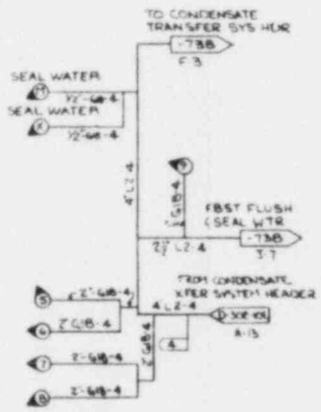
DECANT FROM RBST'S
DECANT FROM CBST'S
DECANT FROM FBST'S
SUPPRESSION POOL CLEANUP DEMIN. BACKWASH
FDD BACKWASH
WD BACKWASH
CROSS-TIE FROM CWT'S
DECANT & FLUSH FROM SRW
RADWASTE PIPE BLDG TUNNEL
RHR FLUSH FOR UNIT 1
RHR FLUSH FOR UNIT 2
COND DEMINERALIZER RINSE
COND DEMIN RINSE UNIT 2
DETAIL A
FROM FLOOR DRAIN SUMPS UNITS 1&2
OFF STANDARD RECYCLE FROM FDST A
OIL SEPARATOR DRAIN
OFF STANDARD RECYCLE
FLOOR DRAIN COLLECTOR TANK (FDCT) 35,000 GAL G50 A002A
FLOOR DRAIN COLLECTOR TANK (FDCT) 35,000 GAL G50 A002B
SEE NOTE 8
LOW PUMP TRIP
INTLK WITH CNDS DEMINERALIZER DRW REGENERATION LOGIC
SAMPLE
FLOOR DRAINS COLLECTOR TRANSFER PUMP (FDTP) 150 GPM, 115' TDH G50 C003A
FLOOR DRAINS COLLECTOR TRANSFER PUMP (FDTP) 150 GPM, 115' TDH G50 C003B
TRIP PUMP
15 HP 3500 RPM 460 V
FROM SUPPRESSION POOL CLEANUP PUMP UNIT #1
REACTOR BLOWDOWN VIA RWCU UNIT #1
FROM SPCU TRIP UNIT #2
REACTOR BLOWDOWN VIA RWCU UNIT #2
FLUSH TO DRW
CNDS PIT DRAW-DOWN
RAD WASTE BLDG
PIPE TUNNEL
FROM AUX STEAM COND RETURN UNITS
FROM EQUIP DRAIN SUMPS UNITS 1&2
OFF STANDARD RECYCLE FROM WST A
OFF STANDARD RECYCLE FROM WST B
WASTE COLLECTOR TANK (WCT) 35,000 GAL G50 A001A
WASTE COLLECTOR TANK (WCT) 35,000 GAL G50 A001B
INTLK WITH CNDS DEMINERALIZER REGENERATION LOGIC
WASTE COLLECTOR TRANSFER PUMP (WCTP) 150 GPM, 115' TDH G50 C001A
WASTE COLLECTOR TRANSFER PUMP (WCTP) 150 GPM, 115' TDH G50 C001B
FL. EL. 574'-10"
FLUSH TO CRW
CRW

REFERENCES -

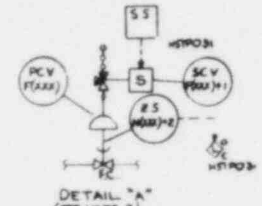
D-302-102 CONDENSATE TRANSFER AND STORAGE SYSTEM P11
D-302-711 TWO BED DEMINERALIZER AND DISTRIBUTION SYSTEM - STORAGE AND NORTH ZONE DISTRIBUTION P21
D-302-712 TWO BED DEMINERALIZER AND DISTRIBUTION SYSTEM - MIDDLE ZONE DISTRIBUTION P21
D-302-730 LRW SYSTEM - WASTE COLLECTOR FILTER AND FLOOR DRAINS FILTER G50
D-302-732 LRW - FLOOR DRAIN DEMINERALIZER AND SAMPLE TANKS, WASTE DEMINERALIZER AND SAMPLE TANKS G50
D-302-733 LRW - CHEMICAL WASTE TANKS, WASTE EVAPORATOR CONDENSERS G50
D-302-734 LRW - CHEMICAL WASTE DISTILLATE TANKS AND PUMPS, AND DETERGENT DRAINS TANKS, PUMPS AND FILTERS G50
D-302-735 LRW - TANKS AND PUMPS FOR CONCENTRATED WASTE AND SPENT RESINS G50
D-302-736 LRW - TANKS AND PUMPS FOR HANDLING CONDENSATE FILTER BACKWASH SLURRY G50
D-302-737 LRW - TANKS AND PUMPS FOR HANDLING RWCU FILTER DEMINERALIZER BACKWASH SLURRY G50
D-302-738 LRW - TANKS AND PUMPS FOR HANDLING BACKWASH SLURRIES FROM FUEL POOL FILTER DEMINERALIZER G50
D-302-741 LIQUID RADWASTE SUMP SYSTEM - LAUNDRY, CHEMICAL AND COMMON FLOOR AND EQUIPMENT DRAIN SUMPS G61
D-302-742 LRW - WASTE EVAPORATOR CONDENSERS G50
D-302-771 NUCLEAR SAMPLING SYSTEM P34
D-302-781 EMERGENCY SERVICE WATER SYSTEM P45
D-006-009 PLANT RADIATION MONITORING - LIQUID [illegible] D17
D-302-739 LIQUID RADWASTE SUMPS SYSTEM G61 EQUIPMENT DRAIN SUMPS AND OIL SEPARATORS
D-352-881 SUPPRESSION POOL CLEANUP SYSTEM G43
D-302-119 CONDENSATE DEMINERALIZER SYSTEM N24
D-302-641
D-302-052 AUXILIARY STEAM P51
D-302-871
D-302-124 MAIN, REHEAT, EXTRACTION, AND MISCELLANEOUS DRAINS N27
D-302-109 CONDENSATE DEMINERALIZER SYSTEM N24
D-302-171 TWO-BED DEMINERALIZER AND DISTRIBUTION SYSTEM - CATION AND ANION EXCHANGERS P21
D-302-104 CONDENSATE FILTRATION SYSTEM N23
D-352-853 FUEL POOL FILTER DEMINERALIZER SYSTEM G41
D-302-712 TWO-BED DEMINERALIZER AND DISTRIBUTION SYSTEM - MIDDLE ZONE DISTRIBUTION P21
D-302-781 EMERGENCY SERVICE WATER SYSTEM P45
D-302-859 FUEL POOL COOLING AND CLEANUP SYSTEM G41







OPERATING DATA						
[stream no.]	PSIG	GPM	F	BY	REMARKS	[rev]
1	5	25 to [illegible]	70	KWG		
2	5	50	70	[illegible]		
3	50	1000	[illegible]	[illegible]		
4	5	[illegible]	70	KWG		
5	80	[illegible]	70	KWG		
9	5	[illegible]	[illegible]	KWG		
10	40	200	70	JG		
11	125	300	125	[illegible]	RARE	
12	5	[illegible]	70	KWG		
13	80	[illegible]	70	DWS		
81	25	200	100	DAL		
83	100	45	300	JKR	5 [illegible]	
84	75	1000	90	DAL	RARE	



DETAIL "A"
(SEE NOTE 7)

DESIGN DATA									
[stream no.]	NORMAL		UPSET			BY		REMARKS	[rev]
	PSIG	F	PSIG	F	TIME				
1	125	150	NA	NA	NA	KWG			
2	125	150	125	150	-	KWG		NOTE 4	
3	15	150	NA	NA	NA	KWG			
4	15	135	NA	NA	NA	[illegible]			
5	18	110	NA	NA	NA	[illegible]			

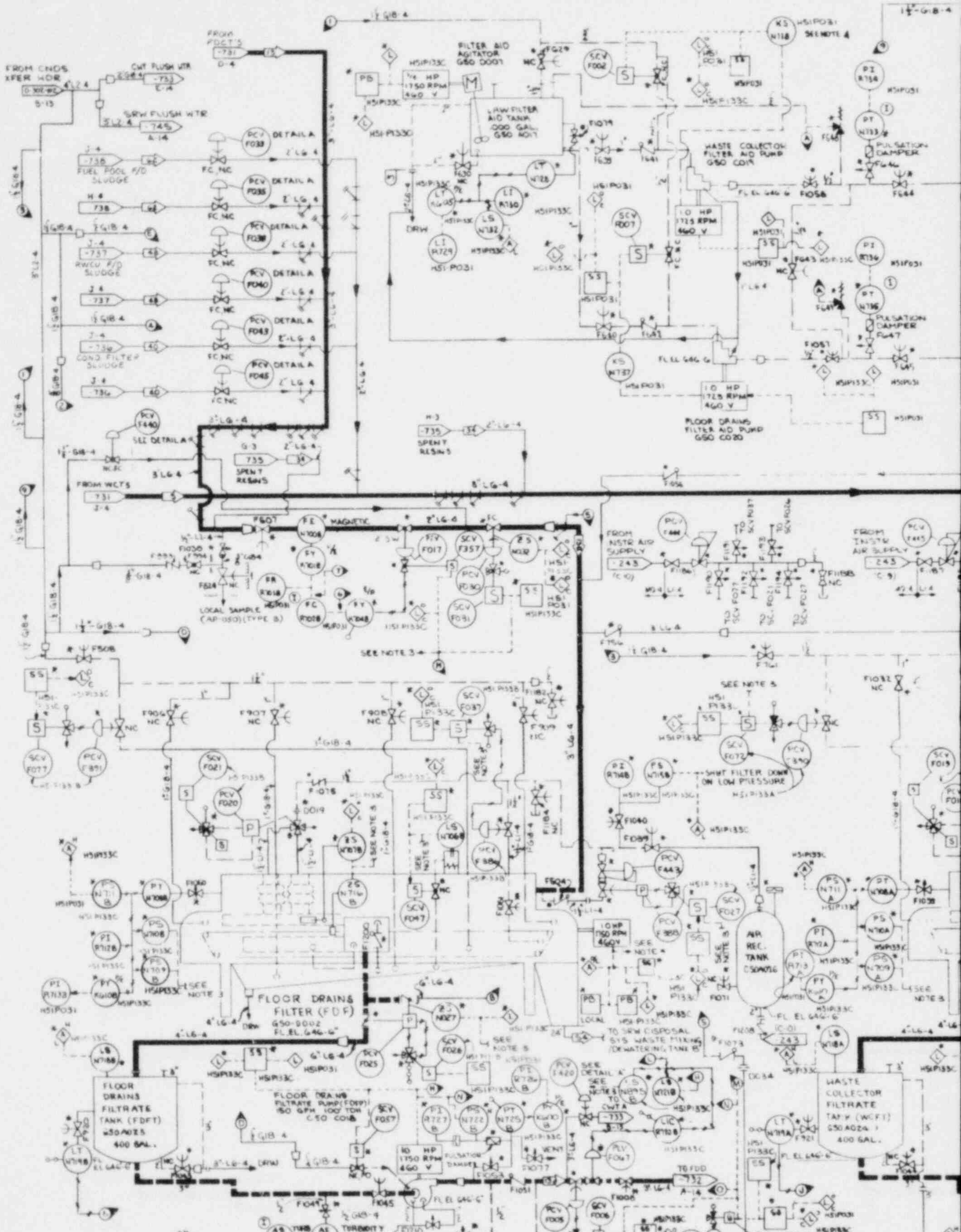
NOTES: -

1. "FP" INDICATES A TEMPORARY FLUSHING WATER CONNECTION POINT
2. REFER TO I & C INDEX FOR LOGIC DIAGRAM NUMBER
3. SA - INDICATES SERVICE AIR
4. PIPING LABELED WITH A #2 DESIGN CONDITION NUMBER IS SEISMIC CATEGORY I AND SAFETY CLASS 3 MINUS MATERIAL CERTIFICATION REQUIREMENTS AND "N" STAMP
5. SEE DWG. D-302-771 FOR DETAILS OF LOCAL AND REMOTE SAMPLES
6. "PROCESSING" MODE FOR COLLECTOR TANKS SHALL INCLUDE AN AUTOMATIC, TIMER-CONTROLLED RECYCLE STEP
7. FXXX - VALVE IDENTIFICATION NUMBER
8. BUBBLER TUBE TO BE INSTALLED BY INSTRUMENT INSTALLATION CONTRACTOR
9. ALL ALARMS ON H51P031 ARE RETRANSMITTED TO CONTROL ROOM
10. ALL LOW POINT (L.P.) DRAINS, TEST CONNECTIONS (T.C.'s) AND VENT DRAIN (V.D.) CONNECTIONS SHALL BE 3/4" NOMINAL PIPE SIZE UNLESS OTHERWISE NOTED

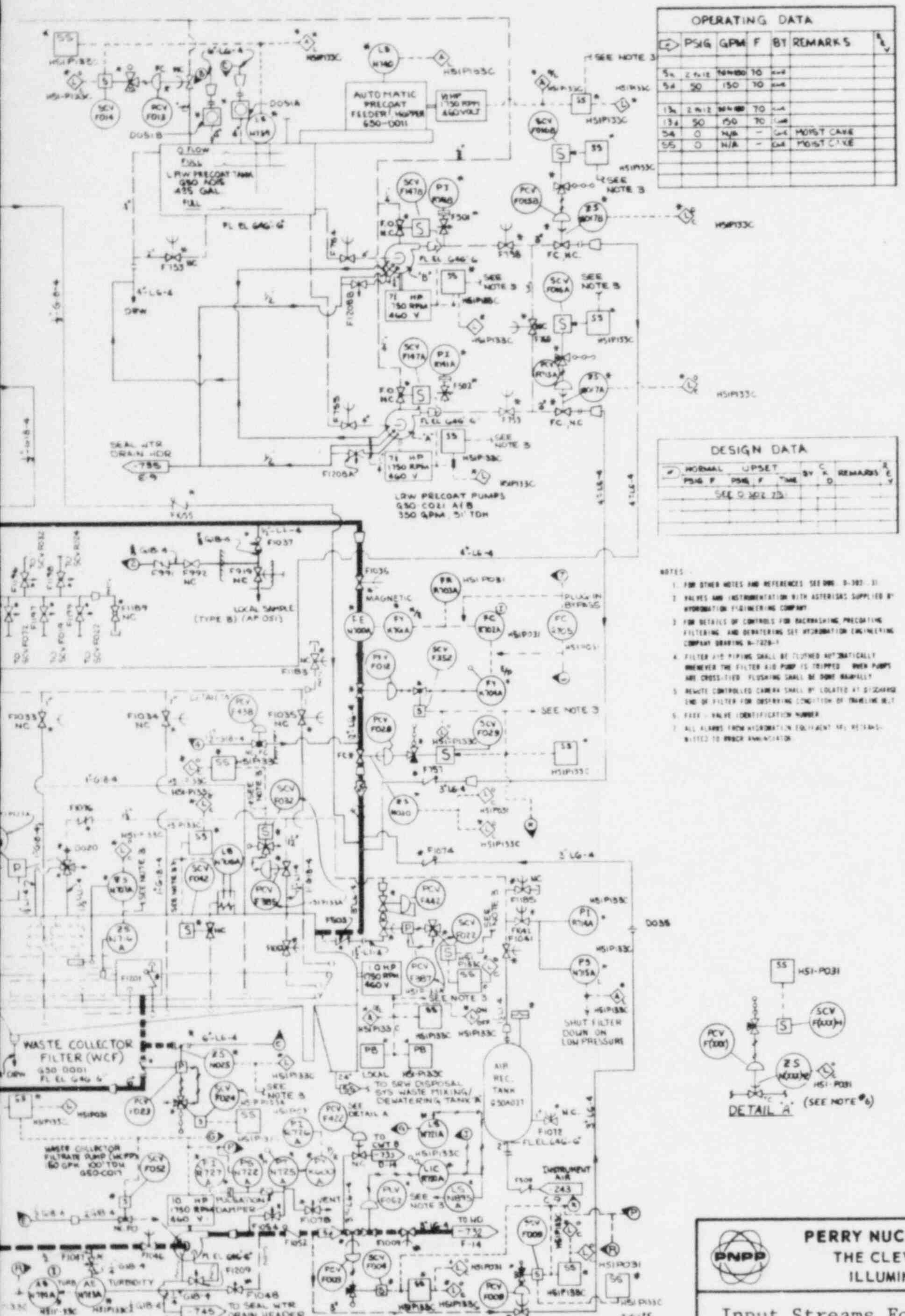
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 6 of 15)
(GAI Dwg. D-302-731)



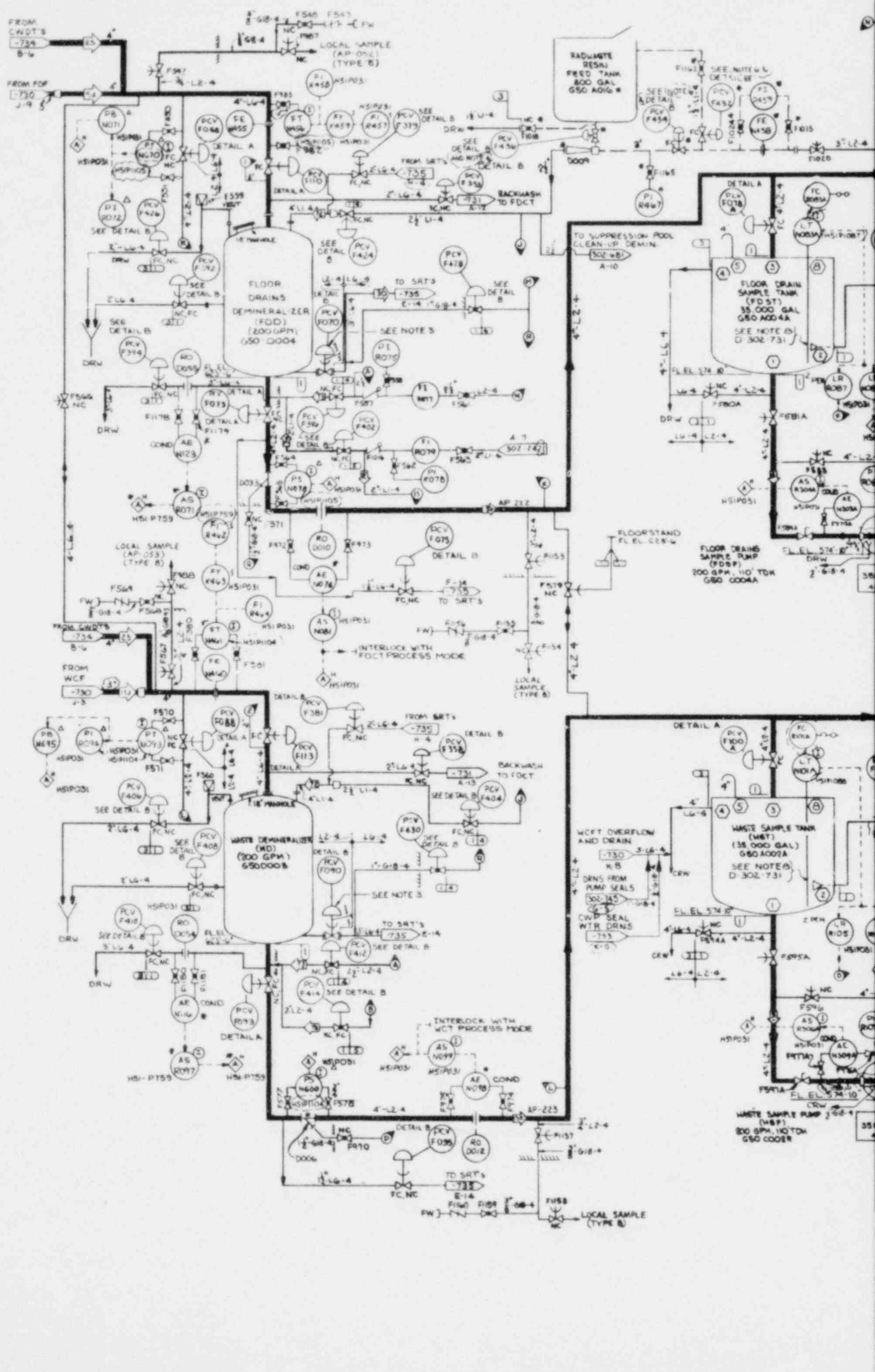
FROM CNDS XFER HDR
CWT FLUSH WTR
SRW FLUSH WTR
FUEL POOL F/D SLUDGE
RWCU F/D SLUDGE
COND. FILTER SLUDGE
FROM FDCT'S
FILTER AID AGITATOR G50 D007
FILTER AID TANK
WASTE COLLECTOR FILTER AID PUMP G50 C019
FLOOR DRAINS FILTER AID PUMP G50 C020
SPENT RESINS
FROM WCTS
MAGNETIC
LOCAL SAMPLE
SEE NOTE 3
FROM INSTR AIR SUPPLY
SHUT FILTER DOWN ON LOW PRESSURE
PULSATION DAMPER
AIR REC. TANK
FLOOR DRAINS FILTER (FDF)
FLOOR DRAINS FILTRATE TANK (FDFT)
400 GAL.
FLOOR DRAINS FILTRATE PUMP (FDFP)
WASTE COLLECTOR FILTRATE TANK (WCFT)
400 GAL.
TO SRW DISPOSAL SYS WASTE MIXING /DEWATERING TANK B
TO FDD
TURBIDITY
TO SEAL WTR DRAIN HEADER
SEAL WTR DRNS TO LRW



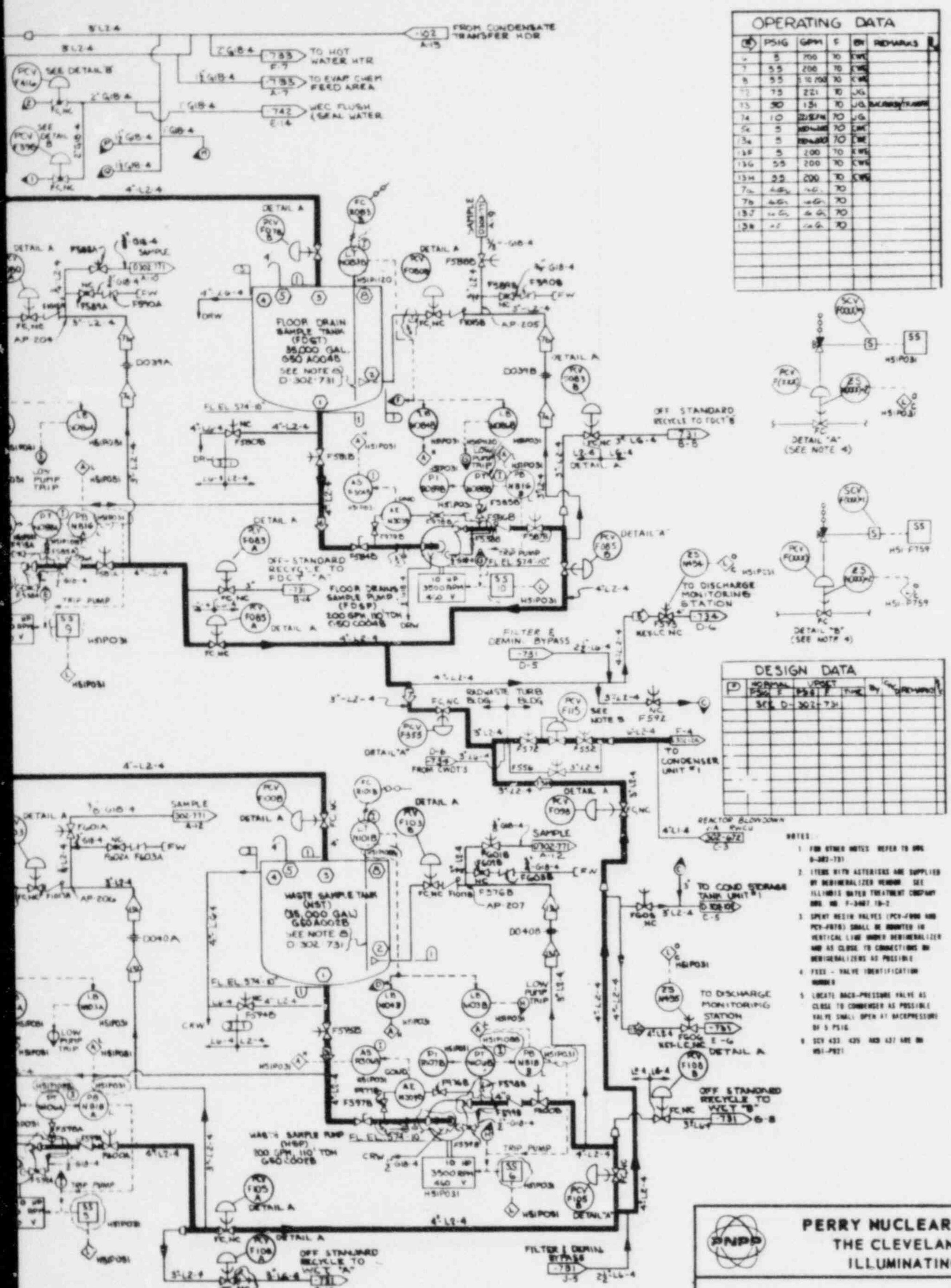
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 7 of 15)
(GAI Dwg. D-302-730)



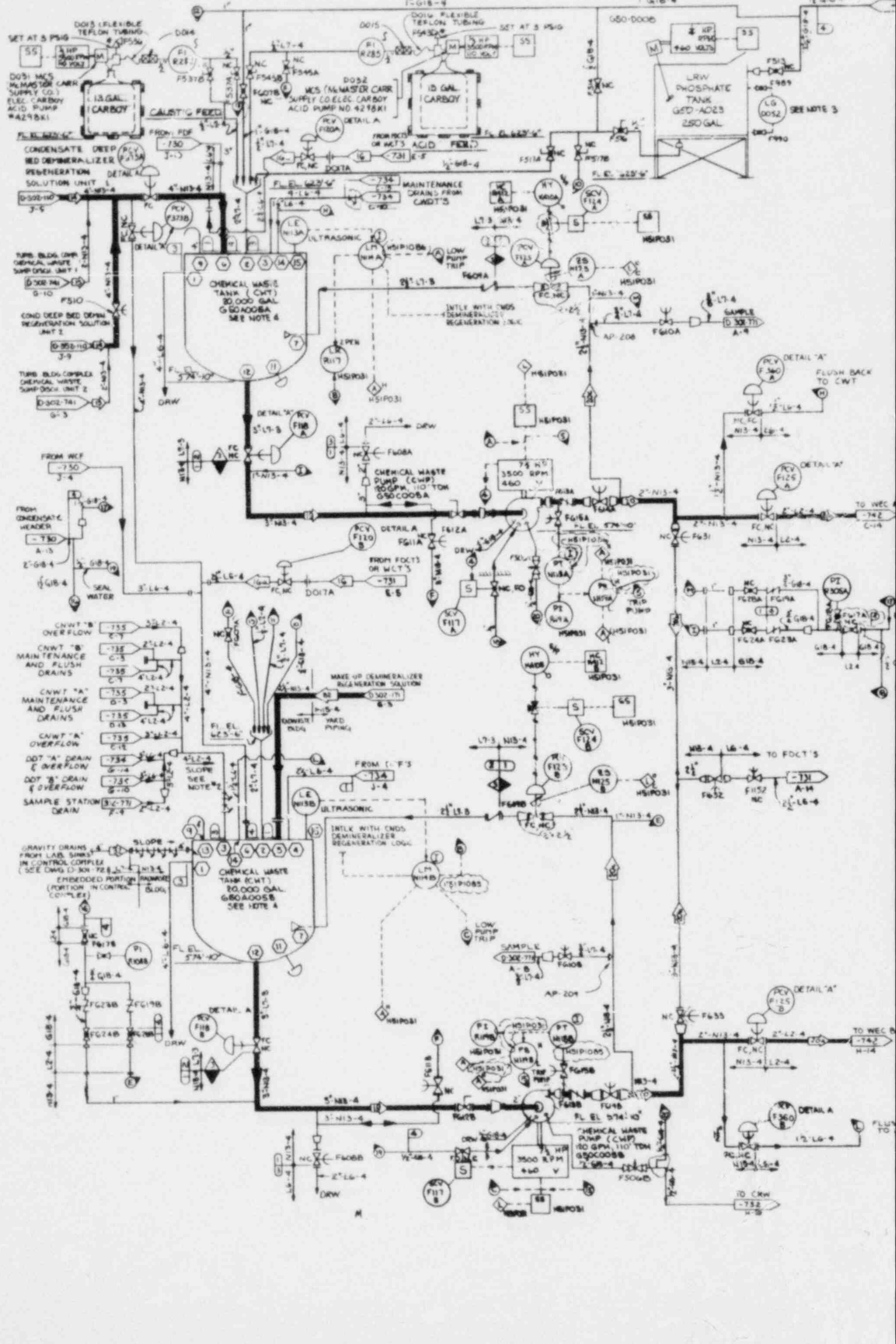
RADWASTE RESIN FEED TANK 800 GAL G50 A016
FLOOR DRAINS DEMINERALIZER (FDD) (200 GPM) G50-D004
FLOOR DRAIN SAMPLE TANK (FDST) 35,000 GAL G50 A004A
FLOOR DRAINS SAMPLE PUMP (FDSP) 200 GPM, 110' TDH G50 C004A
WASTE DEMINERALIZER (WD) (200 GPM) G50D003
WASTE SAMPLE TANK (WST) (35,000 GAL) G50 A002A
WASTE SAMPLE PUMP (WSP) 200 GPM, 110' TDH G50 C002A
TO SUPPRESSION POOL CLEAN-UP DEMIN.
BACKWASH TO FDCT
INTERLOCK WITH FDCT PROCESS MODE
INTERLOCK WITH WCT PROCESS MODE
LOCAL SAMPLE (TYPE B)
WCFT OVERFLOW AND DRAIN
DRNS FROM PUMP SEALS
CWP SEAL WTR DRNS
FLOOR STAND



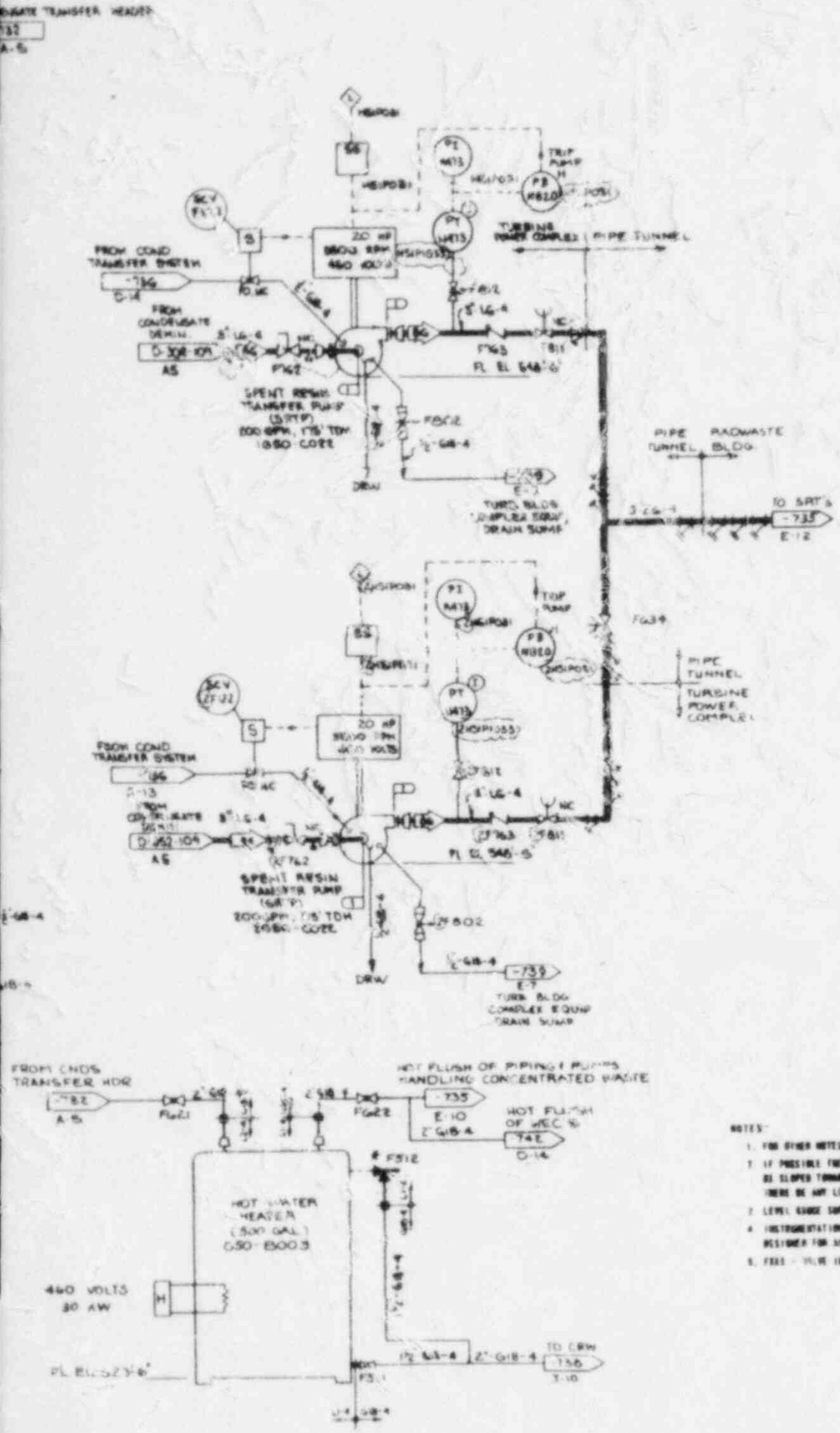
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 8 of 15)
(GAI Dwg. D-302-732)

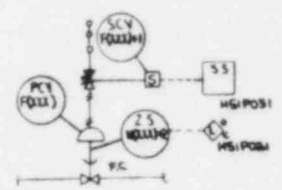


SET AT 3 PSIG
D013 FLEXIBLE TEFLON TUBING
D031 MCS McMASTER CARR SUPPLY CO. ELEC CARBOY ACID PUMP #4298K1
13 GAL CARBOY
CAUSTIC FEED
D014 FLEXIBLE TEFLON TUBING
D032 MCS McMASTER CARR SUPPLY CO. ELEC CARBOY ACID PUMP NO 4298K1
ACID FEED
LRW PHOSPHATE TANK G50-A023 250 GAL
SEE NOTE 3
CONDENSATE DEEP BED DEMINERALIZER REGENERATION SOLUTION UNIT 1
MAINTENANCE DRAINS FROM CNDT'S
CHEMICAL WASTE TANK (CWT) 20,000 GAL G50A005A SEE NOTE 4
ULTRASONIC
LOW PUMP TRIP
INTLK WITH CNDS DEMINERALIZER REGENERATION LOGIC
SAMPLE
FLUSH BACK TO CWT
DRW
FROM WCF
SEAL WATER
CHEMICAL WASTE PUMP (CWP) 120 GPM, 110' TDH G50C005A
3500 RPM 460 V
TO WEC
TO FDCT'S
FROM FDCT'S OR WCT'S
CNWT "B" OVERFLOW
CNWT "B" MAINTENANCE AND FLUSH DRAINS
CNWT "A" MAINTENANCE AND FLUSH DRAINS
CNWT "A" OVERFLOW
DDT "A" DRAIN & OVERFLOW
DDT "B" DRAIN & OVERFLOW
SAMPLE STATION DRAIN
MAKE-UP DEMINERALIZER REGENERATION SOLUTION
GRAVITY DRAINS FROM LAB SINKS IN CONTROL COMPLEX
EMBEDDED PORTION (PORTION IN CONTROL COMPLEX)
CHEMICAL WASTE TANK (CWT) 20,000 GAL G50A005B SEE NOTE 4
CHEMICAL WASTE PUMP (CWP) 120 GPM, 110' TDH G50C005B
TO CRW



OPERATING DATA

	PSIG	GPM	F	BY	REMARKS	
14	40	200	70			
15	25	100	70			
16		150	70			
16A	[illegible]	150	70			
18	50	50	150			
19	5	180	70			
20	65	10/100	70			
32	0	[illegible]	70		GRAVITY DR	
8E		85	70	MFS		
20A	65	30	70			
20B	65	170	70			
20C	65	[illegible]	70			
85		200	70			
86		200	70			



DETAIL "A"
(SEE NOTE 5)

DESIGN DATA

	NORMAL		UPSET			BY	CHK	REMARKS	
	PSIG	F	PSIG	F	TIME				
			SEE D-302-731						

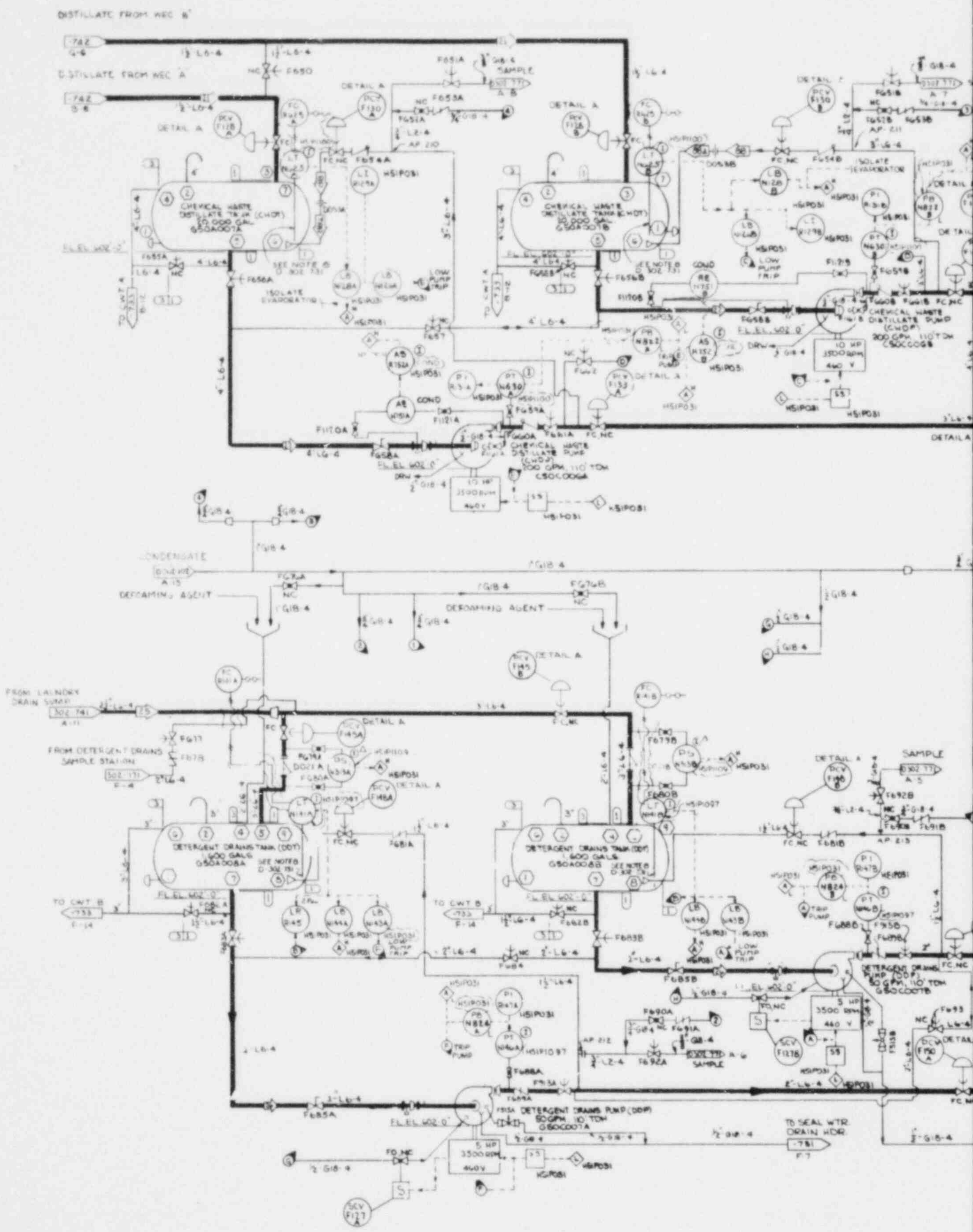
NOTES:

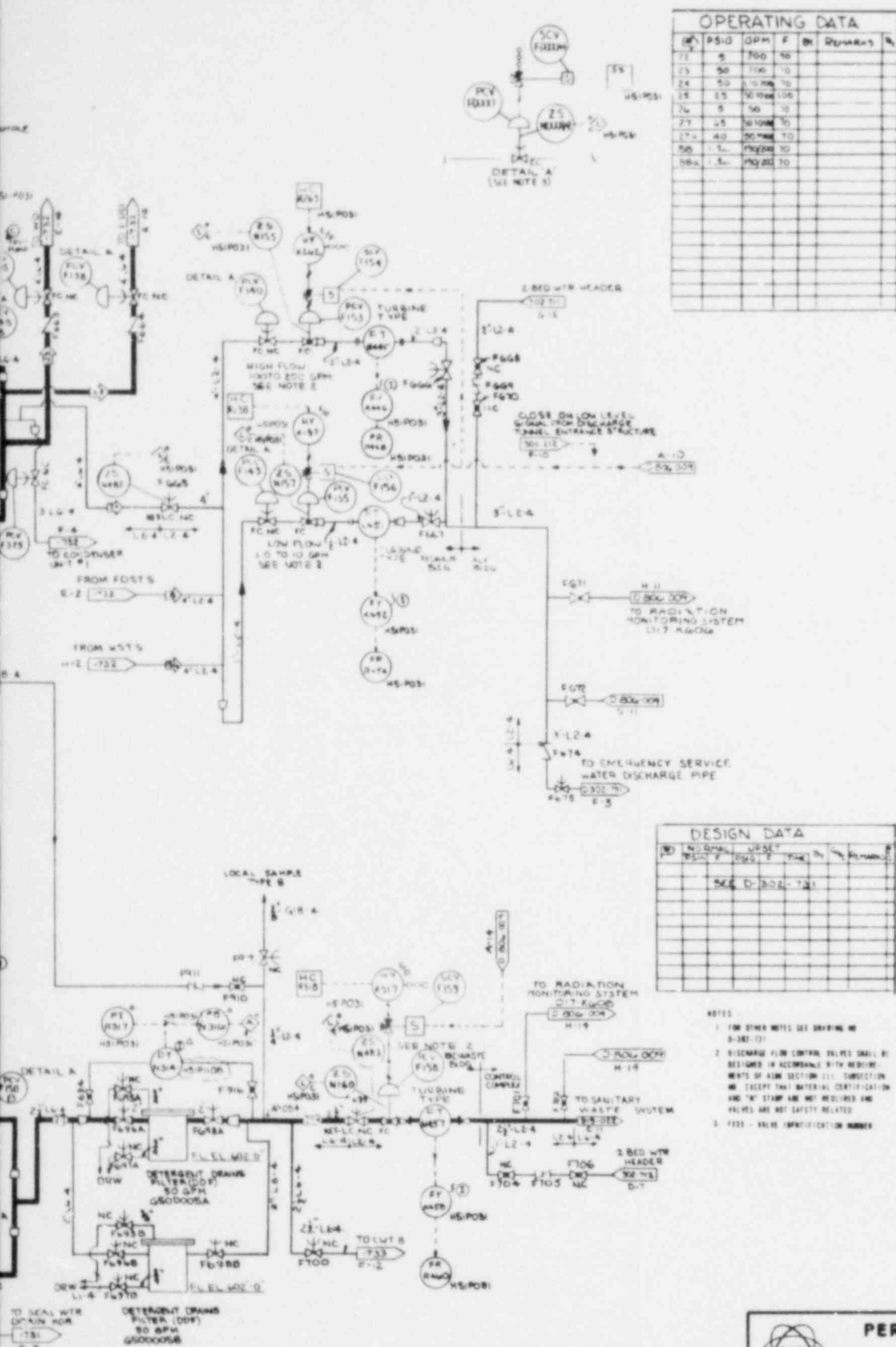
1. FOR OTHER NOTES SEE DRAWING D-302-731.
2. IF POSSIBLE THE DISC. [illegible] LINE TO CRT "B" (NOZZLE #3) SHALL BE SLOPED TOWARDS THE TANK. BUT UNDER NO CIRCUMSTANCES SHALL THERE BE ANY LOW POINT POCKETS IN THIS LINE.
3. LEVEL GAUGE SUPPLIED WITH PHOSPHATE TANK.
4. INSTRUMENTATION FOR THE CRT'S AND ASSOCIATED PIPING SHALL BE DESIGNED FOR ACID SERVICE.
5. F### - VALVE IDENTIFICATION NUMBER.

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 9 of 15)
(GAI Dwg. D-302-733)

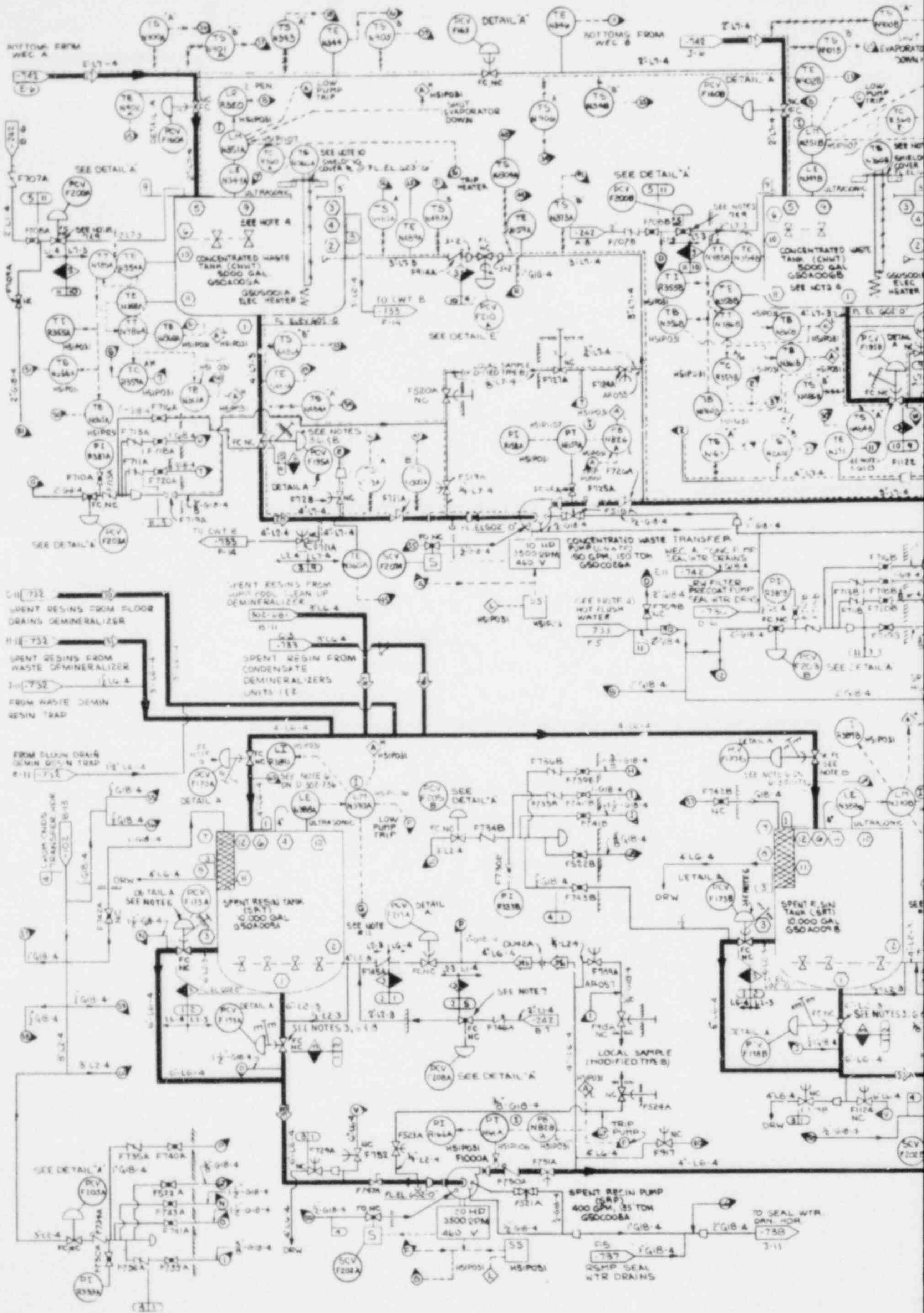

DISTILLATE FROM WEC 'B'
DISTILLATE FROM WEC 'A'
CHEMICAL WASTE DISTILLATE TANK (CHDT) 10,000 GAL G50A007A
CHEMICAL WASTE DISTILLATE TANK (CHDT) 10,000 GAL G50A007B
CHEMICAL WASTE DISTILLATE PUMP (CHDP) 200 GPM 110' TDH C50C006A
CHEMICAL WASTE DISTILLATE PUMP (CHDP) 200 GPM 110' TDH C50C006B
ISOLATE EVAPORATOR
LOW PUMP TRIP
SAMPLE
DETAIL A
CONDENSATE
DEFOAMING AGENT
FROM LAUNDRY DRAIN SUMP
FROM DETERGENT DRAINS SAMPLE STATION
DETERGENT DRAINS TANK (DDT) 1,400 GALS G50A008A
DETERGENT DRAINS TANK (DDT) 1,400 GALS G50A008B
DETERGENT DRAINS PUMP (DDP) 50 GPM 110' TDH G50C007A
DETERGENT DRAINS PUMP (DDP) 50 GPM 110' TDH G50C007B
TO CWT B
TO SEAL WTR. DRAIN HDR
5 HP 3500 RPM 460 V
10 HP 3500 RPM 460 V



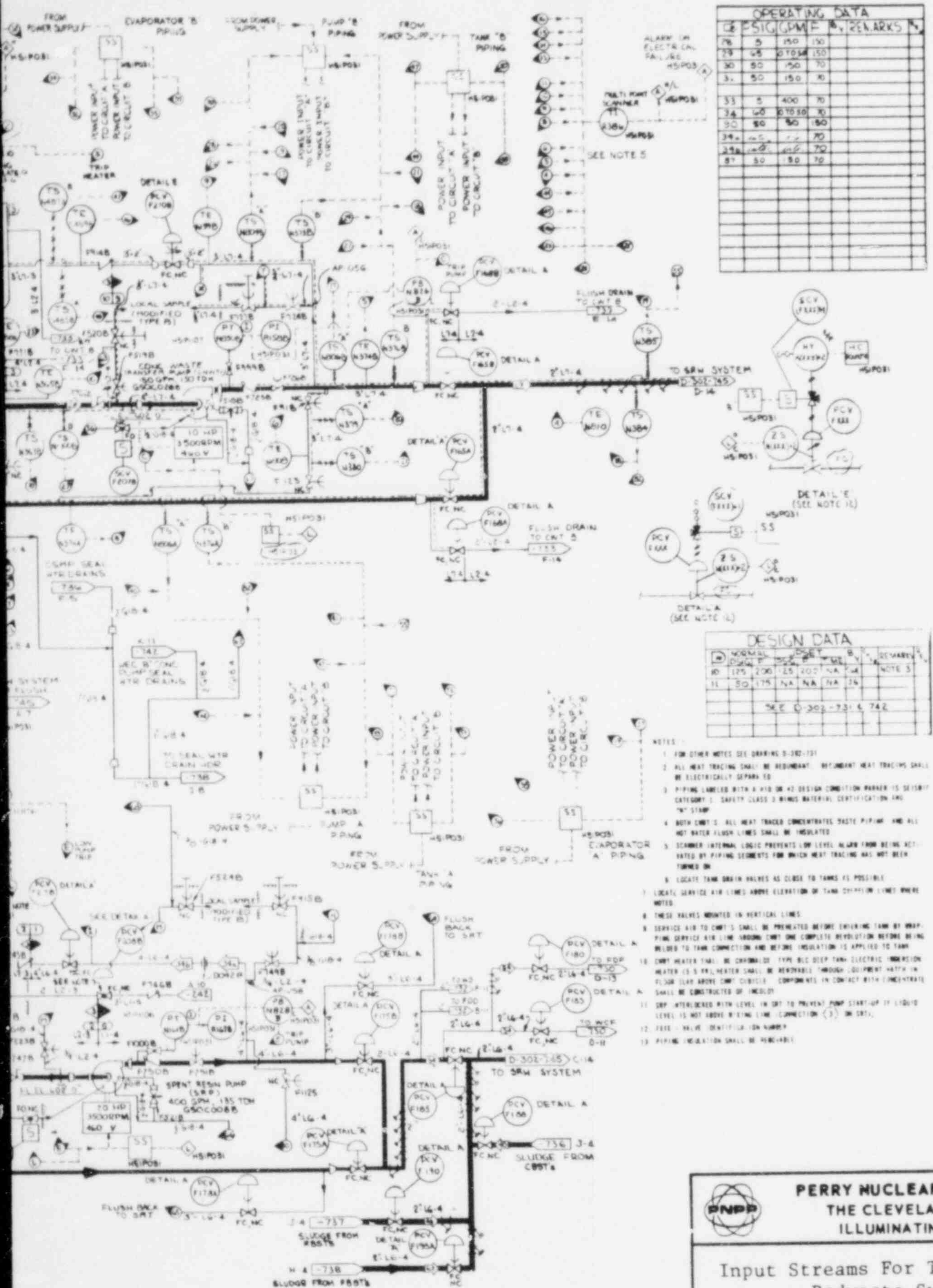
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 10 of 15)
(GAI Dwg. D-302-734)



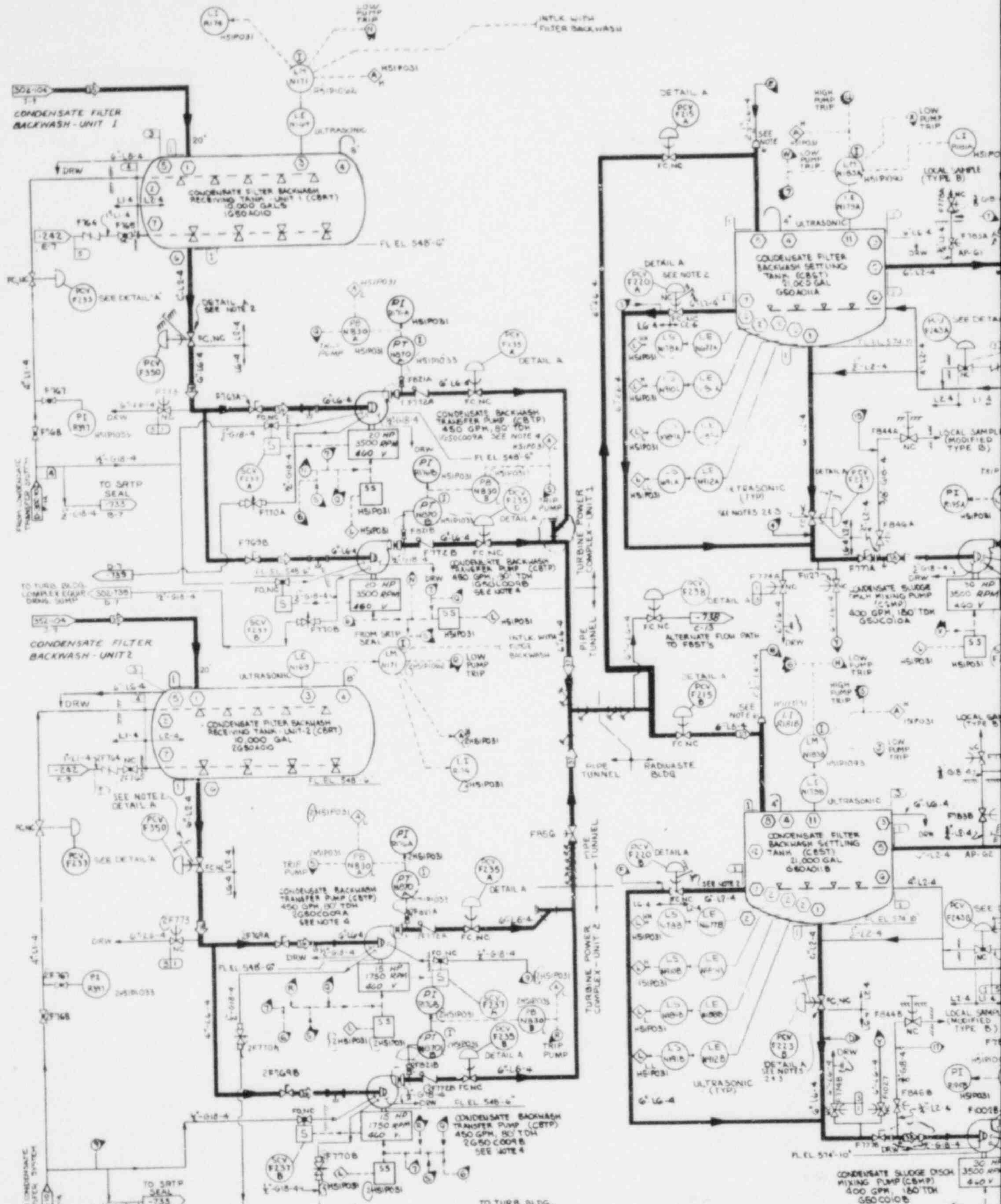
BOTTOMS FROM WEC A
BOTTOMS FROM WEC B
SEE DETAIL 'A'
CONCENTRATED WASTE TANK (CNWT) 5000 GAL G50A005A
CONCENTRATED WASTE TANK (CNWT) 5000 GAL G50A005B
CONCENTRATED WASTE TRANSFER PUMP
SPENT RESINS FROM FLOOR DRAINS DEMINERALIZER
SPENT RESINS FROM WASTE DEMINERALIZER
FROM WASTE DEMIN RESIN TRAP
SPENT RESIN FROM CONDENSATE DEMINERALIZERS
FROM FLOOR DRAIN DEMIN RESIN TRAP
SPENT RESIN TANK (SRT) 10,000 GAL G50A009A
LOCAL SAMPLE (MODIFIED TYPE B)
SPENT RESIN PUMP
TO SEAL WTR DRN HDR



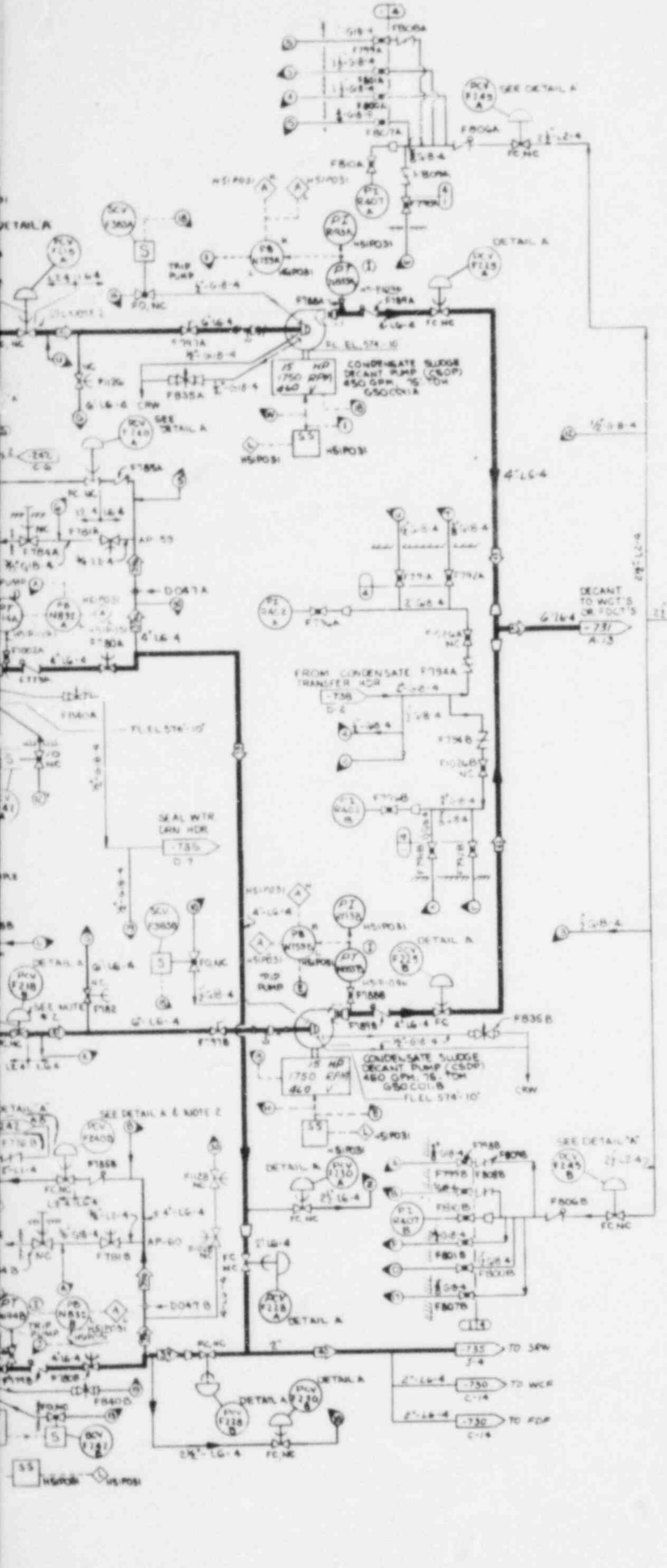
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

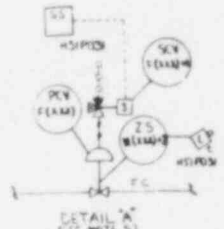
Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 11 of 15)
(GAI Dwg. D-302-735)



CONDENSATE FILTER BACKWASH - UNIT I
CONDENSATE FILTER BACKWASH RECEIVING TANK - UNIT 1 (CBRT) 10,000 GALS 1G50A010
FL EL 548'-6"
CONDENSATE BACKWASH TRANSFER PUMP (CBTP) 450 GPM, 80' TDH 1G50C009A SEE NOTE 4
CONDENSATE FILTER BACKWASH - UNIT 2
CONDENSATE FILTER BACKWASH RECEIVING TANK - UNIT 2 (CBRT) 10,000 GAL 2G50A010
TO SRTP SEAL
TO TURB. BLDG. COMPLEX EQUIP. DRNS. SUMP
TURBINE POWER COMPLEX - UNIT 1
TURBINE POWER COMPLEX - UNIT 2
PIPE TUNNEL
RADWASTE BLDG.
CONDENSATE FILTER BACKWASH SETTLING TANK (CBST) 21,000 GAL G50A011A
CONDENSATE FILTER BACKWASH SETTLING TANK (CBST) 21,000 GAL G50A011B
ALTERNATE FLOW PATH TO FBST'S
CONDENSATE SLUDGE DISCH MIXING PUMP (CBMP) 400 GPM, 180' TDH G50C010A
CONDENSATE SLUDGE DISCH MIXING PUMP (CBMP) 400 GPM, 180' TDH G50C010B
ULTRASONIC
LOW PUMP TRIP
HIGH PUMP TRIP
INTLK WITH FILTER BACKWASH
LOCAL SAMPLE (TYPE B)
DETAIL A
SEE NOTE 2





DETAIL "A" (SEE NOTE 5)

OPERATING DATA						
#	PSIG	GPM	F	BY	REMARKS	
35	<	3600	70	[illegible]		
36	5	450	70	[illegible]		
37	40	450	70	[illegible]		
38	5	450	70	[illegible]		
39	85	0 TO 50	70	[illegible]		
40	85	0 TO 50	70	[illegible]		
41	5	450	70	[illegible]		
42	35	450	70	[illegible]		
43	35	[illegible]	70	[illegible]		
39a	I.I.	I.I.	70			
39b	I.I.	I.I.	70			

DESIGN DATA									
#	NORMAL PSIG	NORMAL F	UPSET PSIG	UPSET F	Time	By		Remarks	
	SEE		D-302-731						

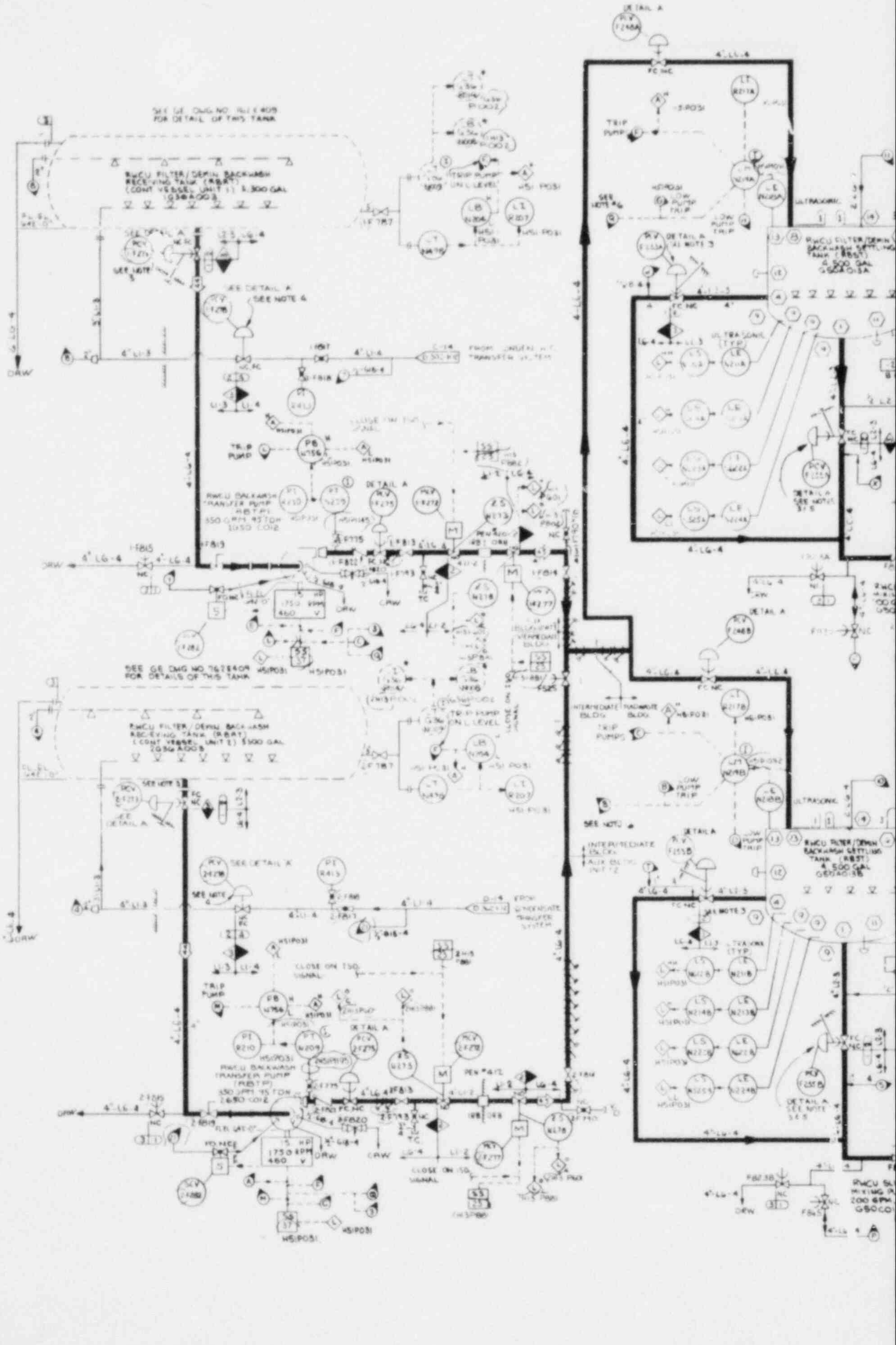
NOTES -

1. FOR OTHER NOTES SEE DWG D-302-731
2. LOCATE ISOLATION VALVES AS CLOSE TO TANKS AS POSSIBLE (WHERE NOTED)
3. THESE VALVES MOUNTED IN VERTICAL LINES
4. CDST'S SHALL BE INTERLOCKED TO START AUTOMATICALLY WHEN [illegible] FILTER IS BACKWASHED AND SHALL ALSO BE INTERLOCKED WITH CDST'S [illegible] THAT PUMP CANNOT START UNLESS LEVEL IN CDST IS BELOW DECANT POINT (CONNECTION (5))
5. F[illegible] - VALVE IDENTIFICATION NUMBER
6. CONNECTION OF FLUSH LINE SHALL BE AS CLOSE TO TANK NOZZLE AS POSSIBLE TO INSURE THAT ALL INPUT STREAM AND FLUSH WATER ARE DIRECTED INTO TANK

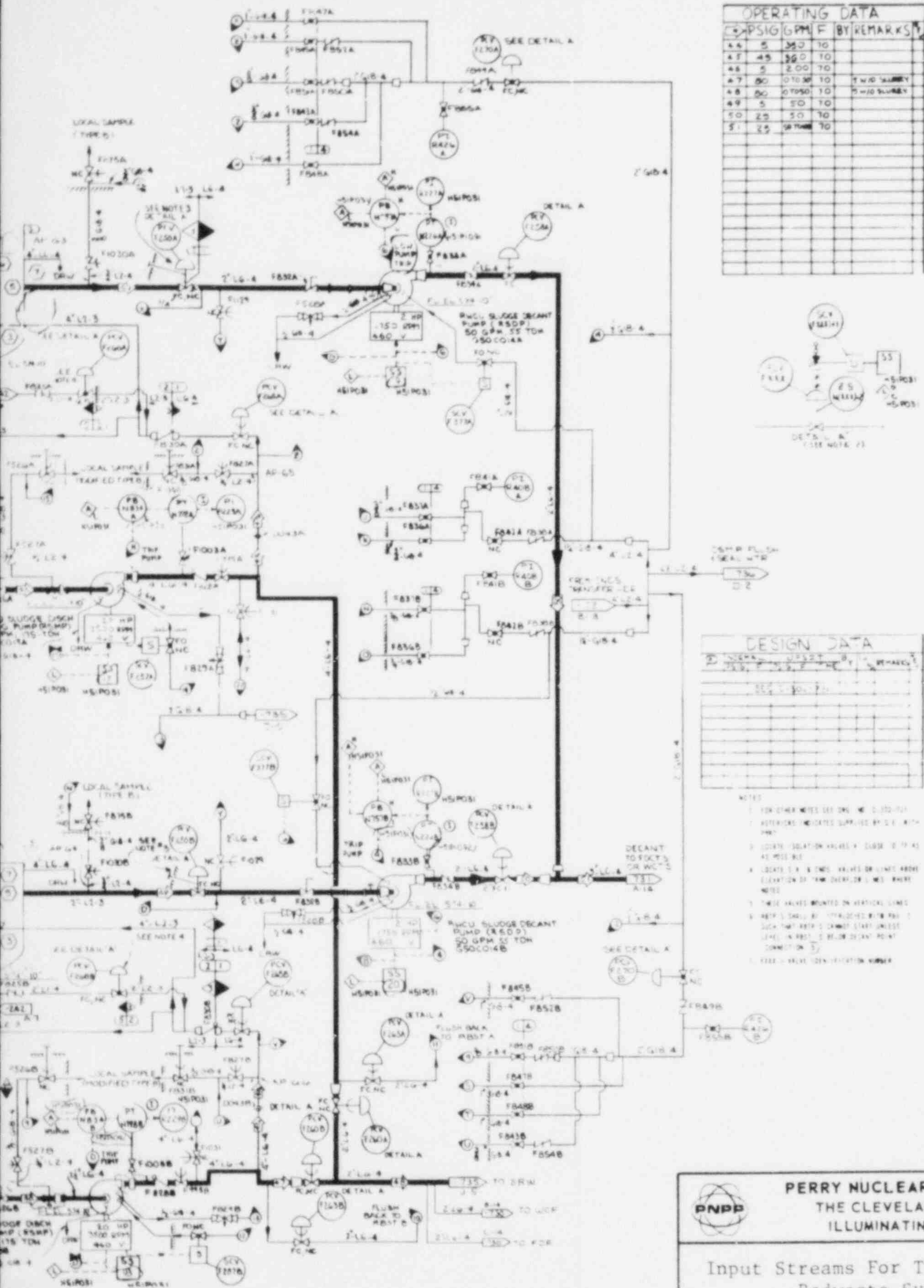
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 12 of 15)
(GAI Dwg. D-302-736)



DETAIL A
SEE GE DWG NO 762E409 FOR DETAIL OF THIS TANK
RWCU FILTER/DEMIN BACKWASH RECEIVING TANK (RBRT) (CONT VESSEL UNIT 1) 5300 GAL
TRIP PUMP ON L LEVEL
SEE DETAIL A
SEE NOTE 4
FROM CONDENSATE TRANSFER SYSTEM
DRW
CLOSE ON TSO SIGNAL
TRIP PUMP
RWCU BACKWASH TRANSFER PUMP (RBTP) 350 GPM 95 TDH
15 HP 1750 RPM 460 V
SEE GE DWG NO 762E409 FOR DETAILS OF THIS TANK
RWCU FILTER/DEMIN BACKWASH RECEIVING TANK (RBRT) (CONT VESSEL UNIT 2) 5300 GAL
INTERMEDIATE BLDG
RADWASTE BLDG
TRIP PUMPS
LOW PUMP TRIP
ULTRASONIC
RWCU FILTER/DEMIN BACKWASH SETTLING TANK (RBST) 4500 GAL
ULTRASONIC (TYP)
SEE NOTE 3
AUX BLDG



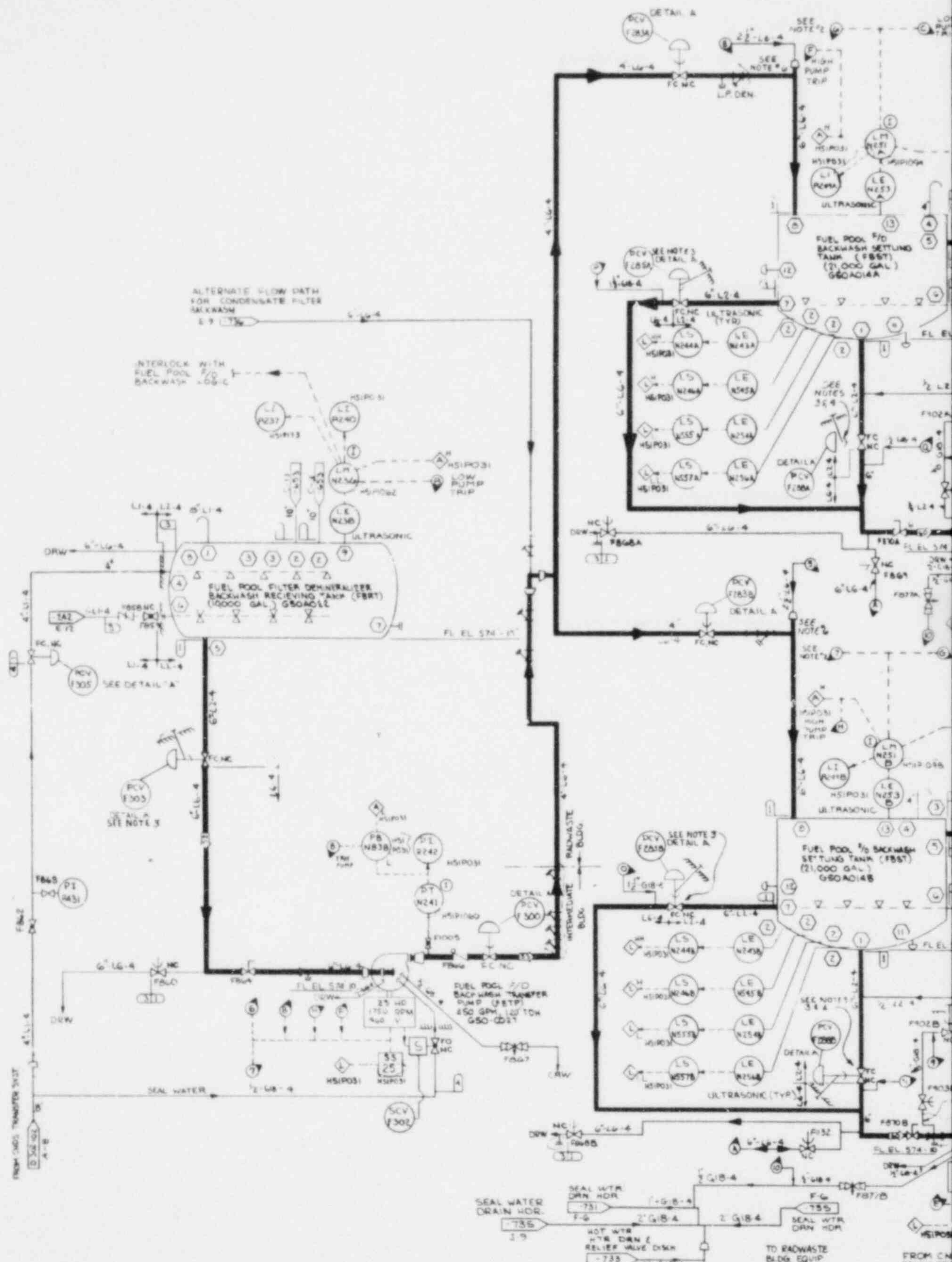
OPERATING DATA

→	PSIG	GPM	F	BY	REMARKS
44	5	360	70		
45	45	360	70		
46	5	200	70		
47	80	0 TO 30	70		1 W/O SLURRY
48	80	0 TO 50	70		5 W/O SLURRY
49	5	50	70		
50	25	50	70		
51	25	50 [illegible]	70		

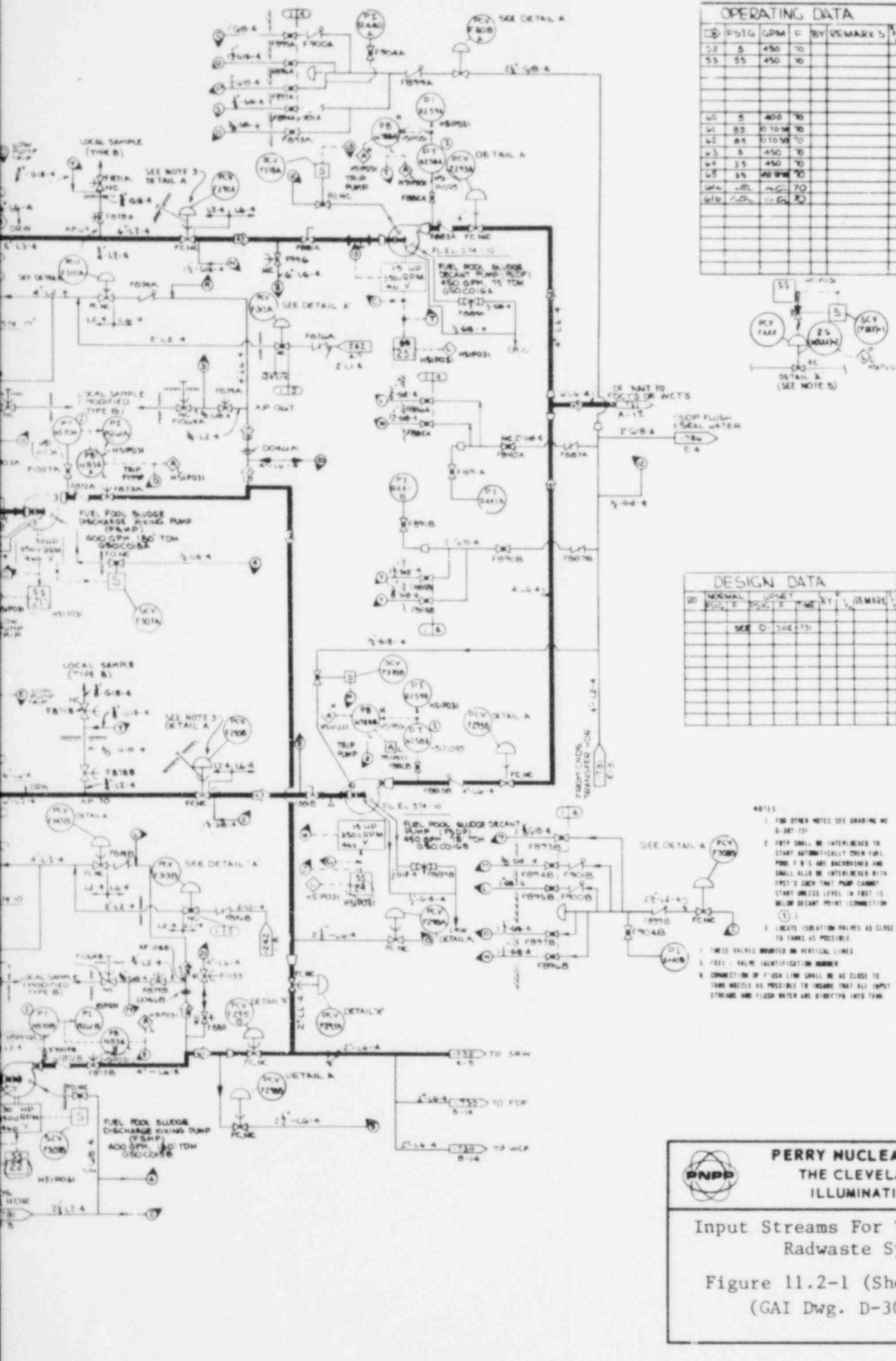
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 13 of 15)
(GAI Dwg. D-302-737)



ALTERNATE FLOW PATH FOR CONDENSATE FILTER BACKWASH
INTERLOCK WITH FUEL POOL F/D BACKWASH LOGIC
LOW PUMP TRIP
ULTRASONIC
FUEL POOL FILTER DEMINERALIZER BACKWASH RECIEVING TANK (FBRT) (10000 GAL) G50A012
SEE DETAIL "A"
SEE NOTE 3
FUEL POOL F/D BACKWASH TRANSFER PUMP (FBTP)
SEAL WATER
FUEL POOL F/D BACKWASH SETTLING TANK (FBST) (21,000 GAL) G50A014A
FUEL POOL F/D BACKWASH SETTLING TANK (FBST) (21,000 GAL) G50A014B
HIGH PUMP TRIP
ULTRASONIC (TYP)
DETAIL A
SEE NOTE 2
RADWASTE BLDG.
INTERMEDIATE BLDG.
SEAL WATER DRAIN HDR.
SEAL WTR DRN HDR
HOT WTR HTR DRN & RELIEF VALVE DISCH
TO RADWASTE BLDG. EQUIP DRAIN SUMP
DRW



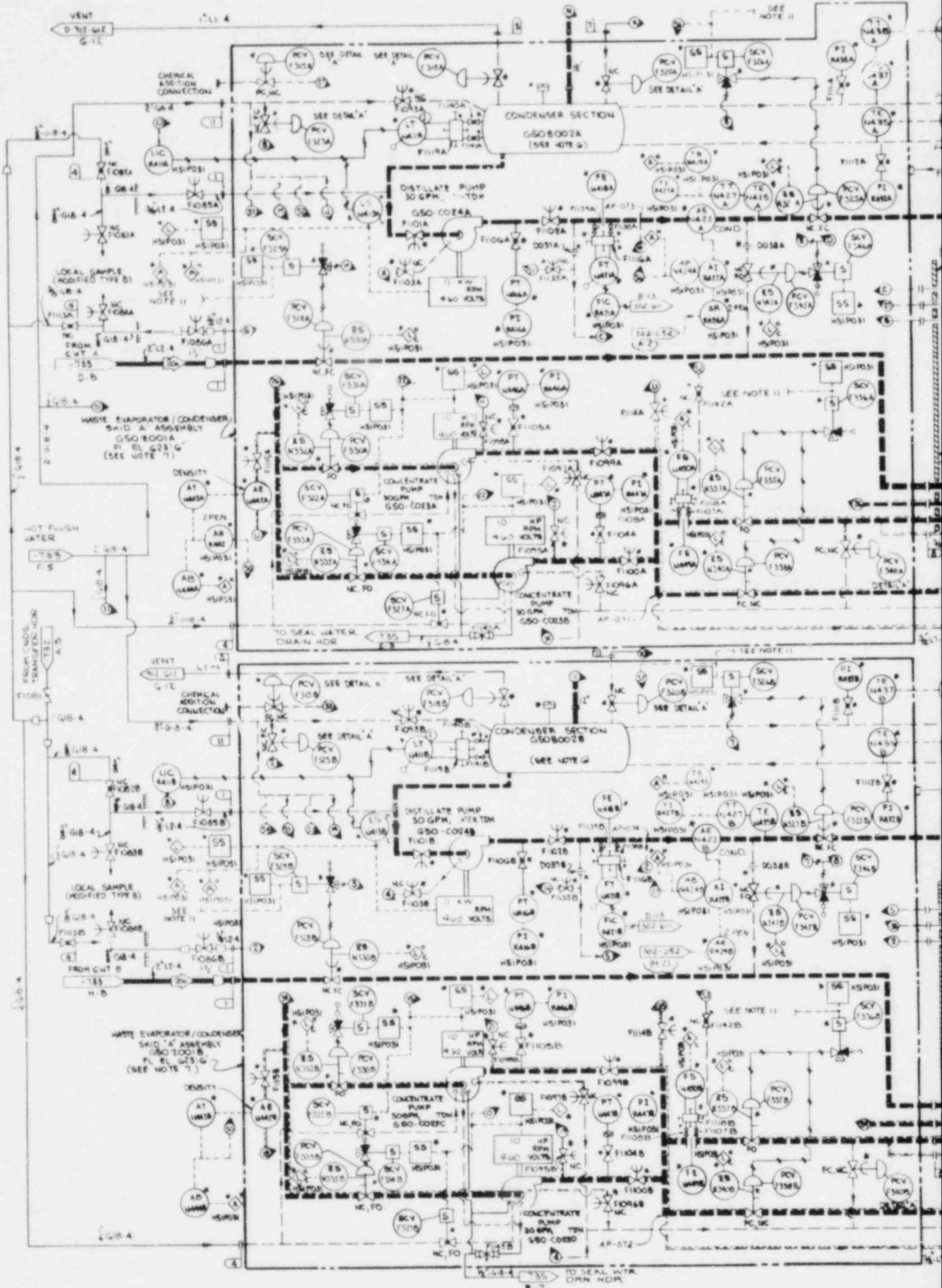
OPERATING DATA						
	PSIG	GPM	F	BY	REMARKS	
52	5	450	70			
53	55	450	70			
60	5	400	70			
61	85	0 TO 50	70			
62	85	0 TO 50	70			
63	5	450	70			
64	35	450	70			
65	35	450 GPM	70			
64a	[illegible]	[illegible]	70			
64b	[illegible]	[illegible]	70			

DESIGN DATA									
	NORMAL		UPSET						
	PSIG	F	PSIG	F	TIME	BY		REMARKS	
		SEE	D-302-731						

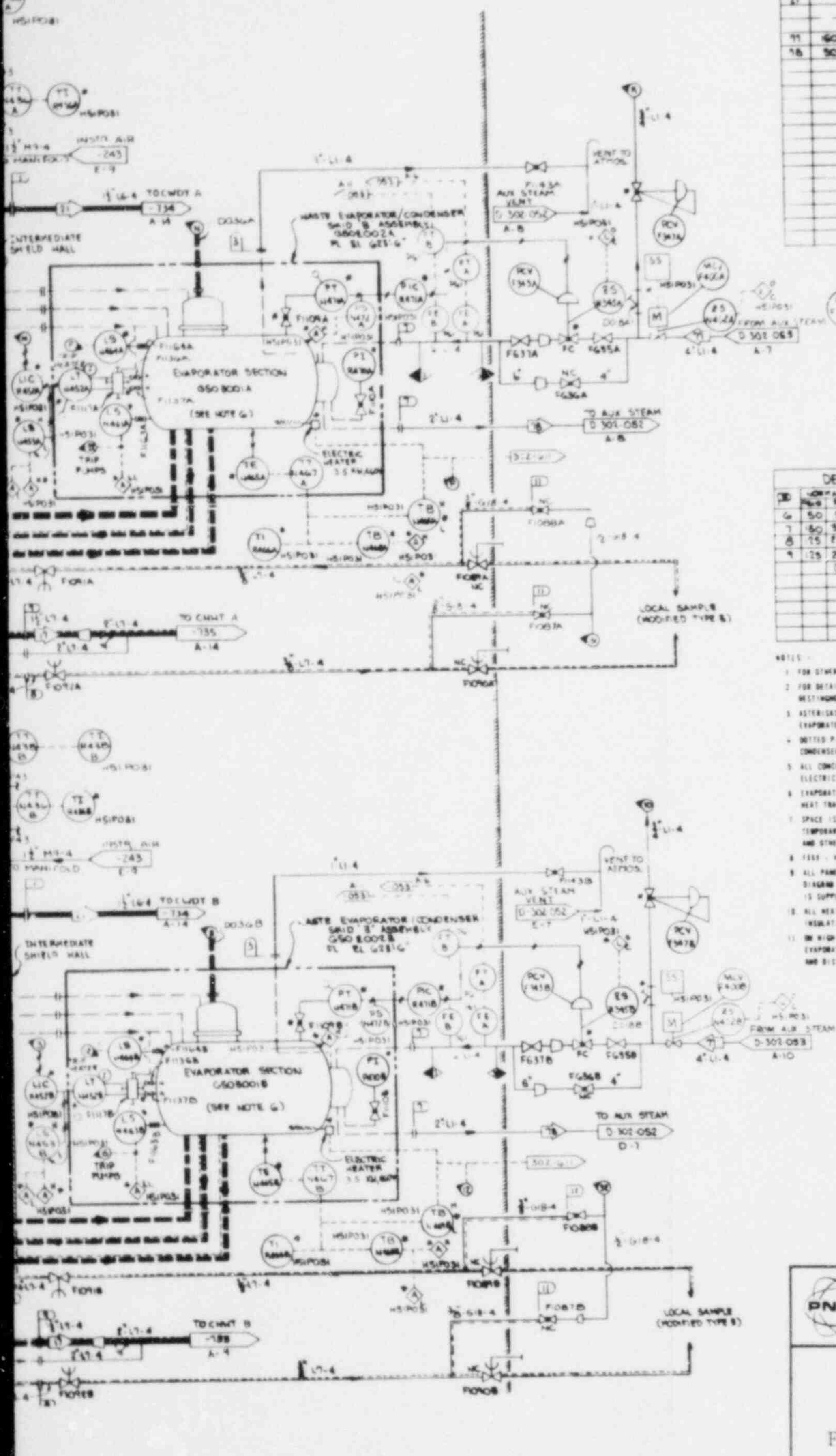
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

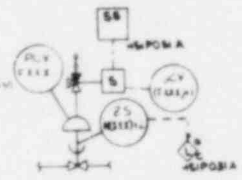
Figure 11.2-1 (Sheet 14 of 15)
(GAI Dwg. D-302-738)



VENT
CHEMICAL ADDITION CONNECTION
CONDENSER SECTION
G50B002A
DISTILLATE PUMP
LOCAL SAMPLE (MODIFIED TYPE B)
SEE NOTE 11
WASTE EVAPORATOR/CONDENSER SKID 'A' ASSEMBLY
DENSITY
HOT FLUSH WATER
CONCENTRATE PUMP
TO SEAL WATER DRAIN HDR
CONDENSER SECTION G50B002B
FROM CHT B
TO SEAL WTR DRN HDR



OPERATING DATA						
[illegible]	PSIG	GPM	F	BY	REMARKS	
19		50	60			
21		80	180			
99	160	[illegible]	366			
98	50	44.5	300			



DETAIL "A"

(SEE NOTE 8)

DESIGN DATA									
[illegible]	NORMAL PSIG	NORMAL F	UPSET PSIG	UPSET F	UPSET TIME	[illegible]	[illegible]	REMARKS	
6	50	50	NA	NA	NA	AB			
7	160	380	NA	NA	NA	[illegible]			
8	15	180	NA	NA	NA	CHE			
9	125	200	NA	NA	NA	CHE			
		(SEE D-302-731 K-135)							

NOTES: -

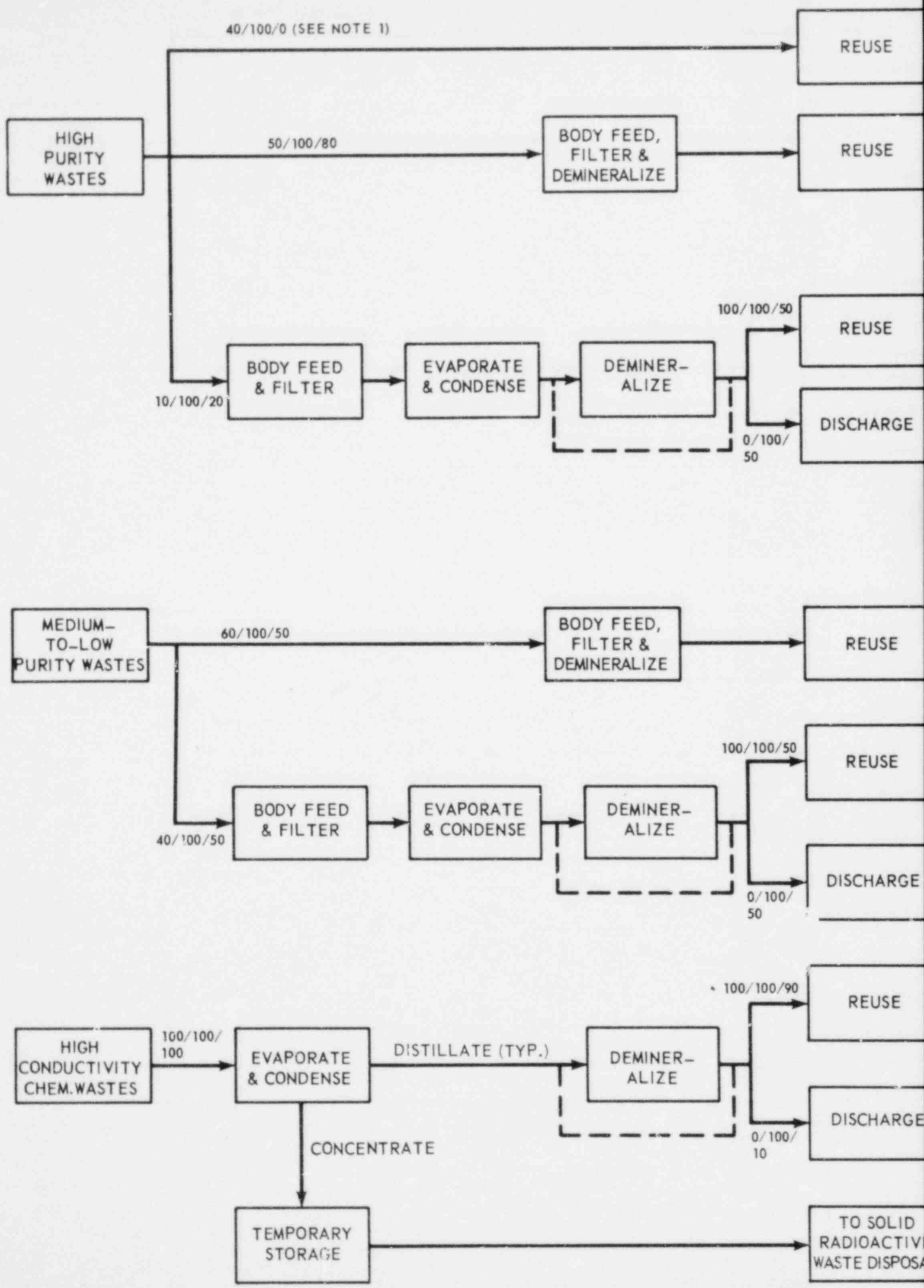
1. FOR OTHER NOTES SEE DWG. D-302-731
2. FOR DETAILS OF EVAPORATOR/CONDENSER CONTROLS SEE WESTINGHOUSE DWG. 737J453.
3. ASTERISKS DENOTE EQUIPMENT SUPPLIED WITH EVAPORATOR/CONDENSER PACKAGE.
4. DOTTED PIPING IS SUPPLIED WITH EVAPORATOR/CONDENSER PACKAGE.
5. ALL CONCENTRATED WASTE PIPING SHALL HAVE REDUNDANT ELECTRIC HEAT TRACING.
6. EVAPORATOR SECTION, CONDENSER SECTION, AND ALL HEAT TRACED PIPING SHALL BE INSULATED.
7. SPACE IS PROVIDED ON SKID "A" FOR ERECTION OF TEMPORARY SHIELDING BETWEEN CONCENTRATE PUMPS AND OTHER EQUIPMENT ON SKID.
8. FXXX - VALVE IDENTIFICATION NUMBER.
9. ALL PANEL MOUNTED INSTRUMENTATION SHOWN ON THIS DIAGRAM IS MOUNTED ON SUBPANEL HSI-P831A WHICH IS SUPPLIED BY WESTINGHOUSE.
10. ALL HEAT TRACED PIPING SHALL HAVE REMOVABLE INSULATION.
11. ON HIGH LEVEL ALARM FROM THE CDST OR CWST THE EVAPORATOR SHALL AUTOMATICALLY RECYCLE CONCENTRATE AND DISTILLATE AND/OR SHUT DOWN.

PNPP

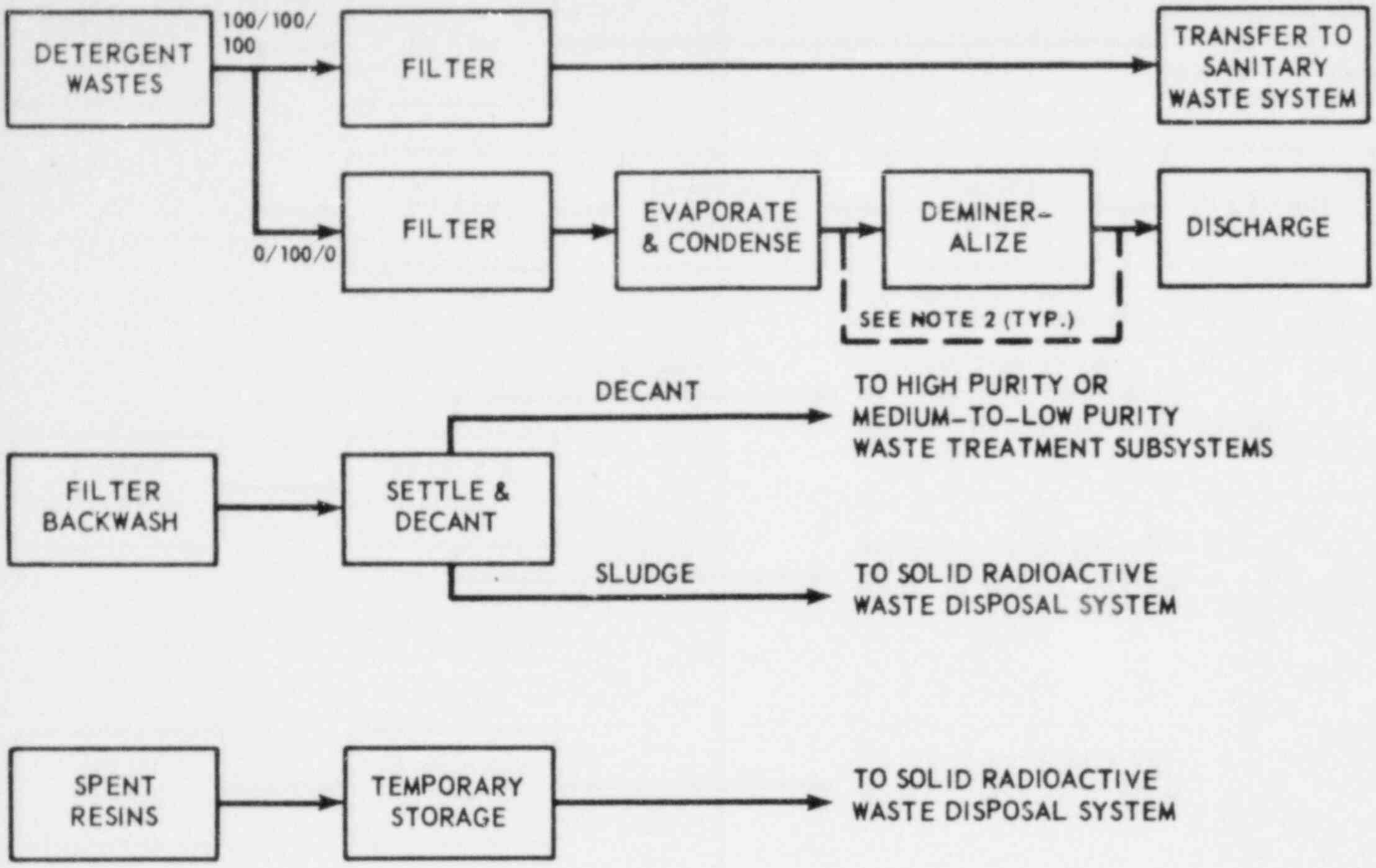
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Input Streams For The Liquid Radwaste System

Figure 11.2-1 (Sheet 15 of 15)
(GAI Dwg. D-302-742)



40/100/0 (SEE NOTE 1)
REUSE
HIGH PURITY WASTES
50/100/80
BODY FEED, FILTER & DEMINERALIZE
REUSE
100/100/50
REUSE
BODY FEED & FILTER
EVAPORATE & CONDENSE
DEMINER-ALIZE
10/100/20
DISCHARGE
0/100/50
MEDIUM-TO-LOW PURITY WASTES
60/100/50
BODY FEED, FILTER & DEMINERALIZE
REUSE
100/100/50
REUSE
BODY FEED & FILTER
EVAPORATE & CONDENSE
DEMINER-ALIZE
40/100/50
DISCHARGE
0/100/50
100/100/90
REUSE
HIGH CONDUCTIVITY CHEM.WASTES
100/100/100
EVAPORATE & CONDENSE
DISTILLATE (TYP.)
DEMINER-ALIZE
DISCHARGE
0/100/10
CONCENTRATE
TEMPORARY STORAGE
TO SOLID RADIOACTIVE WASTE DISPOSA



NOTES:

1. THE THREE PERCENTAGES GIVEN FOR EACH FLOW PATH REPRESENT, IN ORDER, a) THE PERCENTAGE OF THE TOTAL FLOW NORMALLY EXPECTED TO USE THAT FLOW PATH, b) THE PERCENTAGE OF THE TOTAL FLOW USED TO DESIGN AND SIZE EQUIPMENT AND PIPING FOR THAT FLOW PATH, AND c) THE PERCENTAGE OF THE TOTAL FLOW USED TO CALCULATE THE QUANTITY OF RADIOACTIVE ISOTOPES DISCHARGED BY WAY OF THAT FLOW PATH.

2. EVAPORATOR DISTILLATE CAN BE DISCHARGED DIRECTLY (WITHOUT DEMINERALIZING) IF IT MEETS DISCHARGE WATER QUALITY SPECIFICATIONS.

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Process Flow Paths For The Liquid Radwaste System

Figure 11.2-2

11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

11.3.1 DESIGN BASES

11.3.1.1 Design Objective

The objective of the gaseous waste management system is to process and control the release of gaseous radioactive effluents to the site environs so as to maintain as low as reasonably achievable, the exposure of persons in unrestricted areas to radioactive gaseous effluents (Appendix I to 10 CFR 50). This is to be accomplished while maintaining occupational exposure as low as reasonably achievable and without limiting plant operation or availability.

11.3.1.2 Design Criteria

The gaseous effluent treatment systems are designed to limit the dose to off site persons from routine station releases to significantly less than the limits specified in 10 CFR 20 and to operate within the emission rate limits established in the technical specification.

As a design basis for this system, an annual average noble radiogas source term (based on 30 minute decay) of 100,000 μCi/sec of the "1971 Mixture" will be used. Table 11.3-1 indicates the design basis noble radiogas source terms referenced to 30 minute decay.

The annual average exposure at the site boundary during normal operation from gaseous sources is not expected to exceed the dose objectives of Appendix I to 10 CFR 50 in terms of actual doses to actual persons. The radiation dose design basis for the treated off-gas is to delay the gas until the required fraction of the radionuclides has decayed and the daughter products are retained by the charcoal and the HEPA filters.

The gaseous radwaste equipment is selected, arranged and shielded to maintain occupational exposure as low as reasonably achievable in accordance with Regulatory Guide 8.8.

The gaseous effluent treatment system is designed to the requirements of the General Design Criteria that follow.

General Design Criterion

The system has sufficient capacity to reduce the off-gas activity to permissible levels for release during normal operation, including anticipated operational occurrences, and to avoid any termination of releases or limitation of plant operation due to unfavorable site environmental conditions.

General Design Criterion 64

Continuous monitoring of activity levels in the system upstream of the delay line provides advance notice of any potentially significant increase in releases. Continuous monitoring of the system effluent, with automatic isolation at activity levels corresponding to administrative release limits and annunciation at lower levels, along with continuous monitoring of the plant vent release, provide assurance that activity releases to the environment will in all events be maintained within established limits.

11.3.1.3 Equipment Design Criteria

A list of the off-gas system major equipment items which includes materials, rates, process conditions, number of units supplied, and the design codes is provided in Table 11.3-2. Equipment and piping are designed and constructed in accordance with the requirements of the applicable codes as given in Tables 3.2-1 and 3.2-2.

The quality group classifications of the various systems are shown in Table 3.2-1. Seismic category, safety class, quality assurance requirements, and principal construction codes information is contained in Section 3.2. The system is designed to Quality Group Classification D, with additional quality requirements as recommended in Regulatory Guide 1.143.

The failure of the off-gas system is analyzed in Section 15.7.1. The related failure of the steam jet air ejector lines and the gland seal off-gas lines are also analyzed in Section 15.7.1.

The reactor building, turbine building, and radwaste building contain radioactive sources. The design bases for the ventilation systems for these buildings are discussed in Section 9.4.

11.3.2 SYSTEM DESCRIPTION

The off-gas from the main condenser steam jet air ejector is treated by a system using catalytic recombination and low temperature charcoal adsorption (RECHAR system). Descriptions of the major process components including design temperature and pressure are given in Table 11.3-2 and in the sections that follow.

11.3.2.1 Main Condenser Steam Jet Air Ejector Low-Temp RECHAR System

Noncondensible radioactive off-gas is continuously removed from the main condenser by the air ejector during plant operation.

The air ejector off-gas will normally contain activation gases, principally N-16, O-19, and N-13. The N-16 and O-19 have short half-lives and are readily decayed. The 10 minute half-life N-13 is present in small amounts that are further reduced by decay.

The air ejector off-gas will also contain radioactive noble gases including parents of biologically significant Sr-89, Sr-90, Ba-140, and Cs-137. 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.

11.3.2.1.1 Process Description

A main condenser off-gas treatment system has been incorporated in the plant design to reduce the gaseous radwaste emission from the station. The off-gas system uses a catalytic recombiner to recombine radiolytically dissociated hydrogen and oxygen. After cooling (to approximately 130°F) to strip the condensibles and reduce the volume, the remaining noncondensibles (principally air with traces of krypton and xenon) will be delayed in the nominal 10 minute holdup system. The gas is cooled to 45°F and filtered through a HEPA filter. The gas is then passed through a desiccant dryer that reduces the dewpoint to approximately -90°F and is then chilled to about 0°F. Charcoal adsorption beds, operating in a refrigerated vault at about 0°F, selectively adsorb and delay the xenons and kryptons from the bulk carrier gas (principally dry air). After the delay, the gas is again passed through a HEPA filter and discharged to the environment through the off-gas building vent.

11.3.2.1.1.1 Process Flow Diagram

Figure 11.3-1 is the process flow diagram for the system. The process data for startup and normal operating conditions are submitted as proprietary data under separate cover on Table 11.3-3.

The information supporting the process data is presented in Reference 1. The vent is the single release point for this system and is located on the off-gas building. The vent is indicated on proprietary Figures 11.3-1 and 11.3-2.

11.3.2.1.2 Noble Gas Radionuclide Source Term and Decay

The design basis isotopic source terms for the annual average activity input of the main condenser off-gas treatment system are given in Table 11.3-1 at t=30 minutes. The system is mechanically capable of processing three times the source terms of Table 11.3-1 without affecting delay time of the noble gases.

11.3.2.1.3 Piping and Instrumentation Diagram (P&ID)

The P&ID is submitted as proprietary data under separate cover as Figure 11.3-2. The main process routing is indicated by a heavy line.

11.3.2.1.4 Recombiner Sizing

The basis for sizing the recombiner is to maintain the hydrogen concentration by volume below 4 percent (including steam) at the inlet and below 1 percent at the outlet on a dry basis. The exit hydrogen concentration is normally well below the 1 percent maximum allowed. The hydrogen generation rate of the reactor is based on data from nine BWRs. The hydrogen generation rate is given in the process flow diagram and in Table 11.3-3.

11.3.2.1.5 Process Design Parameters

The Kr and Xe holdup time is closely approximated by the following equation:

$$T = \frac{K_D M}{V}$$

where:

T = holdup time of a given gas

K_D = dynamic adsorption coefficient for the given gas

M = weight of charcoal

V = flow rate of the carrier gas in consistent units.

Dynamic adsorption coefficient values for xenon and krypton were reported by Browning.(2) General Electric has performed pilot plant tests at their Vallecitos Laboratory and the results were reported at the 12th AEC Air Cleaning Conference.(3) Moisture has a detrimental effect on adsorption coefficients. The fully redundant -90°F dewpoint, adsorbent air dryers are supplied to prevent moisture from reaching the charcoal. There are redundant moisture analyzers that will alarm on breakthrough of the drier beds; however, breakthrough is not expected since the drier beds will be regenerated

on a time basis. The system is slightly pressurized which, together with very stringent leak rate requirements, prevents leakage of moist air into the charcoal.

Carrier gas is the air inleakage from the main condenser after the radiolytic hydrogen and oxygen are removed by the recombiner. The air inleakage design basis is conservatively sized at 30 scfm total. The Sixth Edition of Heat Exchange Institute Standards for Steam Surface Condensers (Reference 4), Par. Sl(c) (2), indicates that with certain conditions of stable operation and suitable construction, noncondensibles (not including radiological decomposition products) should not exceed 6 scfm for large condensers. Dresden 2, Monticello, Fukushima 1, Tsuruga, and KRB have all operated at 6 scfm or below after initial startup. Dilution air is not added to the system unless the air inleakage is less than 6 scfm. In that event, 6 scfm is added to provide for dilution of residual hydrogen from the recombiner. An initial bleed of oil-free air is added on startup until the recombiner comes up to temperature.

11.3.2.1.6 Charcoal Adsorbers

11.3.2.1.6.1 Charcoal Temperature

The charcoal adsorbers operate at a nominal 0°F temperature. The decay heat is sufficiently small that, even in the no-flow condition, there is no significant loss of adsorbed noble gases due to temperature rise in the adsorbers. The adsorbers are located in a shielded room, and are maintained at a constant temperature by a redundant vault refrigeration system. Failure of the refrigeration system will actuate an alarm in the control room. In addition, a radiation monitor is provided to monitor the radiation level in the charcoal bed vault. High radiation will actuate an alarm in the control room.

11.3.2.1.6.2 Gas Channeling in the Charcoal Adsorber

Channeling in the charcoal adsorbers is prevented by supplying an effective flow distributor on the inlet, having long columns and having a high bed-to-particle diameter ratio of approximately 500. Underhill has stated that channeling or wall effects may reduce efficiency of the holdup bed if this ratio is not greater than 12 (Reference 5). During transfer of the charcoal into the charcoal adsorber vessels radial sizing of the charcoal will be minimized by pouring the charcoal (by gravity or pneumatically) over a cone or other instrument to spread the granules over the surface.

11.3.2.1.6.3 Charcoal Bypass Mode

A bypass line, isolated with double block and bleed valves, is provided to bypass the charcoal adsorbers. The main purpose of this bypass is to protect the charcoal during preoperation and startup testing when gas activity is zero or very low.

It may be desirable to use the bypass for short periods during startup or normal operations. This bypass mode would not be used for normal operation unless some unforeseen system malfunction would necessitate shutting down the power plant or operating in the bypass mode and remaining within the technical specification limits. The activity release is controlled by a process monitor upstream of the vent isolation valve that will cause the bypass valve to close on a high radiation alarm. This interlock can be defeated only by a keylock switch. The alarm setting is covered in Section 7.6.1.3. In addition, there is a high high-high alarm on the same monitor that will cause the off-gas system to be isolated from the vent if established release limits are exceeded.

11.3.2.1.7 Leakage of Radioactive Gases

Leakage of radioactive gases from the system is limited by welding piping connections where possible and using bellows stem seals or equivalent valving. The system operates at a maximum of 7 psig during startup and less than 2 psig

during normal operation so that the differential pressure to cause leakage is small.

11.3.2.1.8 Hydrogen Concentration

Hydrogen concentration or gases from the air ejector is kept below the flammable limit by maintaining adequate process steam flow for dilution at all times. This steam flow rate is monitored and alarmed.

11.3.2.1.9 Field Run Piping

No piping in this system is field routed. This includes major process piping, drain lines, steam lines, and sample lines which are shown on Figure 11.3-2.

11.3.2.1.10 Liquid Seals

There are several liquid seals to prevent gas escape through drains shown on Figure 11.3-2. These seals are protected against permanent loss of liquid by an enlarged section downstream of the seal that can hold the seal volume and will drain by gravity back into the loop after the momentary pressure surge has passed. Each seal has a manual valve that can be used to fill the loop. In the event that a loop seal goes dry, level sensors will initiate closure of an isolation valve in the loop. Seals are also equipped with solenoid valves that close if radioactive release from this system exceeds established limits.

11.3.2.1.11 System Performance

Noble gas activity release is about 50-60 μCi/sec from the exit of the steam jet air ejector off-gas system based upon 30 scfm air inleakage and an input of 100,000 μCi of 30 minute old "1971 Mixture". The isotopic composition is given in Table 11.3-1 in units of μCi/sec and Ci/yr.

Iodine input into the off-gas system is small by virtue of its retention in reactor water and condensate. The iodine remaining is essentially removed by adsorption in the charcoal. This is supported by the fact that charcoal filters remove 99.9 percent of the iodine in 2 inches of charcoal, whereas this system has approximately 76 feet of charcoal in the flow path.

Particulates are removed with a 99.95 percent efficiency by a HEPA filter as gas exits the nominal 10 minute holdup. The noble gas decays within the interstices of the activated charcoal and daughters are entrapped there. The charcoal serves as an excellent filter for other particulates and essentially no particulates exit from the charcoal. The charcoal is followed with a HEPA filter which is a safeguard against escape of charcoal dust. Particulate activity discharged from this system is essentially zero.

11.3.2.1.12 Isotopic Inventory

The isotopic inventory of each equipment piece is given in Appendix 12A for four different operating conditions.

11.3.2.1.13 Previous Experience

Performance of a similar system operating at ambient temperatures and the results of experimental testing performed by General Electric have been submitted in the General Electric Company proprietary topical report, (Reference 1). Non-proprietary portions of this information are reported in Reference 3.

11.3.2.1.14 Single Failures and Operator Errors

Design provisions are incorporated which preclude the uncontrolled release of radioactivity to the environment as a result of any single operator error or of any single equipment malfunction short of the catastrophic equipment failures described in Chapter 15. An analysis of single equipment piece malfunctions is provided in Table 11.3-4.

Design precautions taken to prevent uncontrolled releases of activity include the following:

a. The system design minimizes ignition sources so that a hydrogen detonation is highly unlikely even in the event of a recombiner failure.

b. Even though measures are taken to avoid a possible detonation; the system pressure boundary is designed to be detonation-resistant.

c. All discharge paths to the environment are monitored.

d. Dilution steam flow to the steam jet air ejector is monitored and alarmed, and valving is such that loss of dilution steam cannot occur without coincident loss of motive steam, so that the process gas is sufficiently diluted if it is flowing at all.

11.3.2.1.15 Other Radioactive Gas Sources

Radioactive gases are present in the power plant buildings as a result of process leakage and steam discharges. The process leakage is the source of the radioactive gases in the air discharged through the ventilation system. The design of the ventilation system is discussed in Section 9.4. The building volumes and ventilation flow rates are discussed in Section 12.2.2.

The activity released to the suppression pool from steam discharges is discussed in Section 12.2.2. A tabulation of the expected frequency and the quantity of steam discharged to the suppression pool is provided in Table 11.3-5.

11.3.2.1.16 Cost-Benefit Ratio

In accordance with 10 CFR 50, Appendix I, Section II, Paragraph D, a cost-benefit analysis is not required for this system because it satisfies the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors

proposed in the Concluding Statement of Position of the Regulatory Staff in Docket RM-50-2.

11.3.2.1.17 Maintainability of Gaseous Radwaste System

Design features which reduce or ease required maintenance include the following:

a. Redundant components for all active, in-process equipment pieces.

b. No rotating equipment in the process stream.

c. Rotating equipment is located in the system only where maintenance can be performed while the system is in operation.

Design features which reduce leakage and releases of radioactive material include the following:

a. Extremely stringent leak rate requirements placed upon all equipment, piping, and instruments, and enforced by requiring as-installed helium leak tests of the entire process system.

b. Use of welded joints wherever practicable.

c. Specification of valve types with extremely low leak rate characteristics, i.e., bellows seal, double stem seal, or equal.

d. Use of loop seals with enlarged discharge section to avoid syphoning and to be self-refilling following a pressure surge.

e. Specification of stringent seat leakage characteristics for valves and lines discharging to the environment through other systems.

11.3.2.2 System Design Description

11.3.2.2.1 Main Condenser Steam Jet Air Ejector Off-Gas Low-Temp System

11.3.2.2.1.1 Quality Classification and Construction and Testing Requirements

Equipment and piping are designed and constructed in accordance with the requirements of the applicable codes as given in Table 11.3-6 and will comply with the welding and material requirements and the system construction and testing requirements as follows.

11.3.2.2.1.2 Seismic Design

11.3.2.2.1.2.1 Equipment

Equipment and components used to collect, process, or store gaseous radioactive waste are not designed as Seismic Category I.

11.3.2.2.1.2.2 Buildings Housing Gaseous Radioactive Waste Processing Systems

That portion of the off-gas system upstream of the gas dryer prefilters is housed in the turbine building, which is a non-seismic, non-safety class, reinforced concrete structure. The remaining portion of this system is located in the off-gas building, which is a Safety Class 3, Seismic Category I, reinforced concrete structure. A detailed discussion of the seismic design for this building is given in Section 3.7.

11.3.2.2.1.3 Quality Control

A program is established that is sufficient to assure that the design, construction and testing requirements are met. The following areas are included in the program:

a. Design and Procurement Document Control - Procedures are established to ensure that requirements are specified and included in design and procurement documents and that deviations therefrom are controlled.

b. Control of Purchased Material, Equipment and Services - Procedures are established to assure that purchased material, equipment, and construction services conform to the procurement documents.

c. Inspection - A program for inspection of activities affecting quality is established and executed by or for the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity.

d. Handling, Storage, and Shipping - Procedures are established to control the handling, storage, shipping, cleaning, and preservation of material and equipment in accordance with work and inspection instructions to prevent damage or deterioration.

e. Inspection, Test, and Operating Status - Procedures are established to provide for the identifications of items which have satisfactorily passed required inspections and tests.

f. Corrective Action - Procedures are established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected.

11.3.2.2.1.4 Welding

All welding constituting the pressure boundary of pressure retaining components is performed by qualified welders employing qualified welding procedures per Table 11.3-6.

11.3.2.2.1.5 Materials

Materials for pressure retaining components of process systems were selected from those covered by the material specifications listed in Section II, Part A of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought or cast-iron materials are not used. The components satisfy all of the mandatory requirements of the material specifications with regard to manufacture, examination, repair, testing, identification, and certification.

A description of the major process equipment including the design temperature and pressure and the materials of construction is given in Table 11.3-2.

Impact testing of carbon steel components operating at cold temperatures is in accordance with Paragraph UG84, Section VIII, of ASME Boiler and Pressure Vessel Code, Division 1.

11.3.2.2.1.6 Construction of Process Systems

Pressure retaining components of process systems utilize welded construction to the maximum practicable extent. Process piping systems include the first root valve on sample and instrument lines. Process lines are not less than 3/4-inch nominal pipe size. Sample and instrument lines are not considered as portions of the process systems. Flanged joints or suitable rapid disconnect fittings are not used except where maintenance requirements clearly indicate that such construction is preferable. Screwed connections in which threads provide the only seal are not used. Screwed connections backed up by seal welding or mechanical joints are used only on lines of 3/4-inch nominal pipe size. In lines 3/4-inch or greater, but less than 2-1/2-inch nominal pipe size, socket type welds are used. In lines 2-1/2-inch nominal pipe size and larger, pipe welds are of the butt joint type.

11.3.2.2.1.7 System Integrity Testing

Completed process systems are pressure tested to the maximum practicable extent. Piping systems are hydrostatically tested in their entirety, using available valves or temporary plugs at atmospheric tank connections. Hydrostatic testing of piping systems is performed at a pressure 1.5 times the design pressure, but in no case at less than 75 psig. The test pressure is held for a minimum of 30 minutes with no leakage indicated. Pneumatic testing may be substituted for hydrostatic testing in accordance with the applicable codes. A helium leak test is performed on the entire, as-installed, gaseous radwaste process system.

11.3.2.2.1.8 Instrumentation and Control

This system is monitored by flow, temperature, pressure, and humidity instrumentation, and by hydrogen analyzers to ensure correct operation and control. Table 11.3-7 lists the process parameters that are instrumented to alarm in the control room. It also indicates whether the parameters are recorded or indicated. Instrumentation and controls are described in Section 7.7.1. The operator is in control of the system at all times.

A radiation monitor after the off-gas condenser continuously monitors radioactivity release from the reactor and input to the charcoal adsorbers. This radiation monitor is used to provide an alarm on high radiation in the off-gas.

A radiation monitor is also provided at the outlet of the charcoal adsorbers to continuously monitor the rate from the adsorber beds. This radiation monitor is used to isolate the off-gas system on high radioactivity to prevent treated gas of unacceptably high activity from entering the vent.

The activity of the gas entering and leaving the off-gas treatment system is continuously monitored. Thus, system performance is known to the operator at all times. Provision is made for sampling and periodic analysis of the

influent and effluent gases for purposes of determining their compositions. This information is used in calibrating the monitors and in relating the release to calculated environs dose. Process radiation instrumentation is described in Section 7.6.1.

Environmental monitoring is used; however, at the estimated low dose levels, it is doubtful that the measurements can distinguish doses from the plant from normal variation in background radiation.

11.3.2.2.1.9 Detonation Resistance

The pressure boundary of the system is detonation resistant. The pressure vessels are designed to withstand 350 psig static pressure, and piping and valving are designed to resist dynamic pressures encountered in long runs of piping at the design temperature. This analysis is covered in a proprietary report submitted to the NRC (Reference 6).

By the procedure described in Reference 6, a designer can obtain the required wall thickness of a specific equipment design, which normally or possibly contains a detonable mixture of hydrogen and oxygen. This wall thickness is then translated to the corresponding detonation-containing, static equipment pressure rating by using an appropriate code calculation.

11.3.2.2.1.10 Operator Exposure Criteria and Controls

The system is normally operated from the main control room. Equipment and process valves containing radioactive fluid are placed in shielded cells maintained at a pressure less than that of normally occupied areas.

11.3.2.2.1.11 Equipment Malfunction

Malfunction analysis, indicating consequences and design precautions taken to accommodate failure of various components of the system, is given in Table 11.3-4.

11.3.2.2.1.11.1 Previous Experience

A system with similar equipment is in service at the KRB plant in Germany. Its performance is reviewed in Reference 1. The Tsuruga and Fukushima I plants in Japan have similar recombiners in service. Similar systems (ambient temperature charcoal) are in service at Dresden 2 and 3, Pilgrim, Quad Cities 1 and 2, Nuclenor, Hatch, Browns Ferry 1, 2 and 3, and Duane Arnold.

11.3.2.3 Operating Procedure

11.3.2.3.1 Treated (Delayed) Radioactive Gas Sources

11.3.2.3.1.1 Main Condenser Steam Jet Air Ejector Off-Gas Low-Temp RECHAR System

11.3.2.3.1.1.1 Prestartup Preparations

Prior to starting the main steam jet air ejectors (SJAE), the charcoal vault is cooled to near 0°F, the glycol cooler is chilled to near 35°F and glycol is circulated through the cooler condenser, a desiccant dryer is regenerated and valved in, the off-gas condenser cooling water is valved in, and the recombiner heaters are turned on.

11.3.2.3.1.1.2 Startup

As the reactor is pressurized, preheater steam is supplied and air is bled through the preheater and recombiner. The recombiner is preheated to at least 225°F with this air bleed and/or by admitting steam to the final stage of the SJAE. With the recombiners preheated, and the desiccant drier and charcoal adsorbers valved in, the SJAE string is started. The bleed air is terminated. As the condenser is pumped down and the reactor power increases, the recombiner inlet stream is diluted with a fixed steam supply to less than four percent hydrogen by volume and the off-gas condenser outlet is maintained at less than one percent hydrogen by volume.

11.3.2.3.1.1.3 Normal Operation

After startup, the noncondensibles pumped by the SJAE will stabilize. Recombiner performance is closely followed by the recorded temperature profile in the recombiner catalyst bed. The hydrogen effluent concentration is measured by a hydrogen analyzer.

Normal operation is terminated following a normal reactor shutdown or a scram by terminating steam to the SJAEs and the preheater.

11.3.2.3.1.1.4 Previous Experience

Previous experience is reviewed in Section 11.3.2.2.1.12.

11.3.2.4 Performance Tests

11.3.2.4.1 Treated (Delayed) Radioactive Gas Sources

11.3.2.4.1.1 Main Condenser Steam Jet Air Ejector Off-Gas Low-Temp RECHAR System

This system is used on a routine basis and does not require specific testing to assure operability. Monitoring equipment will be calibrated and maintained on a specific schedule and on indication of malfunction.

11.3.2.4.1.1.1 Recombiner

Recombiner performance is continuously monitored and recorded by thermocouples that monitor the catalyst bed temperature profile and by a hydrogen analyzer that measures the hydrogen concentration of the effluent.

11.3.2.4.1.1.2 Prefilter

These particulate filters are tested at the time of filter installation or replacement using DOP (dioctylphthalate) aerosol to determine whether an installed filter meets the minimum inplace efficiency of 99.95 percent rejection.

The DOP from filter testing is not allowed into the desiccant or the activated charcoal. This equipment is isolated during filter DOP testing and is bypassed until the process lines have been purged clear of test material.

Because the DOP would have a detrimental effect on the desiccant and charcoal, this filter is not periodically tested. This is justified because the main function of this prefilter is to prevent the long-lived daughters of the radioactive xenons generated in the holdup pipe from depositing in the downstream equipment thereby minimizing contamination. Leakage through the filter has no effect on environmental release.

11.3.2.4.1.1.3 Desiccant Gas Drier

Desiccant gas drier performance is continuously monitored by an onstream humidity analyzer.

11.3.2.4.1.1.4 Charcoal Performance

The ability of the charcoal to delay the noble gases can be continuously evaluated by comparing activity measured and recorded by the process activity monitors at the exit of the off-gas condenser and at the exit of the charcoal adsorbers.

Experience with boiling water reactors has shown that the calibration of the off-gas and vent effluent monitors changes with isotopic content. Isotopic content can change depending on the presence of absence of fuel cladding leaks in the reactor and the nature of the leaks. Because of this possible variation, the monitors are calibrated against grab samples periodically and whenever the radiation monitor after the off-gas condenser shows significant variation in noble gas activity indicating a significant change in plant operations.

Grab sample points are located upstream and downstream of the first charcoal bed and downstream of the last charcoal bed and can be used for periodic sampling if the monitoring equipment indicates degradation of system delay performance.

11.3.2.4.1.1.5 Post Filter

On installation and replacements, these particulate filters will be tested using a DOP smoke test or equivalent.

11.3.2.4.1.1.6 Previous Experience

Previous experience is reviewed in Section 11.3.2.2.1.11.1.

11.3.3 RADIOACTIVE RELEASES

11.3.3.1 Release Points

A simplified flow diagram of the radioactive gas flow and treatment for the containment, the control complex, the auxiliary building, the fuel handling building, the radwaste building, the intermediate building, the turbine building, and the off-gas building is presented in Figure 11.3-3. The physical location and elevation of the release points are shown on Figure 1.2-18.

The discharge from the condenser steam jet air ejector is processed by the low TEMP RECHAR System prior to release through the off-gas building vent. Section 11.3.2 discusses the low TEMP RECHAR System.

Table 11.3-8 provides the vent dimensions, effluent velocity and effluent gas temperature for each of the release points.

11.3.3.2 Dilution Factors

The atmospheric dilution factors associated with normal plant releases are based upon the average annual meteorological conditions applicable to the site as well as the effective release height of the effluent discharge pathway. The site meteorological corditions are defined in Section 2.3.5. Also included in Table 2.3-27 are the average annual long-term dilution factors (x/Q).

11.3.3.3 Estimated Releases and Dose Rates

The release rates of radioactive materials in gaseous effluents are presented in Tables 11.3-9, 11.3-10, and 11.3-11. These values were calculated with the GALE computer code and are based on the assumptions and parameters provided in NUREG-0016 (BWR-GALE code) and Table 11.3-8. As shown in Table 11.3-10, the estimated releases are a small fraction of the limits of 10 CFR 20, Table II, Column 1 and are as low as reasonably achievable. The estimated off-site doses for the Perry site and a comparison with the design objectives of Appendix I to 10 CFR 50 and the dose limits of 10 CFR 20 are presented in Section 5.1.4 of the PNPP Environmental Report.

11.3.4 REFERENCES FOR SECTION 11.3

1. Miller, C. W., "Experimental and Operational Confirmation of Off-Gas System Design Parameters," NEDO-10751, January 1973. (Proprietary)

2. Browning, W. E., et al., "Removal of Fission Product Gases from Reactor Off-Gas Streams by Adsorption," (ORNL) CF59-6-47, June 11, 1959.

3. Siegwarth, D. P., "Measurement of Dynamic Adsorption Coefficients for Noble Gases on Activated Carbon," 12th AEC Air Cleaning Conference

4. Standards for Steam Surface Condensers, Sixth Edition, Heat Exchange Institute, New York, NY, 1970.

5. Underhill, Dwight, et al., "Design of Fission Gas Holdup Systems," Proceedings of the Eleventh AEC Air Cleaning Conference, 1970, p. 217.

6. Marrero, T. R., "Airborne Releases from BWR'S from Environmental Impact Evaluations", NEDO-21159, March 1976.

TABLE 11.3-1

ESTIMATED AIR EJECTOR OFF-GAS RELEASE RATES PER UNIT[1]
(30 scfm in-leakage)

Isotope	Half-Life	T=0 μCi/Sec	T=30 Minutes μCi/sec	Normal Discharge from Charcoal Adsorbers[3] μCi/sec	Ci/yr	Additional Discharge from Charcoal Adsorbers During Startup Ci/sec	Ci/startup
Kr-83m	1.86 hr	3.4×10^{3}	2.9×10^{3}				
Kr-85m	4.4 hr	6.1×10^{3}	5.6×10^{3}	4.3	1.2×10^{1}	1.1×10^{1}	1.4
Kr-85[2]	10.74 yr	10 - 20	10 - 20	10 - 20	280-560	0	
Kr-87	76 min	2.0×10^{4}	1.5×10^{4}	-			
Kr-88	2.79 hr	2.0×10^{4}	1.8×10^{4}	2.1×10^{-1}	6.0	1.4	1.7×10^{-1}
Kr-89	3.18 min	1.3×10^{5}	1.8×10^{2}	-			
Kr-90	32.3 sec	2.8×10^{5}	-	-			
Kr-91	8.6 sec	3.3×10^{5}	-	-			
Kr-92	1.84 sec	3.3×10^{5}	-	-			
Kr-93	1.29 sec	9.3×10^{4}	-	-			
Kr-94	1.0 sec	2.3×10^{4}	-	-			
Kr-95	0.5 sec	2.1×10^{3}	-	-			
Kr-97	1 sec	1.4×10^{1}	-	-			
Xe-131m	11.96 day	1.5×10^{1}	1.5×10^{1}	1.3	3.7×10^{1}	3.0×10^{-2}	1.07×10^{-1}
Xe-133m	2.26 day	2.9×10^{2}	2.8×10^{2}	-			
Xe-133	5.27 day	8.2×10^{3}	8.2×10^{3}	$3.3 \times 10^{+1}$	9.4×10^{2}	1.9	6.8
Xe-135m	15.7 min	2.6×10^{4}	6.9×10^{3}	-	-		
Xe-135	9.16 hr	2.2×10^{4}	2.2×10^{4}				
Xe-137	3.82 min	1.5×10^{5}	6.7×10^{2}				
Xe-138	14.2 min	8.9×10^{4}	2.1×10^{4}	-			
Xe-139	40 sec	2.8×10^{5}	-	-			
Xe-140	13.6 sec	3.0×10^{5}	-	-			

TABLE 11.3-1 (Continued)

Isotope	Half-Life	T=0 µCi/Sec	T=30 Minutes µCi/sec	Normal Discharge from Charcoal Adsorbers µCi/sec	Normal Discharge from Charcoal Adsorbers Ci/yr(3)	Additional Discharge from Charcoal Adsorbers During Startup Ci/sec	Additional Discharge from Charcoal Adsorbers During Startup Ci/startup
Xe-141	1.72 sec	$2.4x10^5$	-	-			
Xe-142	1.22 sec	$7.3x10^4$	-	-			
Xe-143	0.96 sec	$1.2x10^4$	-	-			
Xe-144	9 sec	$5.6x10^2$	-	-			
	TOTALS	$\sim 2.5x10^6$	$\sim 1.0x10^5$	49-59	1383-1663	14.3	8.5

NOTES:

1. Release rates are based on the 1971 mixture.

2. Estimated from experimental observations.

3. This is based on curies present at time of release. No decay in environment is included.

TABLE 11.3-2

OFF-GAS SYSTEM MAJOR EQUIPMENT ITEMS

Off-Gas Preheaters - 2 required.

Construction: Stainless steel tubes and carbon steel shell. 350 psig design pressure, 1000 psig tube design pressure 40°F/450°F shell design temperature, 40°F/575°F tube design temperature.

Catalytic Recombiners - 2 required.

Construction: Carbon steel cartridge, carbon steel shell. Catalyst cartridge containing a precious metal catalyst on metal base or porous non-dusting ceramic. Catalyst cartridge to be replaceable without removing vessel. 350 psig design pressure. 900°F design temperature.

Off-Gas Condenser - 1 required.

Construction: Low alloy steel shell. Stainless steel tubes. 350 psig shell design pressure. 250 psig tube design pressure. 900°F shell design temperature. 150°F tube design temperature.

Water Separator - 1 required.

Construction: Carbon steel shell, stainless steel wire mesh. 350 psig design pressure. 250°F design temperature.

Cooler-Condenser - 2 required.

Construction: Carbon or stainless steel shell. Stainless steel tubes. 100 psig tube design pressure. 350 psig shell design pressure. 150°F tube design temperature 32°F/150°F shell design temperature.

Moisture Separators (Downstream of cooler-condenser) - 2 required.

Construction: Carbon steel shell, stainless steel wire mesh. 350 psig design pressure 32°F/150°F design temperature.

Desiccant Dryer - 4 required.

Construction: Carbon steel shell packed with Linde Mol Sieve or equivalent. 350 psig design pressure, 32°F/500°F design temperature.

Desiccant Regeneration Skid - 2 required.

Dryer Chiller - 2 required.

Construction: Carbon steel shell, stainless steel tubes, design temperature 32°F/500°F. Design pressure 50 psig.

TABLE 11.3-2 (Continued)

Regenerator Blower - 2 required.

Construction: Electrical, design pressure 50 psig, design temperature 32°F/150°F. Seller's standard.

Dryer Heater - 2 required.

Construction: Electrical, design temperature 32°F/500°F, design pressure 50 psig.

Gas Cooler - 2 required.

Construction: Carbon or stainless steel material. 1050 psig tube design temperature. -50°F/150°F design temperature.

Glycol Cooler Skid - 1 required.

Glycol Storage Tank - 1 required.

Construction: Carbon steel 3,000 gallon. Water-filled hydrostat static design pressure. 32°F design temperature. API-650.

Glycol Solution Refrigerators and Motor Drives - 3 required.

Construction: Conventional refrigeration units. Glycol solution exit temperature 35°F. Seller's standard.

Glycol Pumps and Motor Drives - 3 required.

Construction: Cast iron, 3 inch connections 0°F design temperature. Seller's standard.

Prefilters and After Filters - 2 required of each type.

Construction: Carbon steel shell. High-efficiency, moisture-resistant filter element. Flanged shell. 350 psig design pressure. -50°F/150°F design temperature.

Charcoal Adsorbers - 8 beds.

Construction: Carbon steel. Approximately 4-ft o.d. x 21-ft vessels each containing approximately 3 tons of activated carbon. Design pressure 350 psig. Design temperature -50°F/250°F.

TABLE 11.3-3

PROCESS DATA FOR THE OFF-GAS (RECHAR) SYSTEM

(PROPRIETARY)

TABLE 11.3-4

EQUIPMENT MALFUNCTION ANALYSIS

Equipment Item	Malfunction	Consequences	Design Precaution
Steam jet air	Low flow of motive high pressure steam	When the hydrogen and oxygen concentration exceed 4 and 5 vol %, respectively, the process gas becomes flammable.	Alarm provided on steam for low steam flow. Recombiner temperature alarm.
		Inadequate steam flow will cause overheating and deterioration of the catalyst.	Steam flow to be held at constant maximum flow regardless to plant level. Recombiner temperature alarm.
	Wear of supply steam nozzle of ejector	Increased steam flow to recombiner. This would reduce degree of recombination at low power levels.	Low temperature alarms on preheater exit (recombiner inlet). Recombiner H_2 analyzers.
Preheaters	Steam leak	Would further dilute process off-gas. Steam consumption would increase.	Spare preheater.
	Low pressure steam supply	Recombiner performance would fall off at low power level, and hydrogen content of recombiner gas discharge may increase, eventually to a combustible mixture.	Low-temperature alarms on preheater exit (recombiner inlet). Recombiner outlet H_2 analyzers.
Recombiners	Catalyst gradually deactivates	Temperature profile changes through catalyst. Eventually excess H_2 would be detected by H_2 analyzer or by a flowmeter. Eventually the stripped gas could become combustible.	Temperature probes in recombiner H_2 analyzer provided spare recombiner.

TABLE 11.3-4 (Continued)

Equipment Item	Malfunction	Consequences	Design Precaution
	Catalyst gets wet at start	H_2 conversion falls off and H_2 is detected by downstream analyzers. Eventually the gas could become combustible.	Condensate drains, temperature probes in recombiner. Air bleed system at startup. Recombiner thermal blanket, spare recombiner and heater, hydrogen analyzer.
Off-gas condenser	Cooling water leak	The coolant (reactor condensate) would leak to the process gas (shell) side. This would be detected if drain well liquid level increases. Moderate leakage would be of no concern from a process standpoint. (The process condensate drains to the hotwell).	None. (Option N-64)
	Liquid level instruments fail	If both drain valves fail to open water will build up in the condenser and pressure drop will increase. The high delta P, if not detected by instrumentation could cause pressure buildup in the main condenser and eventually initiate a reactor scram. If a drain valve fails to close, gas will recycle to the main condenser, increase the load on the SJAE, and increase operating pressure of the main condenser.	Two independent drain systems, each provided with high- and low-level alarms.

TABLE 11.3-4 (Continued)

Equipment Item	Malfunction	Consequences	Design Precaution
Water separator	Corrosion of wire mesh element	Higher quantity of water collected in holdup line and routed to radwaste.	Stainless steel mesh specified.
Cooler condensers	Corrosion of tubes	Glycol-water solution would leak into process (shell) side and be discharged to clean radwaste. If not detected at radwaste, the glycol solution would discharge to reactor condensate system.	Stainless-steel tubes specified. Low level alarm glycol tank level. Spare cooler condenser provided.
	Icing up of tubes	Shell side of cooler could plug up with ice, gradually building up pressure drop. If this happens, the spare unit could be activated. Complete blockage of both units.	Design glycol-H_2 solution temperature well above freezing point. Spare unit provided. Temperature indication and low alarms on glycol temperature and process gas temperature. (Option N-64)
Glycol refrigeration machines	Mechanical	If both spare units fail to operate, the glycol solution temperature will rise and the dehumidification system performance will deteriorate. This will require rapid regeneration cycles for the desiccant beds and may raise the gas dewpoint as it is discharged from the drier.	Two spare refrigerators during normal operation are provided. Glycol solution temperature alarms provided. Gas moisture detectors provided downstream of gas driers.

TABLE 11.3-4 (Continued)

Equipment Item	Malfunction	Consequences	Design Precaution
Moisture separators	Corrosion wire mesh element	Increased moisture would be retained in process gas routed to gas driers. Over a long period, the desiccant drier cycle period would deteriorate as result of moisture pickup. Pressure drop across prefilter may increase if filter media is wetted.	Stainless steel mesh specified. Spare unit provided. High delta P alarm on prefilter.
Prefilters	Loss of integrity of filter	More radioactivity would deposite the drier desiccant. This would increase radiation level in the drier vault and make maintenance more difficult, but would not affect releases to the environment.	Spare unit provided in separate vault. Delta P instrumentation provided.
Desiccant drier	Moisture breakthrough	Moisture would freezeout in gas cooler and would result in increased system pressure drop. Gas with a high dewpoint temperature would reach charcoal bed.	Drier cycles on time. Redundant gas humidity analyzers and alarms supplied. Redundant drier system supplied gas drier and first charcoal bed can be bypassed through alternate drier to second charcoal bed. (Option N-64)
Desiccant regeneration equipment	Mechanical failure	Inability to regenerate desiccant.	Redundant, shielded desiccant beds and drier equipment supplied.

TABLE 11.3-4 (Continued)

Equipment Item	Malfunction	Consequences	Design Precaution
Charcoal adsorbers	Charcoal accumulates moisture	Charcoal performance will deteriorate gradually as moisture deposits. Holdup times for kryton and xenon would decrease, and plant emissions would increase. Provisions made for drying charcoal as required during annual outage.	Highly instrumented, mechanically simple gas dehumidification system with redundant equipment.
Vault refrigeration units	Mechanical failure	If temperature exceeds approximately 0°F, increased emission could occur.	Spare refrigeration unit provided. Vault and charcoal adsorber temperature alarms provided.
After filter	Loss of integrity of filter media	Probably of no real consequence, the charcoal media itself should be a good filter at the low air velocity.	Delta P instrumentation provided. Spare unit provided.
System	Internal detonation	Release of radioactivity if pressure boundary fails.	Main process equipment and piping are designed to contain a detonation.
System	Earthquake damage	Release of radioactivity.	Dose consequences are within 10 CFR 20 limits. Analysis is included in Reference 6. (Option N-64)

TABLE 11.3-5

FREQUENCY AND QUANTITY OF STEAM DISCHARGED TO SUPPRESSION POOL

	Event[(1)]	Frequency Category	Quantity of Steam (lbs/event)
1.	RCIC Test (Monthly)	Moderate	27,600
2.	Inadvertent RCIC Injection	Moderate	4,600
3.	SRV Test (each valve)	Moderate	3,900
4.	SRV Flow Capacity Test (each valve)	Infrequent	15,300
5.	Total SRV Leakage (19 valve max.)	Continuous	380/Hr.
6.	Trip of Both Recirc. Pump Motor	Moderate	30,000
7	Turbine Trip	Moderate	30,000
8.	Generator Load Rejection	Moderate	30,000
9.	Pressure Regulator Failure, Open	Moderate	374,000(2)
10.	Recirc. Controller Failure	Moderate	30,000
11.	Loss of All Feedwater Flow	Moderate	30,000
12.	Inadvertent MSIV Closure	Moderate	374,000(2)
13.	Loss of Condenser Vacuum	Moderate	374,000(2)
14.	Feedwater Control Failure, Max. Demand	Moderate	30,000
15.	Loss of Auxiliary Transformer	Moderate	934,000(2)
16.	Loss of All Grid Connections	Moderate	934,000(2)
17.	Turbine Trip w/o Bypass	Infrequent	374,000(2)
18.	Generator Load Rejection w/o Bypass	Infrequent	374,000(2)
19.	Stuck Open SRV	Moderate	641,000

NOTES:

1. Bases and assumptions for the listed events are as follows:

   a. Events 1 and 2 are based on steam flow rate during test mode per RCIC System Process Diagram 762E421C, for 60 and 10 minutes, respectively.

   b. Event 3 assumes test SRV opened 30 seconds maximum at 300-500 psig vessel pressure.

   c. Event 4 assumes tested SRV opened 30-60 seconds at 1000 psig vessel pressure.

   d. Event 5 is based on maximum average SRV leakage rate of 30 lb/hr/valve.

   e. Event 6 through 18 are based on event description from Chapter 15.

   f. Event 19 is based on vessel depressurized to 100 psia with two additional SRV's opened 10 minutes following scram.

2. Isolation event. Except for events 15 and 16, it is assumed that SRV actuation is terminated 30 minutes into the event whereupon the reactor is depressurized at 100°F/hr via RHR steam condensing mode. For events 15 and 16, it is assumed that loss of plant air prevents availability of RHR steam condensing mode and normal SRV opening, vessel depressurized via ADS SRV's.

TABLE 11.3-6

GASEOUS RADWASTE EQUIPMENT DESIGN REQUIREMENTS

	Design and Fabrication	Materials(1)	Welder Qualification and Procedure	Inspection and Testing
Pressure Vessels	ASMF Code Section VIII Div 1	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII Div 1
Atmospheric or 0-15 psig Tanks	ASME Code(2) Section III Class 3, API 620;650, AWWA D-100	ASME Code Section II	ASME Code Section IX	ASME Code(2) Section III Class 3, API 620;650, AWWA D-100
Heat Exchangers	ASME Code Section VIII Div 1; and TEMA	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII Div 1
Piping and Valves	ANSI B 31.1	ASTM OR ASME Code Section II	ASME Code Section IX	ASME Code(2)
Pumps	Manufacturers(3) Standards	ASME Code Section II or Manufacturer's Standard	ASME Code Section IX (as required)	ASME Code(2) Section III Class 3; and Hydraulic Institute

NOTES:

1. Material manufacturer's certified test reports should be obtained whenever possible.
2. ASME Code stamp and material traceability not required.
3. Manufacturer's standard for the intended service. Hydrotesting should be 1.5 times the design pressure.

TABLE 11.3-7

OFF-GAS SYSTEM ALARMED PROCESS PARAMETERS

Parameters	Control Room Indicated	Control Room Recorded
Air ejector discharge pressure - high	X	
Preheater discharge temperature - low	X	
Recombiner catalyst temperature - high/low		X
Off-gas condenser water level (dual) - high/low		
Off-gas condenser gas discharge temperature - high (LOCAL)		
H_2 analysis (off-gas condenser discharge) - dual - high		X
Off-gas condenser discharge radiation - high		X
Gas flow - high/low		X
Cooler - condenser discharge temperature - high/low		X
Glycol solution temperature - high/low		X
Glycol solution level - low		
Gas drier discharge humidity - high (LOCAL)		
Prefilter dP - high	X	
Charcoal adsorber temperature - high		
Carbon vault temperature - high/low		X
Carbon vault temperature - high/low		X
Carbon train flow - high/low		X
After filter dP - high	X	
Off-gas (carbon bed discharge) radiation - high		X
Steam flow - low		

TABLE 11.3-8

INPUT PARAMETERS USED FOR CALCULATING GASEOUS RELEASES (GALE)

Maximum core thermal power - 3758 Mwt

Total main steam flow rate - 15.4×10^6 lb/hr

Mass of reactor coolant in the reactor vessel - 5.28×10^5 lb

Mass of steam in the reactor vessel - 1.93×10^4 lb

Holdup Times
- Charcoal delay (krypton) - 1.86 days
- Charcoal delay (xenon) - 42.6 days

Mass of charcoal in the off-gas system - 24 tons

Operating and dew point temperatures of off-gas system - 0°F and -20°F, respectively

Dynamic adsorption coefficient for Xe and Kr - 2410 cm^3/g and 105 cm^3/g, respectively

Ventilation and Exhaust Systems

Building	Decontamination Factors (DF)	DF Bases	Purge Rate and Frequency (Reactor Building Only)
Reactor(1)	100	HEPA	5,000 cfm, continuous
	10	Charcoal	30,000 cfm, refueling
Auxiliary(1)	100	HEPA	
	10	Charcoal	
Radwaste(1)	100	HEPA	
	10	Charcoal	
Turbine(2)	1	-	
	1	-	
Off-Gas(3)	100	HEPA	
	10	Charcoal	

TABLE 11.3-8 (Continued)

Release Points	Effluent Velocity (ft/min)	Vent Dimensions	Effluent Gas Temperature (maximum)
Unit 1			
Plant Vent	4100	48"x90"	105°F
Turbine Building/ Heater Bay Vent	4000	120"x120"	115°F
Off-Gas Vent	1900	34"x34"	105°F
Unit 2			
Plant Vent	3500	48"x90"	105°F
Turbine Building/ Heater Bay Vent	4000	120"x120"	115°F
Off-Gas Vent	1900	34"x34"	105°F

NOTES:

1. The reactor building, auxiliary building, and radwaste building releases are through the plant vent.

2. The turbine building releases are through the turbine building/heater bay vent.

3. The off-gas building releases are through the off-gas vent.

TABLE 11.3-9

CALCULATED RELEASE OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS - UNIT 1
(Ci/year)

Nuclide	Unit 1 Plant Vent	Unit 1 Turbine Bldg.	Unit 1 Off-Gas Bldg. Vent	Unit 1 Mech. Vac. Pump Discharge
Kr-83m	(1)	(1)	(1)	(1)
Kr-85m	6	68	82	(1)
Kr-85	(1)	(1)	290	(1)
Kr-87	6	130	(1)	(1)
Kr-88	6	230	5	(1)
Kr-89	(1)	(1)	(1)	(1)
Xe-131m	(1)	(1)	19	(1)
Xe-133m	(1)	(1)	a	(1)
Xe-133	142	250	470	2,300
Xe-135m	92	650	(1)	(1)
Xe-135	113	630	(1)	350
Xe-137	(1)	(1)	(1)	(1)
Xe-138	14	1,400	(1)	(1)
I-131	3.9-2	1.9-1	(1)	3.0-2
I-133	1.5-1	7.6-1	(1)	(1)
Cr-51	9.6-5	1.3-2	-	(1)
Mn-54	3.6-4	6.0-4	-	(1)
Fe-59	1.6-4	5.0-4	-	(1)
Co-58	5.7-5	6.0-4	-	(1)
Co-60	1.1-3	2.0-3	-	(1)
Zn-65	5.5-5	2.0-4	-	(1)
Sr-89	6.3-6	6.0-3	-	(1)
Sr-90	3.1-6	2.0-5	-	(1)
Zr-95	8.5-6	1.0-4	-	(1)
Sb-124	4.7-6	3.0-4	-	(1)
Cs-134	1.3-4	3.0-4	-	3.0-6
Cs-136	1.1-5	5.0-5	-	2.0-6
Cs-137	2.0-4	6.0-4	-	1.0-5
Ba-140	9.0-6	1.1-2	-	1.1-5
Ce-141	2.8-5	6.0-4	-	(1)
C-14	-	-	9.5	-
Ar-41	25	-	-	-
H-3	47	-	-	-

NOTE:

1. Less than 1 Ci/yr noble gas, less than 10^{-4} Ci/yr iodine

TABLE 11.3-10

CALCULATED RELEASE OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS - UNIT 2
(Ci/year)

Nuclide	Unit 2 Plant Vent	Unit 2 Turbine Bldg.	Unit 2 Off-Gas Bldg. Vent	Unit 2 Mech. Vac. Pump Discharge
Kr-83m	(1)	(1)	(1)	(1)
Kr-85m	6	68	82	(1)
Kr-85	(1)	(1)	290	(1)
Kr-87	6	130	(1)	(1)
Kr-88	6	230	5	(1)
Kr-89	(1)	(1)	(1)	(1)
Xe-131m	(1)	(1)	19	(1)
Xe-133m	(1)	(1)	(1)	(1)
Xe-133	132	250	470	2,300
Xe-135m	92	650	(1)	(1)
Xe-135	68	630	(1)	350
Xe-137	(1)	(1)	(1)	(1)
Xe-138	14	1,400	(1)	(1)
I-131	3.4-2	1.9-1	(1)	3.0-2
I-133	1.4-1	7.6-1	(1)	(1)
Cr-51	6.0-6	1.3-2	-	(1)
Mn-54	6.0-5	6.0-4	-	(1)
Fe-59	8.0-6	5.0-4	-	(1)
Co-58	1.2-5	6.0-4	-	(1)
Co-60	2.0-4	2.0-3	-	(1)
Zn-65	4.0-5	2.0-4	-	(1)
Sr-89	1.8-6	6.0-3	-	(1)
Sr-90	1.0-7	2.0-5	-	(1)
Zr-95	8.0-6	1.0-4	-	(1)
Sb-124	4.0-6	3.0-4	-	(1)
Cs-134	8.0-5	3.0-4	-	3.0-6
Cs-136	6.0-6	5.0-5	-	2.0-6
Cs-137	1.1-4	6.0-4	-	1.0-5
Ba-140	8.0-6	1.1-2	-	1.1-5
Ce-141	2.0-6	6.0-4	-	(1)
C-14	-	-	9.5	-
Ar-41	25	-	-	-
H-3	47	-	-	-

NOTE:

1. Less than 1 Ci/yr noble gas, less than 10^{-4} Ci/yr iodine.

TABLE 11.3-11

AVERAGE ANNUAL CONCENTRATIONS OF GASEOUS EFFLUENTS AT EXCLUSION BOUNDARY

Nuclide	Annual Release (Ci/yr - two units)	MPC (μCi/cc)	Fraction of MPC[1]
Kr-83m	(2)	3.-8	-
Kr-85m	312	1.-7	2.7-4
Kr-85	580	3.-7	1.7-4
Kr-87	272	2.-8	1.2-3
Kr-88	482	2.-8	2.1-3
Kr-89	(2)	3.-8	-
Xe-131m	38	4.-7	8.1-6
Xe-133m	(2)	3.-7	-
Xe-133	6314	3.-7	1.8-3
Xe-135m	1484	3.-8	4.2-3
Xe-135	2141	1.-7	1.8-3
Xe-137	(2)	3.-8	-
Xe-138	2828	3.-8	8.1-3
I-131	.51	1.-8	4.4-6
I-133	1.8	7.-9	2.2-5
Cr-51	1.3-2	8.-8	1.4-8
Mn-54	1.6-3	1.-9	1.4-7
Fe-59	1.2-3	2.-9	5.1-8
Co-58	1.3-3	2.-9	5.6-8
Co-60	5.3-3	3.-10	1.5-6
Zn-65	5.0-4	2.-9	2.1-8
Sr-89	1.2-2	1.-9	1.0-6
Sr-90	4.3-5	2.-10	1.8-8
Zr-95	2.2-4	1.-9	1.9-8
Sb-124	6.1-4	3.-8	1.7-9
Cs-134	8.1-4	4.-10	1.7-7
Cs-136	1.2-4	6.-9	1.7-9
Cs-137	1.5-3	5.-10	2.6-7
Ba-140	2.2-2	1.-9	1.9-6
Ce-141	1.2-3	5.-9	2.1-8
C-14	19	1.-7	1.6-5
Ar-41	50	4.-8	1.1-4
H-3	94	2.-7	4.0-5

NOTES:

1. Based on an average annual χ/Q of 2.7-6 sec/m^3.

2. Less than 1 Ci/yr noble gas, less than 10^{-4} Ci/yr iodine.

(PROPRIETARY)

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Off-Gas System Process Diagram

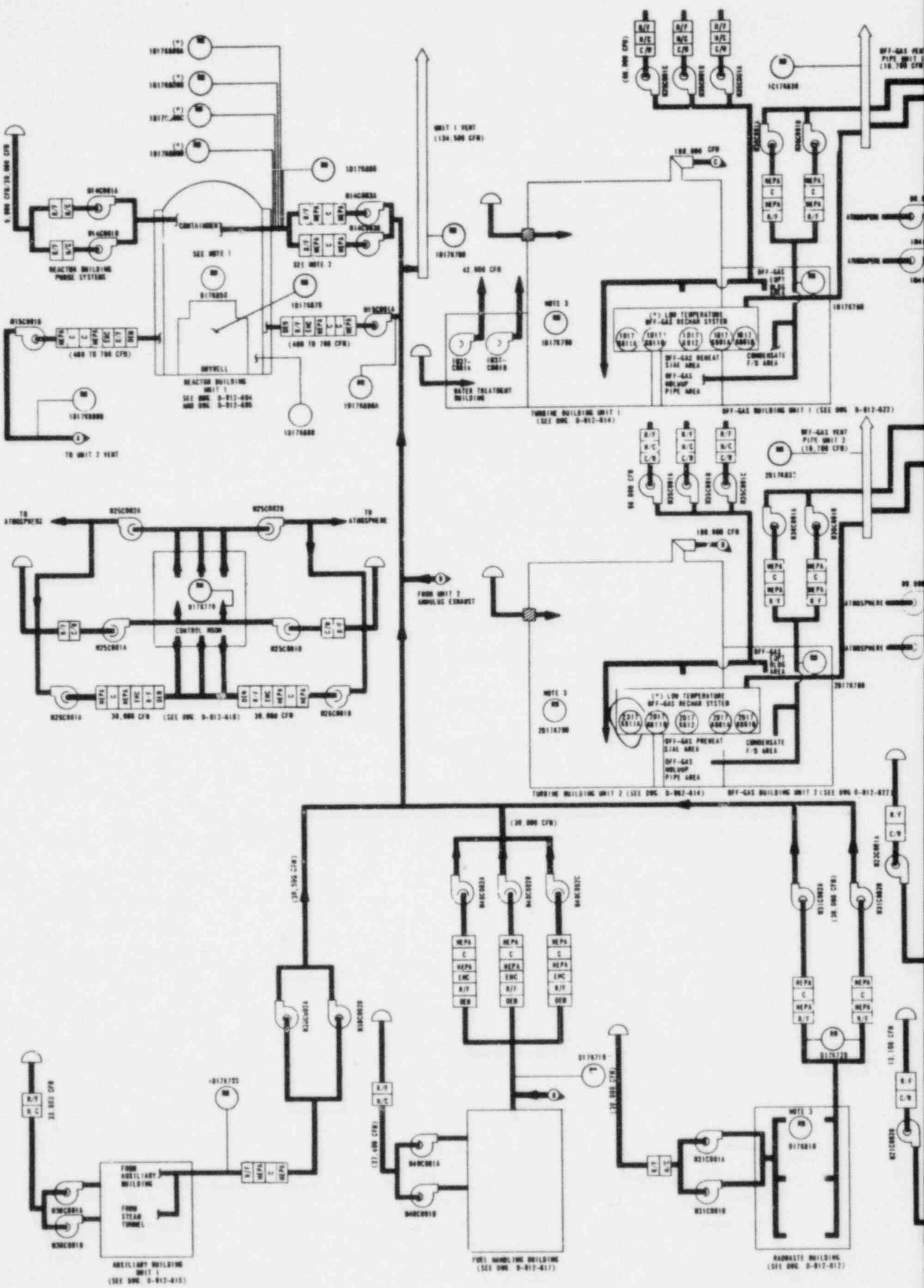
Figure 11.3-1

(PROPRIETARY)

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Off-Gas System Piping and
Instrumentation Diagram

Figure 11.3-2



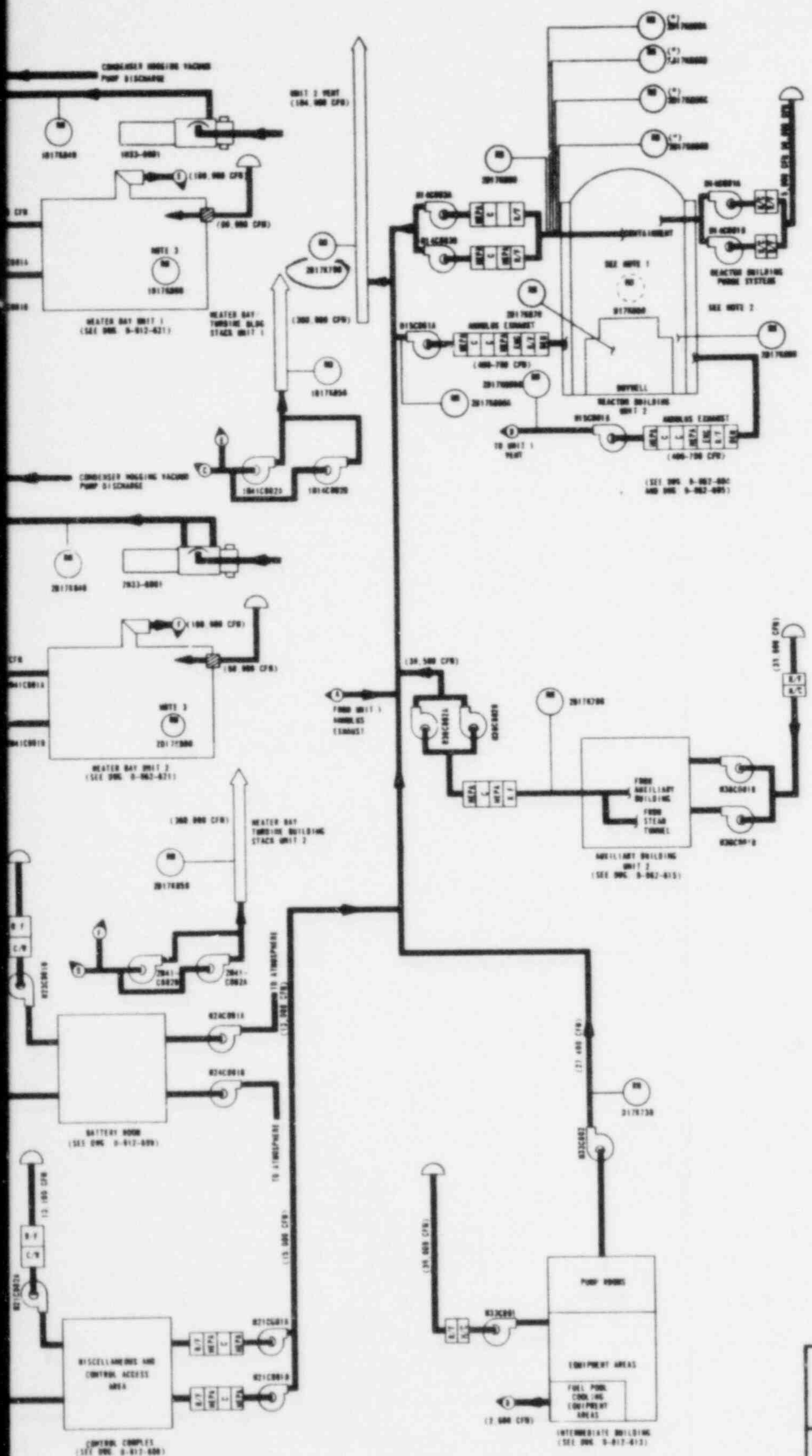
NOTES:-

1. RADIATION MONITOR NO. D17K850 IS A PORTABLE MONITORING UNIT USED TO SERVICE A UNIT ONLY DURING REFUELING.
2. DETECTORS MONITORING THE MAIN STEAM LINE ARE LOCATED JUST DOWNSTREAM FROM THE OUTBOARD ISOLATION VALVE.

1D17K810A	2D17K810A
1D17K810B	2D17K810B
1D17K810C	2D17K810C
1D17K810D	2D17K810D

NOTES:-(CONTINUED)

3. RADIATION MONITORS: 1D17K790 ARE PORTABLE MONITORING UNITS.
   2D17K790
   1P17K800
   2D17K800
   D17K850
   D17K819
4. (*) SUPPLIED BY GENERAL ELECTRIC



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Airborne Radiation Monitoring

Figure 11.3-3
(GAI Dwg. D-806-001)

11.4 SOLID RADIOACTIVE WASTE MANAGEMENT SYSTEM

11.4.1 DESIGN BASES

11.4.1.1 Power Generation Design Objectives

The primary design objective of the solid radioactive waste (SRW) system is to control, collect, handle, process, and package all wet and dry solid radioactive waste generated by the PNPP Units 1 and 2 as a result of normal operation and to store these wastes until they are shipped to authorized receiving and storage areas offsite. This will be done in such a manner that, for all anticipated quantities of waste produced, the availability of the power plant for power generation will not be adversely affected.

The types of solid radioactive waste to be processed, anticipated quantities, and curie content are given in Table 11.4-1. Waste quantities and curie content by isotope are given in Tables 11.4-2, 11.4-3 and 11.4-4.

11.4.1.2 Radiological Design Objectives

Packaging of solid radioactive material is accomplished in a manner which insures that no radioactive material will be released to the environment during shipment of the waste to offsite burial or storage facilities. The SRW system is designed to limit exposures to both operating personnel and the general public to as low as reasonably achievable.

11.4.1.3 Design Criteria

a. The SRW system components, piping and the structure that houses the system are designed and fabricated in accordance with the codes, standards, seismic categories and quality group classifications given in Table 3.2-1.

b. The SRW system design is in compliance with the guidance provided by Regulatory Guide 1.143 and Branch Technical Position ETSB 11-3.

c. All wet radioactive waste (filter backwash slurries, spent resins, evaporator bottoms) are solidified in a mixture of cement and sodium silicate prior to shipment offsite. Packaging and transporting of radioactive wastes is performed in conformance with 10 CFR 71 and applicable ICC and DOT regulations.

d. The SRW system design and shielding provisions assure that (during all phases of processing, handling and shipment of radioactive waste) exposure to operating operating personnel and the general public is within the applicable limits of 10 CFR 20, 49 CFR 173 and as low as is reasonably achievable in accordance with Regulatory Guide 8.8.

e. The SRW system design provides a means to verify the absence of free liquid in the containers and to reprocess containers in which free liquid is detected in accordance with Branch Technical Position ETSB 11-3.

f. The SRW system design, equipment sizing and equipment redundancy assure that the maximum expected quantities of all radioactive waste inputs during any 30 day period can be solidified, packaged and temporarily stored on site without effecting plant availability. Design quantities of radioactive waste inputs to the SRW system are presented in Table 11.4-1.

11.4.1.4 Component Design Parameters

With the exception of normal wearing parts, such as seals and bearings, all pumps, valves, piping, tanks and other components in the SRW system are fabricated from materials which are intended to provide a minimum service life of 40 years without replacement. In selecting materials to meet this criterion, due consideration is given to: a) the corrosive nature of both the process medium and the external environment, b) decontaminability of the

material, and c) wall thickness requirements dictated by design pressures, flow rates, and corrosion rates. The design classifications of SRW system equipment items are given in Table 3.2-1.

11.4.1.5 ALARA Design Features

Numerous features have been incorporated into the design of both the SRW system and the building housing this system to insure that exposures of operating personnel to radiation will be kept within ALARA guidelines. See Section 11.2.1.9 for a listing of the most significant ALARA design features.

11.4.1.6 Safety Precautions

All tanks, pumps and other equipment containing radioactive liquids are located in shielded cubicles or pipe chases. All access to these areas is strictly controlled by administrative procedures.

To minimize safety hazards caused by operator errors, most steps in the SRW system processing procedure are fully automated, using a programable logic controller.

Cement dust is a breathing hazard and potential trouble source for both mechanical and electrical equipment. Thus, special efforts have been made to prevent cement dust from escaping the cement storage or transfer equipment and to contain the dust within a confined area when there is a breach of the storage or transfer equipment. All cement handling equipment is of welded, steel construction and is vented through a large baghouse filter to the outside environment. Rooms or cubicles containing cement handling equipment have all piping, electrical, instrumentation, and ventilation penetrations sealed with silicone rubber foam. In areas inside the radwaste building where cement or the waste/cement mixture are handled, the floor drains can be isolated from the remainder of the radwaste building floor drains. These drains can be routed to an empty 55 gallon drum on elevation 602'-0" rather than to the radwaste building floor drain sump, if cement is found in this drain water, either by sampling or because of a known system failure.

11.4.2 SYSTEM DESCRIPTION

11.4.2.1 Treatment of Wet Solid Radioactive Waste

The types, anticipated quantities, and expected activity levels of wet solid radioactive waste to be processed are identified in Table 11.4-1.

The system diagram is presented in Figure 11.4-1. This diagram shows the process flow routes, process flow conditions, equipment capacities, instrumentation, and system design data.

Instrumentation, controls, alarms, and protection devices are discussed under Section 11.4.2.4.

The SRW system is designed to process evaporator concentrate, spent resin slurry, precoat-type filter backwash slurry, and traveling belt discharge cake. These waste streams are transferred from the LRW system collection tanks or traveling belt filters to one of the two redundant waste mixing/dewatering tanks on a batch basis. After this transfer, the fill isolation valve is closed and the fill line is backflushed to the tank from which the waste stream originated.

Filling of the waste mixing/dewatering tank and subsequent processing of the waste are controlled automatically through a programmable logic controller in the SRW control panel. Using selector switches on this panel, the operator selects which waste storage tank to take waste from, which waste mixing tank to use, and the proper size shipping container. After the proper amount of waste has been transferred to the tank, a dewatering pump removes excess free water from the batch (except when the waste being handled is traveling belt filter cake, in which case a predetermined amount of water is added to the tank for slurry transfer of the waste and for mixing with the cement solidification agent).

After the tank filling/dewatering step is completed, a positive displacement type waste feed pump transfers the waste slurry at a preset rate to a waste/cement mixing pump. Cement is metered to this pump from a cement day tank using a vibrating screw feeder fastened directly to the bottom of the day tank. The waste/cement mixing pump is located directly below the screw feeder and as close to it as possible to prevent residual buildup of cement in the transfer piping.

The waste/cement mixing pump is a positive displacement, progressing cavity type pump which both mixes the waste and cement together and transfers it at a preset rate to the shipping container fill port station. Prior to the container filling operation, the operator uses a remote controlled overhead bridge crane to lift an empty container (or containers) onto a motor operated transfer cart, which is mounted on rails running the length of the processing gallery at elevation 616'-0". The transfer cart can handle three 55 gallon drums or one of any of the following:

a. 50 cubic foot container
b. 200 cubic foot container
c. 282 gallon modified fuel oil storage tank
d. 550 gallon modified fuel oil storage tank

All these containers are equipped with a fill opening designed to take an ICC 17H 55 gallon drum lid with ring clamp. After the shipping container or containers have been set on top of the transfer cart, the cart is indexed remotely from the SRW control panel until the container fill opening is lined up directly below the fill port. The fill port seal plate, which is a circular steel plate slightly larger in diameter than a 55 gallon drum lid, is then lowered by remote controlled hydraulic pistons until a leak tight seal is formed between the container and fill line. The waste fill nozzle is designed to spray the waste/cement mixture into the shipping container while sodium silicate is metered into a second, concentric nozzle by a positive displacement sodium silicate transfer pump. In this manner, the waste/cement and sodium silicate streams are thoroughly mixed. When a preset level is

reached in the shipping container, the waste, cement, and sodium silicate feed valves are automatically closed and a timer controlled flush of the waste transfer piping is initiated. The flush water generated by this operation is directed into the shipping container, where it is solidified along with the radioactive waste.

After the container is filled, the transfer cart is indexed to the drum capper station, where a 55 gallon drum lid is remotely lowered onto the fill opening and securely fastened with a ring clamp. Also at this station, a long-handled swipe test tool, manipulated remote-manually through a shielded ball joint in the shield wall between the capper/swipe test station and the operating gallery, is used to swipe the shipping container with a cotton swab attached to the end of the tool. The swab is then dropped onto a long-handled tray and removed from the capper/swipe test station through an opening in the shield wall. Both the capping and swipe test operations can be viewed on CCTV monitors located on the SRW control panel.

After the capping/swipe test operation is completed, the transfer cart is indexed to the decontamination/pick-up station. If the container is contaminated, a remotely controlled set of water spray nozzles are used to wash down the container. Following decontamination, the transfer cart is indexed to the dryer station, where hot air is blown over the container to accelerate the drying process. The cart is then indexed back to the decontamination/pick-up station, where the overhead bridge crane picks up the container and takes it either to an onsite short term storage area or directly to a truck bay where it is loaded onto a tractor trailer for shipment to an authorized receiving and storage area located offsite.

11.4.2.1.1 Component Failure and System Malfunctions

The SRW system is designed to preclude the accidental release of radioactive waste into the solid waste packaging area due to component failure or system malfunctions. Instrumentation and controls monitor each phase of the packaging operation, serving to detect possible system malfunctions and terminate the packaging operation as required to prevent inadvertent releases

of radioactive waste into the solid waste packaging area. Full operator surveillance will be maintained during the entire packaging operation through a CCTV monitor located on the control panel. Means are provided for the operator to terminate the packaging operation in instances of component failures which may cause the release of radioactive materials from the SRW system. The possibility of component failures is considered very low because of the low pressures at which the packaging operation occurs.

The air flow patterns in the drumming station are such that any radioactive gases released would pass into the radwaste ventilation system, and be treated by a series of roughing, HEPA, and charcoal filters prior to release to the environs (Figure 9.4-7).

11.4.2.2 Treatment of Dry Solid Radioactive Waste

A dry solid radwaste subsystem is provided for processing dry filter media (ventilation filters), contaminated clothing, equipment, tools and glassware, and miscellaneous radioactive wastes that are not amenable to solidification prior to packaging.

11.4.2.2.1 Compressible Dry Solid Radioactive Waste

Contaminated clothing, paper, and similar low-level activity wastes are accumulated in 55 gallon drums and compressed with a dry waste hydraulic compactor when a sufficient amount of material has accumulated. The compacted waste in 55 gallon drums is stored until a sufficient amount accumulates to warrant shipment to an authorized receiving and storage area located offsite.

11.4.2.2.2 Incompressible Dry Solid Radioactive Waste

Spent filter cartridges, air filter elements, contaminated tools, and similar incompressible solid wastes are packaged in 55 gallon drums or 50 cubic foot shipping containers, depending on their size. Shielding is provided around the shipping container as required. Highly radioactive material is centered in the shipping container and solidification agent is added, thus providing additional shielding.

11.4.2.3 Detailed Component Design

a. Collection Tank Design

These tanks are treated as a part of the LRW system; refer to Section 11.2.2.10, Item a for this information.

b. General Pump Design

All pumps, whether centrifugal or positive displacement, are designed to the requirements of the Hydraulic Institute Standards for rating, testing, application, and materials. For pumps handling radioactive fluids, shafts are sealed with mechanical seals which are balanced, single (or double if process fluid necessitates) seals with a carbon stationary insert, tungsten carbide rotating seal ring, silicone or "EPR" elastomer O-rings, 316L SS metal parts, flushing connection, vent and drain connection, and throttle bushing (for single mechanical seals only). The vent and drain connections and the throttle bushings are provided to permit installation of a drain for the fluid that leaks from a worn seal. The bearing lubrication that may leak out of the lubrication system will be allowed to accumulate on the pump base separate from the pump shaft seal drain piping. A solenoid operated shutoff valve is provided for control of seal water to each pump with mechanical seals. This valve is designed to open when the pump is started, to close when the pump is stopped, and to fail open on loss of power.

c. Cement Handling Equipment

The cement silo is a 1000 cubic foot, carbon steel, vertical cone-bottomed tank mounted on steel support legs at elevation 620'-6" in the solidification agent storage building. This building is a non-safety class, non-seismic category, steel framed structure with sheet metal siding. To minimize the chance of cement dust entering the radwaste building, the ventilation system for the structure consists only of roof

ventilators which discharge directly to the outside atmosphere rather than through the radwaste building ventilation system.

To further protect against cement dust entering the plant environs, all penetrations between this storage structure and the radwaste building are sealed with a silicone rubber foam. The cement silo itself is a closed tank vented to the atmosphere through a baghouse filter mounted on top of the tank. The tank is filled through a pipe interconnecting the tank with a cement truck unloading station in the yard outside the storage building. A caged ladder is welded to the side of the silo for access to the bag filter house on top of the silo. A manway with hinged cover on the roof of the silo permits access to the inside of the silo.

Periodically cement must be transferred from the silo to the cement day tanks inside the radwaste building. This is accomplished by using a motor-operated bucket elevator and a gravity-operated air slide. The air slide is a rectangular shaped duct pitched at a slope of 8° below horizontal to allow the cement to flow by gravity. It is divided into upper and lower chambers by a porous polymer plastic membrane. The cement flows through the larger upper chamber. The lower chamber is a plenum for uniform distribution of low pressure fluidizing air. The two halves of the air slide are flanged together, allowing access to the membrane for inspection or replacement. To facilitate removal of the upper shell, the air slide is supported from underneath only. All sections of the air slide are totally enclosed and vented back to the cement silo.

The bucket elevator is a standard, motor-operated, chain drive unit totally enclosed and vented back to the cement silo. It is used to take cement flowing through a short section of air slide connected to the bottom of the cement silo up to a second air slide at an elevation high enough to permit the cement to flow by gravity into the cement day tanks.

Operating air for the air slide is provided by a three hp blower located beside the cement silo at elevation 620'-6". This blower also supplies air to tank vibrators located in the bottom of the cement silo. As a backup source of air, a line from the plant service air system is connected to the blower discharge line.

The redundant, 50 cu. ft. cement day tanks are carbon steel, vertical, cone bottomed vessels mounted off the floor on carbon steel support legs at elevation 630'-0". A motor operated, mechanical vibrator is built into the bottom of each tank. The day tanks are totally enclosed and vented back to the cement silo. As a precaution against cement dust entering the plant environs, all piping, electrical, I&C, and ventilation duct penetrations to and from the cement day tank cubicles are sealed with silicone rubber foam.

Located in the cement day tank discharge line directly below the tank is a silicon control rectifier (SCR) variable speed, d-c motor driven, vibrating screw feeder, which meters the correct amount of cement into the suction hopper of the waste/cement mixing pump. The screw feeder is operated from the control panel automatically. Between the feeder and mixing pump is an air operated pinch valve. This valve closes automatically prior to the system flushing operation to prevent flush water from entering the cement feeder and reacting with any cement still in the feeder.

d. Sodium Silicate Handling Equipment

The 4860-gallon sodium silicate storage tank is an atmospheric, vertical, flat bottomed, closed tank constructed of carbon steel and located on a 6-inch raised pad at elevation 620'-6" of the solidification agent storage structure. The tank has connections for fill, drain, vent and level monitoring. A ladder welded to the side of the tank provides access to the tank roof, and a manway with hinged cover is provided on the roof for access to the tank internals. To prevent the sodium silicate from absorbing moisture from the air while being stored, a thin

layer of water is poured on top of the sodium silicate when the tank is initially filled. This forms a hard water-glass surface that moves up and down with tank level and acts as a barrier against further absorption of moisture by the sodium silicate.

A sodium silicate transfer pump is mounted on the floor next to the sodium silicate storage tank for transfer of sodium silicate to either of the two fill port stations. This pump is a progressing cavity, positive displacement, metering pump. It is driven by an SCR variable speed, one hp, d-c motor and is controlled automatically from the SRW control panel. The SCR controller can be adjusted to obtain a flow rate ranging from 3 to 10 gpm. The pump is constructed of carbon steel. The shaft seal is a packing gland type.

e. Waste/Cement Mixing Pumps

The waste/cement mixing pump is a progressing cavity, positive displacement, metering pump built to food industry standards. It is driven by an SCR variable speed, three hp, d-c motor and is controlled automatically from the SRW control panel. The SCR control unit for this pump, as well as all other SCR control units, is located on the back side of the SRW control panel. Although this controller does not normally need adjustment, it can be reset at this panel for any flow rate desired between 15 and 40 gpm. Portions of the mixing pump in contact with radioactive liquids are constructed of 316L stainless steel. Seals are double mechanical type. In the event of a power failure while the waste/cement mixture is still in the mixing pump, a special hand crank can be used to turn the pump rotor from behind a shield wall.

f. Waste Mixing/Dewatering Tanks

Two redundant mixing/dewatering tanks are provided in shielded cubicles at elevation 630'-0". Each tank is an atmospheric, 750 gallon, vertical, cone bottomed, 316L stainless steel vessel mounted off the floor on carbon steel support legs. Connections are provided for vent/overflow,

concentrate and slurry waste feeds, hot flushing water, level monitors, traveling belt filter chute discharge, dewatering and drain. Redundant electrical heat tracing, controlled from the LRW control panel, is wrapped around the outside of the tank for use when the tank contains evaporator bottoms. A one inch layer of insulation blankets the heat tracing.

A 3.0 hp tank mixer is mounted on top of the tank and is controlled from the SRW control panel. A manway with hinged cover is also located on top of the tank. Inside the tank are the tank washdown nozzles, mixer blades and dewatering filter, all constructed of 316 or 316L stainless steel. The dewatering filter is a mesh type filter element attached to a swivel arm and float that moves up and down with the water level in the tank. The filter element can also be raised by hydraulic piston actuators controlled from the SRW control panel.

g. Waste Dewatering Pumps

The dewatering pump is mounted on a base plate attached to the legs of the mixing/dewatering tank. It is a 10 gpm, centrifugal pump driven by a three hp motor and controlled from the SRW control panel. The pump has two suction connections. When being used to dewater wastes, it takes suction from a line connected to the mixing/dewatering tank filter element. When used to drain the tank, it takes suction from a connection near the bottom of the tank. The dewatering pump is constructed of 316 stainless steel. Pump seals are single mechanical type.

h. Waste Feed Pumps

The waste feed pump is mounted on a skid plate attached to the legs of the mixing/dewatering tank. It is a progressing cavity, positive displacement, metering pump built to food industry standards. It is driven by an SCR variable speed, three hp, d-c motor and is controlled automatically from the SRW control panel. The SCR controller can be reset to adjust the pump flow rate from 15 to 40 gpm. Portions of the feed pump in contact with radioactive fluids are constructed of 316L stainless steel. Seals are double mechanical type.

i. Fill Ports

Two redundant fill ports are provided in the processing gallery at elevation 616'-0". Each fill port is a 316L stainless steel seal plate 26 inches in diameter and attached to carbon steel, overhead supports by hydraulic pistons which move the seal plate up and down. A soft seating material is fastened to the underside of the seal plate to form a water tight seal between the fill port and shipping container when filling the container. Connections are provided on the fill port for waste/cement feed, sodium silicate feed, vent, high level sensor, and continuous level monitor.

j. Drum Capper

The drum capper is a remotely-operated unit. It is mounted on an overhead monorail running along the ceiling between the processing gallery and the shielded operator control area. In the control area, the operator clamps a standard 55 gallon drum lid to the capper, which is then raised to the ceiling and moved along the monorail through an opening in the shield wall to the capping station. By remote command from the control panel, the capper is lowered until the drum lid is in place on the drum. The lid is then secured in place by a ring clamp that is automatically tightened on command from the control panel.

k. Hot Air Dryer

The hot air dryer consists of an electrical resistance type heater mounted in a short section of ductwork between a 200 scfm, 1/4 hp, centrifugal fan and a stainless steel drying hood, which directs the hot air over the entire surface of the shipping container. The entire hot air dryer assembly is wall mounted in the process gallery far enough above the transfer cart to permit clearance of the transfer cart loaded with a shipping container. The hot air dryer is controlled remotely from the SRW control panel.

l. Decontamination Station

The decontamination station is an area at the north end of the processing gallery enclosed by a motorized, roll-up, rubber door that is controlled from the SRW control panel. Within this area are a series of spray nozzles connected to a carbon steel ring header. Water to the spray nozzles is controlled by an isolation valve which can be operated from the SRW control panel.

m. Overhead Bridge Crane

The bridge crane has a rated capacity of 15 tons and a span of 34'-3". It is mounted on 60 pound ASCE rails that allow full travel of the crane in the north-south direction between column lines RW-A and RW-D, permitting full access to the truck bay, temporary storage facility, and processing gallery.

The unit is controlled entirely from the SRW control panel. A 3-position digital indexing and readout system on the control panel indicates where the bridge, trolley, and hoist are at all times. In addition to this system, the operator can view all movements of the crane on a closed circuit TV monitor. For maintenance purposes, a local control station is provided, with controls for bridge, hoist and trolley.

The bridge, trolley, and hoist have both high and low speeds; the former is for rough positioning and the latter is for accurate final positioning. High/low speeds for the bridge, trolley, and hoist are approximately 58/5.8, 50/5.0, and 22.5/2.25 fpm, respectively. The bridge and trolley drives have full magnetic soft start electric starting controls to minimize drive wear. The crane travel controls are such that when the load is not fully up, the bridge and trolley can only be moved by jogging. Bridge rail end stops are provided to limit travel of the bridge so that the load cannot hit the end walls. On loss of power, a manual crank in the truck bay permits the crane to be moved to an

accessible area for repairs. All necessary controls, relays, etc., for controlling a power-operated container uprighting mechanism are wired into the bridge crane and control panel for use in the event that one is purchased for future use.

n. Transfer Cart

The transfer cart is a motorized platform which moves shipping containers back and forth between the various processing stations along the length of the process gallery that runs from column line RW-A to column line RW-C. The cart and its drive unit are rated for a 25,000 pound load capacity. It is mounted on 60 pound ASCE rails at elevation 616'-0". Rail end stops are provided to prevent the unit from hitting the end walls of the process gallery.

The transfer cart is controlled entirely from the SRW control panel. A vane type limit switch on the cart will energize the appropriate position - indicating light on the control panel as the cart moves from one processing station to another. A self-winding reel is provided for the power and control cables between the cart and the control panel. Controls on the panel for the transfer cart include those for forward, reverse, and limit switch override.

On loss of power to the transfer cart motor, a stainless steel follower cable and hand crank are provided to manually move the cart to the container pickup station. The hand crank is located outside the process gallery for protection of the operator against radiation.

The cart has an all-welded, structural steel frame with stainless steel deck and gutters. A detachable, stainless steel rack is provided for proper positioning of three 55 gallon drums when these are used instead of a single, large shipping container for drumming waste.

o. Shipping Containers

Normally, standard DOT 17H steel drums will be used as shipping containers for solidifed or compacted waste. However, larger containers may be used when conditions indicate that it would be more economical to do so. Some of the factors that would affect this decision are burial costs, transportation costs, container costs, solidification costs, quantities of waste, waste activity levels, and isotopic content of the waste. The size of large containers considered for use are listed in Section 11.4.2.1. If used, these containers will meet the applicable design criteria of 49 CFR 173 and 10 CFR 71 for packaging of the waste being shipped.

p. Dry Solid Radioactive Waste Hydraulic Compactor

The dry waste hydraulic compactor is designed specifically to compact paper, cloth, glass, floor sweepings and other low-level dry waste in standard 55-gallon drums.

The hydraulic system operates at the relatively low pressure of 780 psi for long life. However, the compacting piston is capable of giving a total force of 30,000 pounds.

The drum extension space is evacuated by a built-in fan to prevent the dust's escaping into the room. The air to the fan is drawn through a roughing filter and then a 0.3 micron HEPA filter, effectively trapping the dust. Differential pressure gauges tell the operator when the filters need changing. The used filters can be dropped into a drum in the compactor without being touched by hand.

Ram motion and direction are controlled by large heavy-duty operating levers located at the operator's station, as is the drum extension cylinder. Control pushbuttons and indicating lights are also mounted in this location. A NEMA 12 electrical box complete with disconnect switch, wired to all compactor electrical components is built into the right side of the machine.

q. Solidified Waste Storage Vault

A shielded area measuring 50'-6" long by 25'-6" wide by 13'-4" high (useable height) is used to provide temporary onsite storage of packaged waste in order to gain further decay time or to lessen the effects on plant operations of such events as a trucker's strike or temporary shutdown of a burial site.

r. Low Level Compacted Waste Storage Area

A shielded area measuring 46'-0" long by 11'- 6" wide by 10'-0" high (useable height) is provided for temporary onsite storage of compacted waste.

11.4.2.4 Instrumentation, Controls, Alarms and Protective Devices

11.4.2.4.1 Controls

The SRW system is controlled entirely from the SRW panel during all normal operations. All control functions are either automatic or manual-electrically initiated. The control panel is equipped with the following: a semi-graphic display of the processing system; control switches for all normally used valves; control switches for all motor driven equipment; status lights for all power operated valves, pumps, fans, and blowers; process selector switches; drum capper controls; indexing controls and readout for the bridge crane and transfer cart; readout of certain process parameters (flows, levels, pressures, etc.); and a CCTV monitoring system of the processing gallery, storage vault, and truck bay. The control panel contains a solid state programmable controller to control the processing system. In general terms, the process is controlled as explained in the following paragraphs:

To begin filling one of the waste mixing/dewatering tanks, the operator first selects the A or B tank on a process train selector switch. Once a tank is selected, the other tank is locked out from being processed. A second selector switch must then be used to set up the indexing logic for the

transfer cart based on container size. This switch is labeled "drum/large container". For 55 gallon drums, three containers must be lined up sequentially at each processing station (since three drums will be on the transfer cart). For large containers only one container is carried on the transfer cart. A process selector switch is used to select one of five process modes: "evaporator bottoms," "spent resins," "filter/demineralizer sludge," "condensate filter/demineralizer sludge," or "traveling belt filter sludge".

The position that this switch is in will determine the proper mixing ratio of waste, cement and sodium silicate.

Once the system is in a process mode, interlock signals are sent out to the waste transfer lines from the LRW system as follows:

a. If the "TBF sludge" mode is selected, a permissive signal is sent to the TBF control panel to allow the TBF to be indexed, provided level in the waste mixing/dewatering tank is below a predetermined point.

b. If the "F/D sludge," "condensate F/D sludge," or "spent resins" modes are selected, a permissive signal is sent to the LRW system control panel to allow any of the filter backwash slurry or resin slurry transfer valves to open, provided level in the waste mixing/dewatering tank is below a predetermined point.

c. If the "evaporator bottoms" mode is selected, a permissive signal is sent to the LRW system control panel to allow the concentrate transfer valve to open, provided level in the waste mixing/dewatering tank is below a predetermined point.

After the filling operation is completed, the tank fill valves will close on high level signal. Backwashing of the waste transfer line is then initiated from the LRW system control panel. If, for any reason the fill valve had not closed (high level not reached, for instance), the flush initiation signal will also close the fill valve before the flash valve is opened.

After the waste mixing/dewatering tank contents have been prepared for processing, and interlock signals are present to indicate that: (a) the shipping container is in place at the fill point; and (b) sufficient levels of cement and sodium silicate are present in the storage tanks, the waste/cement/sodium silicate mixing and container filling steps proceed automatically. The container filling process is stopped by either high level in the shipping container or by some abnormal occurrence, such as loss of flow of one of the feed streams or high radiation level at the fill port. After the mixing/filling procedure is stopped, the transfer piping flush mode is automatically initiated.

11.4.2.4.2 Instrumentation

a. Waste Mixing/Dewatering Tanks

Each of these tanks has an ultrasonic level transmitter for level readout and high/low alarms on the control panel, and for control interlocking functions. A back-up high level probe is provided for control interlocking. A thermocouple is provided for low temperature alarm and control interlocking functions.

b. Waste Dewatering Pumps

Each of these pumps has a differential pressure switch for high alarm on the control panel. A suction pressure switch is provided for low alarm on the control panel and control interlocking functions.

c. Waste Feed Pumps

For each pump, a discharge pressure switch is provided for high/low alarm on the control panel and control interlocking functions. Each discharge line also has a magnetic flowmeter for flow recording on the control panel. Accurate measurement of the total flow of each constituent in the waste/cement/sodium silicate mixture is used to prove that each batch is within technical specification limits for a solidified product that is guaranteed to have no free water.

d. Waste/Cement Mixing Pumps

The discharge line of each of these pumps has a magnetic flowmeter for flow recording on the control panel, and a pressure switch for high/low level alarm and control interlocking functions.

e. Cement Day Tanks

Each of these tanks has an ultrasonic level transmitter for level readout and high/low alarms on the control panel, and for control interlocking functions. The tank discharge line has a vane type flow switch for control interlocking functions.

f. Cement Silo

The cement silo has an ultrasonic level transmitter for level readout and high/low alarms on the control panel, and for control interlocking functions.

g. Sodium Silicate Storage Tank

This tank has an ultrasonic level transmitter for level readout and high/low alarms on the control panel, and for control interlocking functions.

h. Sodium Silicate Feed Pump

The discharge line for this pump has a magnetic flowmeter for flow recording on the control panel, and a pressure switch for high/low alarm and control interlocking functions.

i. Fill Ports

Each fill port has an ultrasonic level transmitter for level readout and high/low level alarms on the control panel, and for control interlocking functions. A capacitance type level switch is provided for backup

control interlocking functions. A radiation monitor is wall mounted near each fill port station for readout and high alarm on the control panel, and for control interlocking functions.

TABLE 11.4-1

MAXIMUM MONTHLY RADIOACTIVE WASTE INPUTS TO SOLID RADIOACTIVE WASTE SYSTEM

Waste Inputs	Quantity			Maximum Activity Level (Ci/ft^3)	Method of Processing	Container Size to be Used (ft^3)
	Vol. per Batch (ft^3)	Max Batches per Month	Max Vol per Month (ft^3)			
1. Radioactive evaporator bottoms (25% Na_2SO_4 solution)	667	2	1334	2.78×10^{-2}	Solidify as is; or mix with dewatered resins and then solidify.	50 or 200
2. Spent resin slurry from:						
a. Condensate demineralizers	520 (Wet Resin)(1) 813 (Free Water)(2) 1,333 (Total)	1	520 (Wet Resin) 813 (Free Water) 1,333 (Total)	5.15×10^{-3} (per ft^3 resin)	Dewater and solidify; or dewater, mix with evaporator bottoms, and then solidify.	50 or 200
b. Radwaste demineralizers	504 (Wet Resin)(1) 830 (Free Water)(2) 1,334 (Total)	1	504 (Wet Resin) 830 (Free Water) 1,334 (Total)	2×10^{-1} (per ft^3 resin)	Same as for condensate demin. resins.	50 or 200
3. Backwash slurry from:						
a. Condensate filters (Powdered) resins)	333 (Sludge)(3) 600 (Free Water)(2) 933 (Total).	15	5,000 (Sludge) 9,000 (Free Water) 14,000 (Total)	5.15×10^{-2} per ft^3 sludge)	Dewater and solidify; or dewater, mix with evaporator bottoms, and then solidify.	50 or 200
b. Reactor Water Cleanup F/D (Powdered resins)	80 (Sludge)(3) 207 (Free Water)(2) 287 (Total)	5	400 (Sludge) 1,035 (Free Water) 1,435 (Total)	9.9 (per ft^3 sludge)	Same as for condensate filter sludge.	50
c. Fuel Pool F/D (Powered resins)	333 (Sludge)(3) 600 (Free Water)(2) 933 (Total)	1	333 (Sludge) 600 (Free Water) 933 (Total)	1.55×10^{-2} (per ft^3 sludge)	Same as for condensate filter sl[illegible]ge.	50 or 200
4. Traveling belt filter cake (Diatomaceous earth)	0.133(4)	65	8.65	1.55×10^{-2}	Solidify as is; or mix with evaporator bottoms and then solidify.	50 or 200

NOTES:

1. Density of wet resin mixture is approximately 71.5 lb/ft^3, of which, weight of resin is 23.25 lb and weight of absorbed and interstitial water is 48.25 lb.
2. The term "free water" is used here to mean the volume of water in excess of the sum of the amount absorbed in the resins and the amount occupying the void spaces in the settled resin volume.
3. Density of powdered resin sludge is approximately 66 lb/ft^3, of which, weight of powdered resin is 13 lb, and weight or absorbed and interstitial water is 53 lb.
4. Backwash from TBF is a moist cake, containing approximately 15.3 lb of diatomaceous earth and crud, and up to 35.7 lb of water.

TABLE 11.4-2

SOLID RADWASTE SYSTEM INFLUENT NUCLIDE ACTIVITIES

Isotope	Condensate F/D Sludge (1) μCi/cc	Radwaste Filter Sludge (2) μCi/cc
Na-24	2.9-3	Negligible
P-32	4.6-3	9.7-6
Cr-51	1.4-1	4.6-3
Mn-54	1.2-2	8.8-3
Co-58	1.4+0	3.7-1
Co-60	1.6-1	1.3-1
Fe-59	2.2-2	2.7-3
Zn-65	6.2-4	4.0-4
Zn-69m	3.1-5	Negligible
Ag-110m	1.8-2	1.2-2
Ag-110	1.8-2	1.2-2
W-187	2.0-2	Negligible
TOTAL	1.8+0	5.5-1

NOTES:

1. Activity based on 4 days accumulation of 8 batches followed by a 2 day decay period.

2. Activity based on 100 days accumulation of 149 batches of filter sludge from the waste collector and floor drain systems followed by a 100 day decay period.

TABLE 11.4-3

SOLID RADWASTE SYSTEM CHEMICAL WASTE CONCENTRATE

Isotope	Chemical Waste Concentrate (μCi/cc)	Isotope	Chemical Waste Concentrate (μCi/cc)
P-32	4.0 - 6	Te-132	7.5 - 5
Cr-51	3.1 - 4	I-132	7.7 - 5
Mn-54	7.7 - 5	Cs-137	7.3 - 2
Co-58	6.7 - 3	Ba-137m	7.3 - 2
Co-60	1.1 - 3	Ba-140	4.2 - 2
Fe-59	8.0 - 5	La-140	4.8 - 2
Zn-65	3.8 - 6	Pr-143	2.1 - 4
I-131	1.6 - 1	Ce-144	8.4 - 3
Sr-89	2.8 - 1	Pr-144	8.4 - 3
Cs-134	4.5 - 2	Nd-147	3.5 - 5
Cs-136	5.8 - 4	Pm-147	8.2 - 6
Sr-90	7.0 - 2	Np-239	1.2 - 5
Y-90	7.0 - 2	Pu-239	1.1 - 6
Mo-99	7.6 - 6	Y-91	2.6 - 3
Tc-99m	8.4 - 6	Zr-95	4.6 - 3
Ru-103	1.3 - 3	Nb-95m	9.8 - 5
Rh-103m	1.2 - 3	Nb-95	5.9 - 3
Ru-106	6.6 - 4	Te-129m	2.0 - 3
Rh-106	6.6 - 4	Ce-141	5.0 - 3
Ag-110m	1.2 - 4		
Ag-110	1.2 - 4	Total	9.1 - 1

TABLE 11.4-4

SOLID RADWASTE SYSTEM DEMINERALIZER ACTIVITIES

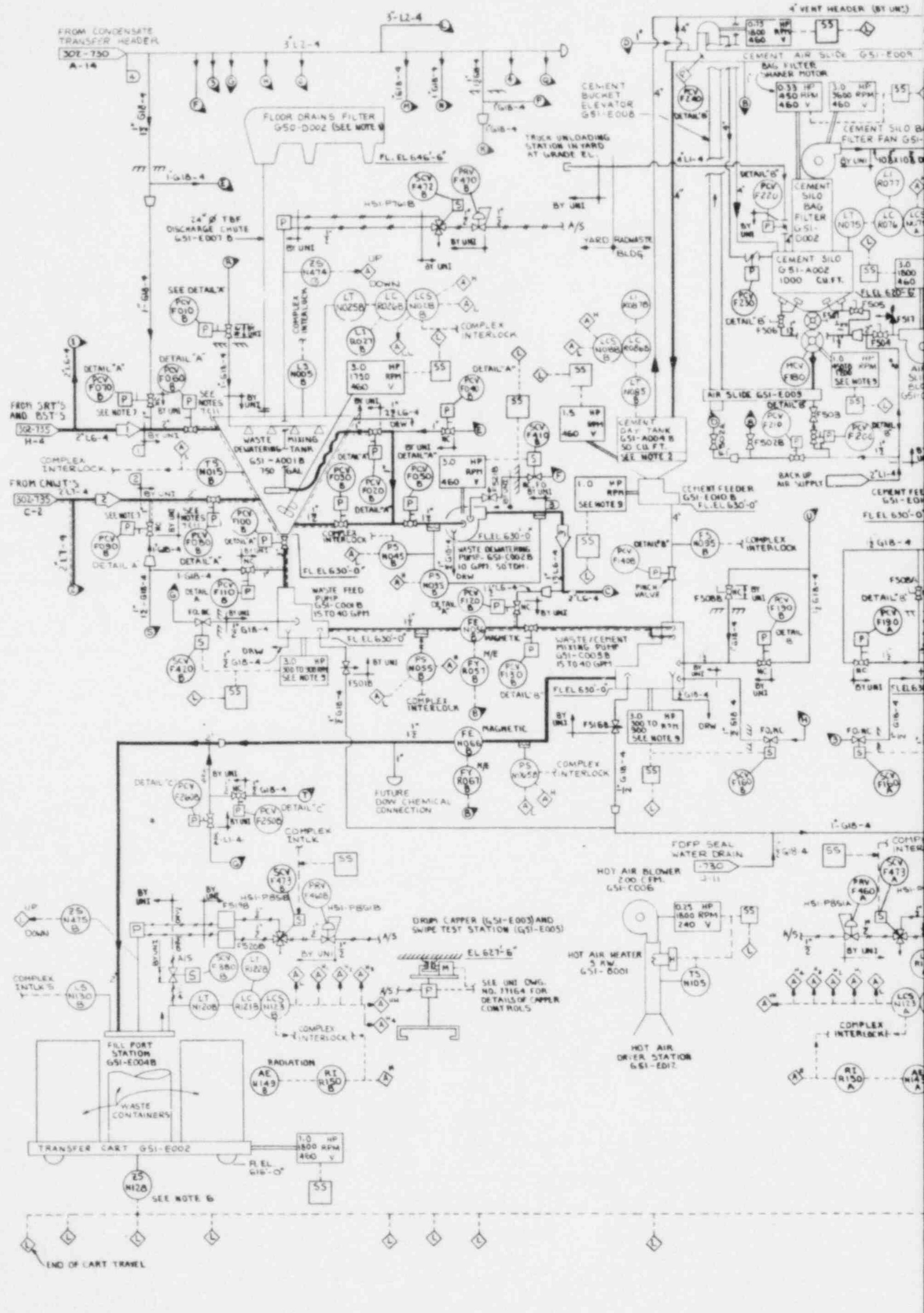
Isotope	RWCU Filter/ Demineralizer Sludge (μCi/cc)	Condensate Demineralizer (μCi/cc)	Radwaste Demineralizer (μCi/cc)
P-32	2.1-2	--	--
Cr-51	3.5+0	--	--
Mn-54	2.1+0	--	--
Co-58	1.4+2	--	--
Co-60	3.1+1	--	--
Fe-59	1.3+0	--	--
Zn-65	1.0-1	--	--
Br-83	--	--	6.5-4
Br-84	--	--	1.2-4
I-131	8.7-1	6.6-7	2.9-1
I-134	--	--	1.8-3
Sr-89	7.0+1	2.2-2	4.1-1
Tc-101	--	--	2.2-4
Cs-134	1.1+1	1.8-2	5.3-2
Cs-136	1.0-1	3.2-7	4.1-3
Cs-138	--	--	7.0-4
Ba-139	--	--	2.5-3
Sr-90	1.7+1	3.2-2	8.1-2
Y-90	1.7+1	3.2-2	6.5-2
Sr-92	--	--	6.0-3
Y-92	--	--	9.2-3
Mo-99	2.3-5	--	1.6-1
Tc-99m	2.5-5	--	8.1-2

TABLE 11.4-4 (Continued)

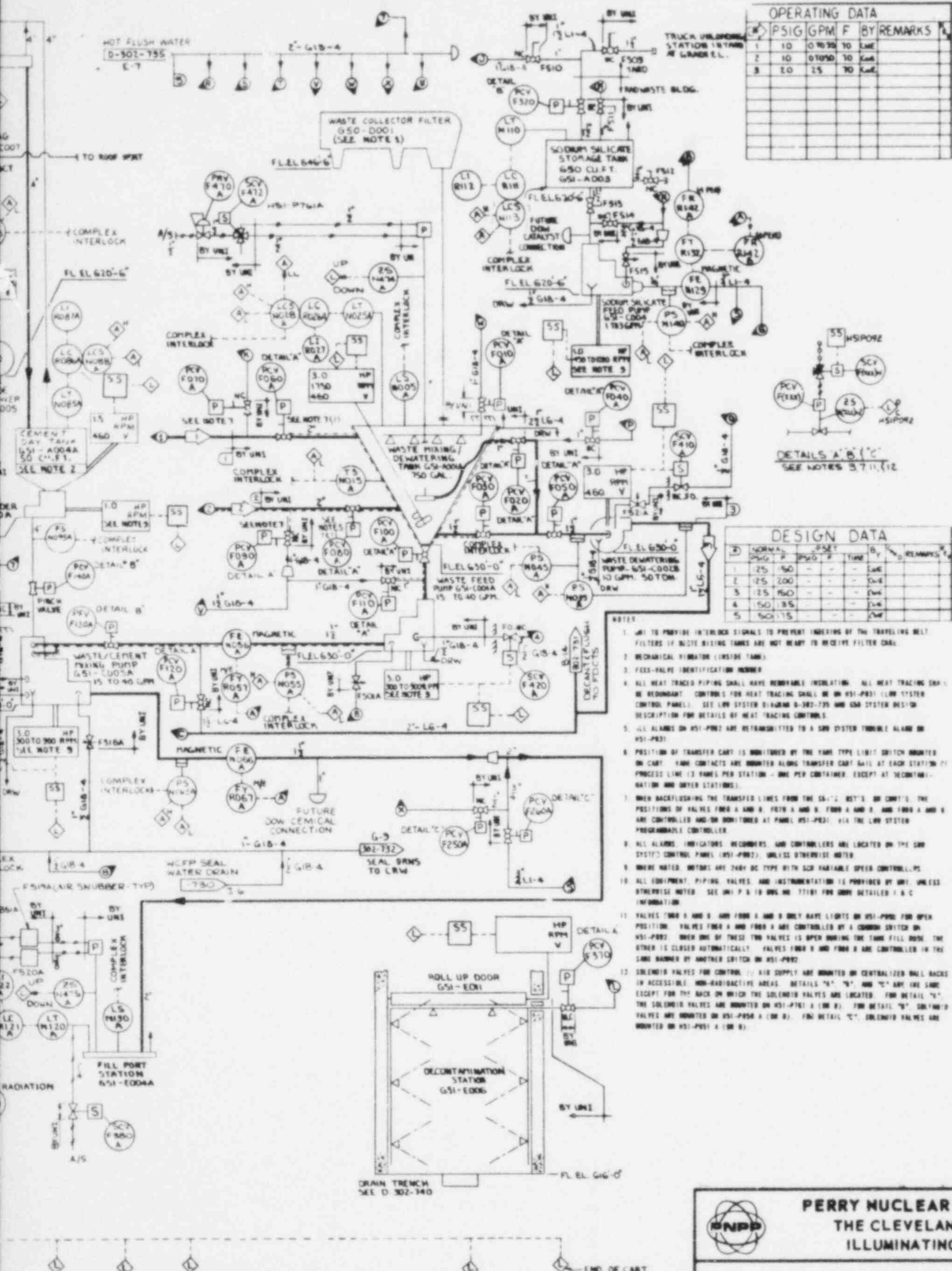
Isotope	RWCU Filter/ Demineralizer Sludge (μCi/cc)	Condensate Demineralizer (μCi/cc)	Radwaste Demineralizer (μCi/cc)
Ru-103	3.0-1	5.5-5	2.1-3
Rh-103m	2.9-1	5.3-5	1.1-3
Ru-106	1.6-1	2.3-4	7.6-4
Rh-106	1.6-1	2.3-4	6.0-4
Ag-110m	2.9+0	--	--
Ag-110	2.9+0	--	--
Te-132	5.2-4	--	3.9-1
I-132	5.2-4	--	2.3-2
I-135	--	--	3.8-2
Cs-137	1.8+1	3.4-2	8.1-2
Ba-137m	1.8+1	3.4-2	6.5-2
Ba-140	6.6+0	1.2-5	3.2-1
La-140	7.7+0	1.4-5	6.5-2
Ba-142	--	--	2.1-4
La-142	--	--	7.6-4
Ce-143	--	--	1.1-4
Pr-143	3.8-2	--	1.5-3
Ce-144	2.1+0	2.9-3	9.7-3
Pr-144	2.1+0	2.9-3	7.6-3
Nd-147	5.6-3	--	4.2-4
Pm-147	9.4-3	3.4-6	2.5-5
Np-239	1.3-5	--	1.4+0

TABLE 11.4-4 (Continued)

Isotope	RWCU Filter/ Demineralizer Sludge (μCi/cc)	Condensate Demineralizer (μCi/cc)	Radwaste Demineralizer (μCi/cc)
Pu-239	2.2-3	4.5-7	6.5-1
Br-85	--	--	9.2-6
Sr-91	--	--	3.8-2
Y-91m	--	--	3.6-3
Y-91	1.3+0	1.9-4	2.7-1
Zr-95	1.1+0	5.3-4	6.5-3
Nb-95m	2.4-2	1.1-5	8.7-5
Nb-95	1.9+0	9.8-4	8.1-3
Zr-97	--	--	4.2-5
Nb-97m	--	--	3.0-6
Nb-97	--	--	4.9-6
Te-129m	4.9-1	6.1-5	3.8-3
Te-129	--	--	8.7-6
I-129	--	--	4.8-6
I-133	--	--	1.4-1
Ba-141	--	--	3.5-4
La-141	--	--	2.8-3
Ce-141	1.2+0	1.4-4	2.4+0
Totals	3.6+2	1.8-1	7.1+0



FROM CONDENSATE TRANSFER HEADER
302-730
A-14
FLOOR DRAINS FILTER G50-D002 (SEE NOTE 9)
FL. EL 646'-6"
TRUCK UNLOADING STATION IN YARD AT GRADE EL.
CEMENT BUCKET ELEVATOR G51-E008
4" VENT HEADER (BY UNI)
CEMENT AIR SLIDE G51-E009
BAG FILTER SHAKER MOTOR
CEMENT SILO BAG FILTER G51-D002
CEMENT SILO G51-A002 1000 CU.FT.
24" Ø TBF DISCHARGE CHUTE G51-E007 B
YARD RADWASTE BLDG
SEE DETAIL "A"
COMPLEX INTERLOCK
FROM SRT'S AND BST'S
302-735
H-4
FROM CRWT'S
302-735
C-2
WASTE DEWATERING MIXING TANK G51-A001B 750 GAL
CEMENT DAY TANK G51-A004 B 50 CU.FT. SEE NOTE 2
CEMENT FEEDER G51-E010 B FL.EL 630'-0"
AIR SLIDE G51-E003
BACK UP AIR SUPPLY
WASTE DEWATERING PUMP G51-C002B 10 GPM. 50 TDH
WASTE FEED PUMP G51-C001 B 15 TO 40 GPM
WASTE/CEMENT MIXING PUMP G51-C003B 15 TO 40 GPM
PINCH VALVE
FL. EL 630'-0"
FUTURE DOW CHEMICAL CONNECTION
MAGNETIC
FOFP SEAL WATER DRAIN
HOT AIR BLOWER 200 CFM G51-C006
HOT AIR HEATER 5 KW G51-B001
HOT AIR DRIER STATION G51-E017
DRUM CAPPER (G51-E003) AND SWIPE TEST STATION (G51-E005)
EL 627'-6"
SEE UNI DWG. NO. 11164 FOR DETAILS OF CAPPER CONTROLS
RADIATION
FILL PORT STATION G51-E004B
WASTE CONTAINERS
TRANSFER CART G51-E002
FL. EL 616'-0"
SEE NOTE 6
END OF CART TRAVEL



OPERATING DATA

#	PSIG	GPM	F	BY	REMARKS	
1	10	0 TO 30	70	LWE		
2	10	0 TO 50	70	KWE		
3	20	25	70	KWE		

DESIGN DATA

#	NORMAL PSIG	NORMAL F	PSET PSIG	PSET F	TIME	BY		REMARKS	
1	125	150	-	-	-	LWE			
2	125	200	-	-	-	DWE			
3	125	150	-	-	-	DWE			
4	150	135	-	-	-	DWE			
5	50	115	-	-	-	DWE			

NOTES:

1. GAI TO PROVIDE INTERLOCK SIGNALS TO PREVENT INDEXING OF THE TRAVELING BELT FILTERS IF WASTE MIXING TANKS ARE NOT READY TO RECEIVE FILTER CAKE.
2. MECHANICAL VIBRATOR (INSIDE TANK).
3. FXXX-VALVE IDENTIFICATION NUMBER.
4. ALL HEAT TRACED PIPING SHALL HAVE REMOVABLE INSULATION. ALL HEAT TRACING SHALL BE REDUNDANT. CONTROLS FOR HEAT TRACING SHALL BE ON H51-P831 (LRW SYSTEM CONTROL PANEL). SEE LRW SYSTEM DIAGRAM D-302-735 AND G50 SYSTEM DESIGN DESCRIPTION FOR DETAILS OF HEAT TRACING CONTROLS.
5. ALL ALARMS ON H51-P992 ARE RETRANSMITTED TO A SRW SYSTEM TROUBLE ALARM ON H51-P831.
6. POSITION OF TRANSFER CART IS MONITORED BY THE VANE TYPE LIMIT SWITCH MOUNTED ON CART. VANE CONTACTS ARE MOUNTED ALONG TRANSFER CART RAIL AT EACH STATION OF PROCESS LINE (3 VANES PER STATION - ONE PER CONTAINER, EXCEPT AT DECONTAMINATION AND DRYER STATIONS).
7. WHEN BACKFLUSHING THE TRANSFER LINES FROM THE [illegible], RST'S, OR CRRT'S, THE POSITIONS OF VALVES F[illegible] A AND B, F070 A AND B, F[illegible] A AND B, AND F[illegible] A AND B ARE CONTROLLED AND/OR MONITORED AT PANEL H51-P831 VIA THE LRW SYSTEM PROGRAMMABLE CONTROLLER.
8. ALL ALARMS, INDICATORS, RECORDERS, AND CONTROLLERS ARE LOCATED ON THE SRW SYSTEM CONTROL PANEL (H51-P992), UNLESS OTHERWISE NOTED.
9. WHERE NOTED, MOTORS ARE 240V DC TYPE WITH SCR VARIABLE SPEED CONTROLLERS.
10. ALL EQUIPMENT, PIPING, VALVES, AND INSTRUMENTATION IS PROVIDED BY GAI, UNLESS OTHERWISE NOTED. SEE UNI P & ID DWG.NO. 77181 FOR UNI DETAILED I & C INFORMATION.
11. VALVES F[illegible] A AND B, AND F[illegible] A AND B ONLY HAVE LIGHTS ON H51-P992 FOR OPEN POSITION. VALVES F[illegible] A AND F[illegible] A ARE CONTROLLED BY A COMMON SWITCH ON H51-P992. WHEN ONE OF THESE TWO VALVES IS OPEN DURING THE TANK FILL MODE, THE OTHER IS CLOSED AUTOMATICALLY. VALVES F[illegible] B AND F[illegible] B ARE CONTROLLED IN THE SAME MANNER BY ANOTHER SWITCH ON H51-P992.
12. SOLENOID VALVES FOR CONTROL AIR SUPPLY ARE MOUNTED ON CENTRALIZED WALL RACKS IN ACCESSIBLE, NON-RADIOACTIVE AREAS. DETAILS "A", "B", AND "C" ARE THE SAME EXCEPT FOR THE RACK ON WHICH THE SOLENOID VALVES ARE LOCATED. FOR DETAIL "A", THE SOLENOID VALVES ARE MOUNTED ON H51-P761 A (OR B). FOR DETAIL "B", SOLENOID VALVES ARE MOUNTED ON H51-P950 A (OR B). FOR DETAIL "C", SOLENOID VALVES ARE MOUNTED ON H51-P951 A (OR B).

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Solid Radwaste System

Figure 11.4-1
(GAI Dwg. D-302-745)

11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLING SYSTEMS

The process and effluent radiological monitoring and sampling systems are provided to allow determination of the content of radioactive material in various gaseous and liquid process and effluent streams. The design objective and criteria are primarily determined by the system designation of either:

a. Instrumentation systems required for safety, or
b. Instrumentation systems required for plant operation.

11.5.1 DESIGN BASES

11.5.1.1 Design Objectives

11.5.1.1.1 Systems Required for Safety

The main objective of radiation monitoring systems required for safety is to initiate appropriate protective action to limit the potential release of radioactive materials from the reactor vessel and primary and secondary containment if predetermined radiation levels are exceeded in major process/effluent streams. An additional objective is to provide control room personnel with an indication of the radiation levels in the major process/effluent streams plus alarm annunciation if high radiation levels are detected.

Main steam line and containment ventilation exhaust radiation monitoring is provided to meet these objectives.

11.5.1.1.2 Systems Required for Plant Operation

The main objective of radiation monitoring systems required for plant operation is to provide operating personnel with measurement of the content of radioactive material in all effluent and important process streams. This allows demonstration of compliance with plant normal operational technical specifications by providing gross radiation level monitoring and collection of

halogens and particulates on filters (gaseous effluents) as required by Regulatory Guide 1.21. Additional objectives are to initiate discharge valve isolation on the off-gas or liquid radwaste systems if predetermined release rates are exceeded and to provide for sampling at certain radiation monitor locations to allow determination of specific radionuclide content.

The radiation monitoring provided to meet these objectives are:

a. For gaseous effluent streams

   1. Plant vent
   2. Off-gas vent pipe
   3. Turbine Building/heater bay vent

b. For liquid effluent streams

   1. Radwaste discharge
   2. Underdrain

c. For gaseous process streams

   1. Off-gas pretreatment
   2. Off-gas post-treatment
   3. Carbon bed vault
   4. Annulus exhaust
   5. Steam packing exhauster

d. For liquid process streams

   1. Emergency service water system (Loops A and B)
   2. Nuclear closed cooling water

11.5.1.2 Design Criteria

11.5.1.2.1 Systems Required for Safety

The design criteria for the safety related radioactivity monitoring systems are that the systems:

a. Withstand the effect of natural phenomena (e.g., earthquakes) without loss of capability to perform their functions.

b. Perform their intended safety function in the environment resulting from normal and postulated accident conditions.

c. Meet the reliability, testability, independence and failure mode requirements of engineeered safety features.

d. Provide continuous outputs on control room panels.

e. Permit checking of the operational availability of each channel during reactor operation with provision for calibration function and instrument checks.

f. Assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.

g. Initiate prompt protective action prior to exceeding plant technical specification limits.

h. Provide warning of increasing radiation levels indicative of abnormal conditions by alarm annunciation.

i. Insofar as practical, provide self-monitoring of components to the extent that power failure or component malfunction causes annunciation and channel trip.

j. Maintain full scale output if radiation detection exceeds full scale.

k. Have sensitivities and ranges compatible with anticipated radiation levels.

The applicable General Design Criteria are 63 and 64. The systems meet the design requirements for Safety Class 2, Seismic Category I systems, along with the quality assurance requirements of 10 CFR 50, Appendix B.

11.5.1.2.2 Systems Required for Plant Operation

The design criteria for operational radiation monitoring systems are that the systems:

a. Provide continuous indication of radiation levels in the control room.

b. Provide warning of increasing radiation levels indicative of abnormal conditions by alarm annunciation.

c. Insofar as practical, provide self-monitoring of components to the extent that power failure or component malfunction causes annunciation and, for systems initiating discharge isolation, channel trip.

d. Monitor a sample representative of the bulk stream or volume.

e. Have provisions for calibration, function and instrumentation checks.

f. Have sensitivities and ranges compatible with anticipated radiation levels and technical specification limits.

g. Maintain full scale output if radiation detection exceeds full scale.

The instrument channels monitoring discharges from the gaseous and liquid radwaste treatment systems have provisions to alarm and to initiate automatic closure of the waste discharge valve on the affected treatment system prior to exceeding the normal operation limits specified in technical specifications, as required by Regulatory Guide 1.21.

The applicable General Design Criteria are 60, 63, and 64.

11.5.2 SYSTEM DESCRIPTION

11.5.2.1 Systems Required for Safety

Information on the system monitors is presented in Table 11.5-1 and the arrangements shown in Figure 11.5-1 (Sheets 1 through 12).

11.5.2.1.1 Main Steam Line Radiation Monitoring System

This system monitors the gamma radiation level exterior to the main steam lines. The normal radiation level is produced primarily by coolant activation gases plus smaller quantities of fission gases being transported with the steam. In the event of a gross release of fission products from the core, this monitoring system provides channel trip signals to the reactor protection and containment and reactor vessel isolation control systems to initiate protective action.

The system consists of four redundant instrument channels. Each channel consists of a local detector (gamma-sensitive ion chamber) and a control room ratemeter with an auxiliary trip unit. Power for the two channels (A and D) is supplied from the reactor protection system (RPS) bus A and for the other two channels (B and C) from RPS bus B. Channels A and D are physically and electrically independent of channels B and C.

The detectors are physically located in separate pipe wells which extend into the steam tunnel near the main steam lines just downstream of the outboard main steam line isolation valves. The detectors are geometrically arranged

so that this system is capable of detecting significant increases in radiation level with any number of main steam lines in operation. Table 11.5-2 lists the range of the detectors.

Each radiation monitor has two upscale (high-high and high), one downscale and one inoperative trip circuits. Each trip is visually displayed on the affected radiation monitor. A high-high or inoperative trip in the radiation monitor results in a channel trip in the auxiliary unit which is an input to the reactor protection system (RPS). An RPS logic trip from a one-out-of-two twice MSL channel trip results in initiation of main steam line isolation valve closure, reactor scram, condenser air removal pump shutdown, and closure of the condenser air removal pump isolation valve. A high trip actuates a MSL high radiation control room annunciator. A downscale trip actuates a MSL downscale control room annunciator common to all channels. High and low trips do not result in a channel trip. Each radiation monitor visually displays the measured radiation level.

11.5.2.1.2 Containment Ventilation Exhaust Radiation Monitors

This system monitors the radiation level exterior to the containment ventilation system exhaust duct. A high activity level in the ductwork could be due to fission gases from a leak or an accident.

The system consists of four redundant instrument channels. Each channel consists of a local detection assembly (containing a Geiger-Mueller (GM) tube and electronics) and a control room ratemeter. Power for two channels (A and D) is supplied from RPS bus A and for the other two channels (B and C) from RPS bus B. Channels A and D are physically and electrically independent of channels B and C. One two-pen recorder powered from the 125 volt d-c backed bus A allows the output of any two channels to be recorded by the use of selection switches. The detection assemblies are physically located outside and adjacent to the exhaust ducting downstream of the containment discharge isolation valves.

Each radiation monitor provides both an analog output signal and a contact which opens on upscale (high-high) radiation or an inoperative circuit. Two-out-of-two upscale/inoperative trips in channels A and D initiate closure of the containment ventilation outboard isolation valves and the drywell outboard isolation valves. The same condition for channels B and C initiates closure of the containment inboard valves and drywell inboard valves.

An upscale/inoperative trip is visually displayed on the affected radiation monitor ratemeter and actuates a containment and drywell ventilation exhaust high-high radiation control room annunciator. A downscale trip is also visually displayed on the radiation monitor ratemeter. Containment and drywell vent high radiation and downscale trip control annunciators common to all channels and are generated from the analog signal. Each radiation monitor ratemeter visually displays the measured radiation level. Table 11.5-2 lists the range of the detectors.

11.5.2.2 Systems Required for Plant Operation

Information on these systems is presented in Table 11.5-1, 11.5-2, and 11.5-3 and the arrangements are shown in Figure 11.5-1.

11.5.2.2.1 Off-Gas Pretreatment Radiation Monitor

This system monitors radioactivity in the condenser off-gas at the inlet to the holdup piping after it has passed through the off-gas condenser and moisture separator. The monitor detects the radiation level which is attributable to the fission gases produced in the reactor and transported with steam through the turbine to the condenser.

A continuous sample is extracted from the off-gas pipe via a sample line. It is then passed through a sample chamber and a sample panel before being returned to the suction side of the steam jet air ejector (SJAE). The sample chamber is a stainless steel pipe which is internally polished to minimize plateout. It can be purged with room air to check detector response to background radiation by using a three-way solenoid operated valve. The valve

is controlled by a switch located in the control room. The sample panel measures and indicates sample line flow. A detector (GM tube) is positioned adjacent to the vertical sample chamber and is connected to a ratemeter in the control room.

Power is supplied from channel A of the containment and drywell ventilation exhaust monitoring system for the radiation monitor and detector, and from the 120 volt a-c instrument bus for a recorder, and from a 120 volt a-c local bus for the sample and vial sampler panels.

The radiation monitor has three trip circuits: two upscale (high-high and high), one downscale (low/inoperative).

The trip outputs are used for alarm function only. Each trip is visually displayed on the radiation monitor ratemeter and actuates a control room annunciator for each of the following: off-gas high-high, off-gas high, and off-gas downscale/inoperative. High or low sample line flow measured at the sample panel actuates a control room off-gas sample high-low flow annunciator.

The radiation level output by the monitor can be directly correlated to the concentration of the noble gases by using the semiautomatic vial sampler panel to obtain a grab sample. To draw a sample, a serum bottle is inserted into a sampler chamber, the sample lines are evacuated and a solenoid-operated sample valve is opened to allow off-gas to enter the bottle. The bottle is then removed and the sample is analyzed in the counting room with a multichannel gamma pulse height analyzer to determine the concentration of the various noble gas radionuclides. A correlation between the observed activity and the monitor reading permits calibration of the monitor.

11.5.2.2.2 Off-Gas Post-Treatment Radiation Monitor

This system monitors radioactivity in the off-gas piping downstream of the off-gas system charcoal adsorbers and upstream of the off-gas system discharge valve. A continuous sample is extracted from the off-gas system piping, passed through the off-gas post-treatment sample panel for monitoring and sampling, and returned to the off-gas system piping. The sample panel has a

pair of filters (one for particulate collection and one for halogen collection) in parallel (with respect to flow) with two identical continuous gross radiation detection assemblies. Each gross radiation assembly consists of a shielded chamber, a set of GM tubes, and a check source. Two radiation monitor ratemeters in the control room analyze and visually display the measured gross radiation level.

The sample panel shielded chambers can be purged with room air to check detector response to background radiation by using a solenoid valve operated from the control room. The sample panel measures and indicates sample line flow. A solenoid operated check source for each detection assembly operated from the control room can be used to check operability of the gross radiation channel.

Power is supplied from 125 volt d-c non-divisional bus for the radiation monitors and recorders, and from a 120 volt a-c instrument bus for the sample panel purge circuit.

Each radiation monitor has three trip circuits: two upscale (high-high-high and high), and one downscale (low/inoperative). Each trip is visually displayed on the radiation monitor. These three trips actuate corresponding control room annunciators: off-gas post-treatment high-high-high radiation, off-gas post-treatment high radiation, and off-gas post-treatment downscale/inoperative. A trip circuit on the recorder actuates an off-gas post-treatment high-high radiation annunciator. High or low sample flow measured at the sample panel actuates a control room off-gas vent pipe sample high-low flow annunciator.

An auxiliary trip unit in the control room takes the high-high-high (HHH) and downscale trip outputs and, if its logic is satisfied, initiates closure of the off-gas system discharge and drain valves. The logic is satisfied if two HHH, one HHH and one downscale, or two downscale trips occur. The HHH trip setpoints are determined such that valve closure is initiated prior to exceeding technical specification limits. Any one high upscale trip initiates closure of off-gas system bypass line valve and initiates opening of the treatment line valve.

A vial sampler panel similar to the pretreatment sampler panel is provided for grab sample collection to allow isotopic analysis and gross monitor calibration.

11.5.2.2.3 Carbon Bed Vault Radiation Monitor

Carbon vault A and B are monitored for gross gamma radiation level. Each channel includes detector, a ratemeter and a locally mounted auxiliary unit. The ratemeter is located in the control room. The channel provides for sensing and readout both local and remote of gamma radiation over a range of six logarithmic decades (1 to 10^6 mR/hr).

The ratemeter has one adjustable upscale trip circuit for alarm and one downscale trip circuit for instrument trouble. The trip circuits are capable of operational verification by means of test signals or through the use of portable gamma sources. Power is supplied from the 125 volt d-c non-divisional bus.

11.5.2.2.4 Plant Vent Radiation Monitor

This unit monitors a sample of the plant vent effluent discharge (Figure 9.4-18) for particulate, iodine, and gas radioactivity and also provides samples of the collected particulate and halogen for laboratory analysis. A representative sample is continuously extracted from the plant vent through an isokinetic probe in accordance with ANSI N13.1-1969 with the additional feature of regulating the sample flow in proportion to the vent stack flow (autokinetic). A portion of this representative sample is taken by another isokinetic probe and passed through the shielded particulate, iodine, and gas detector assemblies which are provided with scintillation detectors and check sources. The ratemeters in the control room analyze and visually display the measured radiation level for the particulate (gross Beta), gas (gross Beta) and Iodine (I-131 gamma photopeak).

Power is supplied from the diesel backed non 1-E 120 volt a-c bus for the radiation monitor ratemeters and recorders. The 480 volt a-c 3Ø diesel backed bus supplies power for the sample pumps.

Each of the ratemeters has two upscale and one downscale trip circuits which are visually displayed on the ratemeter and annunciated in the control room. High or low differential pressure across the filters at the sample panel are annunciated in the control room.

11.5.2.2.5 Turbine Building/Heater Bay Vent Radiation Monitor

This unit monitors a sample of the turbine building/heater bay vent discharge for particulate, iodine, and gas radioactivity and also provides samples of the collected particulate and halogen for laboratory analysis. A representative sample is continuously extracted from the turbine building/heater bay discharge vent downstream of the exhaust fans shown in Figure 9.4-9. Sampling and monitoring is as described for the plant vent radiation monitor.

Power is supplied from the diesel backed non-1E 120 volt a-c bus for the ratemeters and recorders. The 480 volt a-c 3Ø diesel backed bus supplies power for the sample pumps.

Each of the ratemeters has two upscale and one downscale trip circuits which are displayed on the ratemeters and annunciated in the control room. High or low differential pressure across the filters at the sample panel are annunciated in the control room.

11.5.2.2.6 Off-Gas Vent Pipe Monitor

This unit monitors a sample of the off-gas vent pipe discharge downstream of the exhaust fans (Figure 9.4-26) for particulate, iodine, and gas activity and also provides samples of the collected particulate and halogen for laboratory analysis. A representative sample is continuously extracted from the off-gas vent pipe and monitored as described for the plant vent radiation monitor.

Power is supplied from diesel backed non-1E 120 volt a-c bus for the radiation monitor ratemeters and recorders. 480 volt a-c 3Ø diesel backed bus supplies power for the sample pumps.

Each of the ratemeters has two upscale and one downscale trip circuits which are visually displayed on the ratemeters and annunciated in the control room. High or low differential pressure across the filters, measured at the sample panel, are annunciated in the control room.

11.5.2.2.7 Annulus Exhaust Radiation Monitor

These units monitor the annulus exhaust for gas activity (gross Beta) and provides samples of collected particulate and halogen for laboratory analysis. The units are identified as Annulus Exhaust - Train A Radiation Monitor and Annulus Exhaust - Train B Radiation Monitor. A sample is continuously extracted from the annulus exhaust duct downstream of the annulus exhaust filter trains A and B through an isokinetic probe (see Figure 6.5-1). The sample is passed through a fixed particulate sample filter, a fixed halogen collection cartridge, and through a shielded scintillation detector with a check source. The detector monitors the gross Beta gas activity. Ratemeters in the control room analyze and visually display the measured gas activity.

Power is supplied from the diesel backed non-1E 120 volt a-c bus for the ratemeters and recorders while the sample pumps are supplied by the 480 volt a-c 3Ø diesel backed bus.

The ratemeter has two upscale and one downscale trip circuits which are visually displayed on the ratemeter and annunciated in the control room. High or low differential pressure measured across the filters in the sample panel are annunciated in the control room.

11.5.2.2.8 Steam Packing Exhauster Radiation Monitor

The discharge from the steam packing exhauster is monitored for radioactivity by a shielded in-line detector assembly which is provided with a scintillation detector and a check source. The detector assembly is located on the steam packing exhauster effluent line which discharges to the off-gas vent pipe as shown in Figure 10.1-10. A ratemeter in the control room analyzes and visually displays the measured radiation (gross Beta).

Power is supplied from the diesel backed non-1E 120 volt a-c bus for the ratementer and recorder.

The ratemeter has two upscale and one downscale trips which are displayed on the ratemeter and are annunciated in the control room.

11.5.2.2.9 Liquid Process and Effluent Monitoring Systems

These systems, listed in Table 11.5-3, monitor the gamma radiation levels of liquid process and effluent streams. With the exception of the radwaste system effluent, the streams monitored normally contain only background levels of radioactive materials. Increases in radiation level may be indicative of heat exchanger leakage or equipment malfunction.

Power is supplied from 125 volt d-c non-divisional buses for the radiation monitors and recorders, and from a 120 volt a-c local bus for the sample panels.

Each radiation monitor has three trip circuits: two upscale (high-high and high) and one downscale (low). Each trip is visually displayed on the affected radiation monitor. Two of these trips actuate corresponding control room annunciators: one upscale (high radiation) and the downscale for the affected liquid monitoring channel. High or low sample flow measured at the sample panel actuates a control room flow annunciator for the affected liquid channel.

For each liquid monitoring location, except for the underdrain system, a continuous sample is extracted from the liquid process pipe, passed through a liquid sample panel which contains a detection assembly fo. gross gamma radiation monitoring, and returned to the process pipe. The detection assembly consists of a scintillation detector mounted in a shielded sample chamber equipped with a check source. A ratemeter in the control rcom displays the measured gross radiation level and the analog signal is recorded.

The sample panel chamber and lines can be drained to allow assessment of background building. The panel measures and indicates sample line flow. A solenoid operated check source operated from the control room can be used to check operability of the channel.

11.5.2.2.9.1 Radwaste Effluent Radiation Monitors

This system consists of two channels, radwaste effluent to ESW discharge pipe and radwaste effluent to sanitary waste treatment, which monitors the radioactivity in the radwaste effluent prior to its discharge (refer to Figure 11.2-1).

Liquid waste can be discharged from several radwaste processed water tanks such as the floor drain sample tanks, equipment drain sample tanks or distillate sample tanks. These tanks contain liquids that have been processed through one or more treatment systems such as evaporation, filtration and ion exchange. Prior to discharge from any tank, the liquid in the appropriate tank is sampled and analyzed in the laboratory. Based upon this analysis, discharge is permitted at a specified release rate and dilution rate.

The upscale trip on the radwaste effluent radiation monitor is used to initiate closure of the radwaste system discharge valve. The trip point is set such that closure is initiated prior to exceeding technical specification limits for liquid effluents. The upscale trip also actuates an annunciator in the control room.

11.5.2.2.9.2 Emergency Service Water Radiation Monitoring

This system consists of two channels (refer to Figure 11.3-2): one for monitoring downstream of equipment in emergency service water system Loop A and the other for Loop B. If a high radiation level is detected, the affected emergency service water line can be manually isolated.

11.5.2.2.9.3 Nuclear Closed Cooling System Radiation Monitoring

This system has a channel for monitoring downstream of equipment in the nuclear closed cooling water system (Figure 9.2-4).

11.5.2.2.9.4 Underdrain System Radiation Monitor

Amounts of radioactive material resulting in radionuclide concentration in the underdrain system approaching significant levels has been analyzed and is considered highly unlikely (see Section 2.4.13.5). A radiological monitoring program consisting of periodic sampling and analysis of groundwater will be conducted as part of the operational surveillance sampling program. In addition, in order to continuously monitor and detect gross amounts of radioactive concentrations in the groundwater of the underdrain system, radiation monitors will be located inside the gravity discharge system manholes at the point where the lower subsystem liquid effluent discharges into the gravity drain system.

These radiation monitors are in-line type liquid monitors mounted directly on the lower subsystem effluent discharge pipe header at the point where the underdrain service and backup pumps discharge into the manhole (Figure 2.4-71). One monitor will be located in the east gravity discharge system manhole and one monitor will be located in the west gravity discharge system manhole.

Each monitor uses a gamma scintillation detector to monitor the liquid effluent stream for gross gamma activity. The detector is shielded by lead in order to achieve maximum sensitivity. Each radiation monitor will transmit a

preamplified signal to its associated ratemeter located in the control room. When the level of radioactivity at either radiation monitor exceeds a value to be specified in the technical specifications, the associated channel will alarm in the control room, alerting the operator, and automatically stop the seven - 50 gpm service pumps, and the two - 100 gpm backup pumps in the underdrain system. Radioactive concentrations of the magnitude as postulated by the failure of a waste collector tank (Sections 15.7.2 and 15.7.3), can be detected and alarmed by these radiation monitors.

A sampling program in conjunction with continuous monitoring of the liquid effluent discharge from the underdrain system will ensure that the limits of 10 CFR 20 Appendix B are not exceeded, and that early detection of abnormalities is achieved.

11.5.2.3 Inspection, Calibration and Maintenance

11.5.2.3.1 Inspection and Tests

During reactor operation, daily checks of system operability are made by observing channel behavior. At periodic intervals during reactor operation, the detector response (of each monitor provided with a remotely positioned check source) will be recorded together with the instrument background count rate to ensure proper functioning of the monitors. Any detector whose response cannot be verified by observation during normal operation or by using the remotely positioned check source will have its response checked with a portable check source. A record will be maintained showing the background radiation level and the detector response.

The system has electronic testing and calibrating equipment which permits channel testing without relocating or dismounting channel components. An internal trip test circuit, adjustable over the full range of the readout meter, is used for testing. Each channel is tested in accordance with technical specifications. Verification of valve operation, ventilation diversion, or other trip function will be done at this time if it can be done without jeopardizing the plant safety. The tests will be documented.

11.5.2.3.1.1 Detailed Inspection and Tests

a. The following monitors have alarm trip circuits which can be tested by using test signals or portable gamma sources:

1. Main steam line
2. Containment ventilation exhaust
3. Off-gas pretreatment
4. Carbon bed vault

b. The following monitors include built-in check sources which can be operated from the control room:

1. Off-gas post-treatment
2. Annulus exhaust
3. Off-gas vent pipe
4. Plant vent
5. Turbine building/heater bay
6. Steam packing exhauster
7. Radwaste effluent to sewage
8. Radwaste effluent to ESW
9. Emergency service water
10. Nuclear closed cooling water
11. Underdrain

11.5.2.3.2 Calibration

The radiation monitor's calibration is traceable to certified National Bureau of Standards or commercial radionuclide standards. The source-detector geometry during primary calibration is identical to the sample-detector geometry in actual use. Secondary standards which were counted in reproducible geometry during the primary calibration may be used with each monitor for calibration after installation. Each monitor is calibrated in accordance with technical specifications. A calibration can also be performed by using liquid or gaseous radionuclide standards or by analyzing particulate, Iodine or gaseous grab samples with laboratory instruments.

11.5.2.3.3 Maintenance

The detectors, electronics, recorders and sample pumps are serviced and maintained on an annual basis or in accordance with manufacturer's recommendations to ensure reliable operations. Such maintenance includes cleaning, lubrication, and assurance of free movement of the recorder in addition to the replacement of adjustment of components required after performing a test or calibration check. If work is performed which would affect the calibration, a recalibration is performed at the completion of the work.

11.5.2.3.4 Audits and Verifications

Independent audits and verifications of test, calibration and maintenance records and procedures are conducted as described in Section 17.2.

11.5.3 EFFLUENT MONITORING AND SAMPLING

11.5.3.1 Implementation of General Design Criterion 64

All potentially radioactive effluent discharge paths are continuously monitored for gross radiation level. Liquid releases are monitored for gross gamma. Solid waste shipping containers are monitored with gamma sensitive portable survey instruments. Gaseous releases are monitored for gross gamma. The following gaseous effluent paths are sampled and monitored:

a. Plant vents
b. Off-gas vent pipe
c. Turbine Building/Heater Bay Ventilation System

The following liquid effluent path is sampled and monitored:

Liquid Radwaste System
Underdrain System

The monitors and ranges are listed in Table 11.5-2.

An isotopic analysis is performed periodically on samples obtained from each effluent release path in order to verify the adequacy of effluent processing to meet the discharge limits to unrestricted areas.

This effluent monitoring and sampling program is used to provide the information for the effluent measuring and reporting programs required by 10 CFR 50 Section 36A, Appendix A, General Design Criterion 64, and Appendix I and Regulatory Guide 1.21 in semiannual reports to the NRC. The frequency of the periodic sampling and analysis described herein is a minimum and will be increased if effluent levels approach Technical Specification limits. Tables 11.5-4, 11.5-5, 11.5-6, and 11.5-7 present the sample schedules.

11.5.4 PROCESS MONITORING AND SAMPLING

11.5.4.1 Implementation of General Design Criterion 60

The potentially significant radioactive discharge paths are equipped with a control system to automatically isolate the discharge on indication of a high radiation level. These include:

a. Off-gas post-treatment
b. Containment ventilation exhaust
c. Liquid radwaste effluent

The effluent isolation functions for each monitor are given in Tables 11.5-1 and 11.5-3.

11.5.4.2 Implementation of General Design Criterion 63

Radiation levels in radioactive and potentially radioactive process streams are monitored by the following process monitors:

a. Main steam line
b. Off-gas pretreatment

c. Off-gas post-treatment

d. Carbon bed vault

e. Nuclear closed cooling water

f. Emergency service water

g. Steam packing exhauster

h. Annulus exhaust

Airborne radioactivity in the containment, drywell, fuel handling building, and other areas are monitored as described in Section 12.3.4 as these are used to monitor in-plant airborne radioactivity.

The area radiation monitors described in Section 12.3.4 detect abnormal radiation levels in the various process equipment rooms.

Batch releases are sampled and analyzed prior to discharge in addition to the continuous effluent monitoring. The radwaste process monitoring systems are listed in Table 11.5-2. The gaseous and liquid process streams or effluent release points are monitored and sampled according to Table 11.5-8.

TABLE 11.5-1

GASEOUS AND AIRBORNE PROCESS AND EFFLUENT RADIATION MONITORS

Radiation Monitor (1)	Sample Point	Instrument Channels	Function	Location
1D17K610 A,B,C,D 2D17K610 A,B,C,D Main Steam Line	Pipewells in steam tunnel downstream of outer isolation valve	Ion chambers - redundant channels	Control Room alarms and indication. Isolates Main Steam Line	Steam Tunnel, Auxiliary Building 615'
1D17K612 2D17K612 Off-Gas Pretreatment	Sample from steam Jet Air Ejectors	Geiger-Mueller	Control Room alarms and indication	Turbine Building 577'
1D17K601 A,B 2D17K601 A,B Off-Gas Post-Treatment	Sample from carbon vault discharge	Ion chambers with sample pump	Control Room alarms and indication. Isolates Off-Gas System	Off-Gas Building 584'
1D17K611 A,B 2D17K611 A,B Carbon Bed Vault	Detectors in Carbon Bed Vaults A and B	Geiger-Mueller	Control Room indication and alarms	Off-Gas Building 584'
1D17K609 A,B,C,D 2D17K609 A,B,C,D Containment Ventilation Exhaust	Ventilation duct downstream of Containment Isolation Valve	Geiger-Mueller Redundant channels	Control Room indication and alarms. Close Containment and Drywell Purge Ventl. System valves	Intermediate Building, Containment Ventl. Exh. Duct 672'
1D17K690 A,B 2D17K690 A,B Annulus Exhaust Train A and Train B	Isokinetic sample downstream of filter trains	Gas scintillation channel and sample filters for particulate and halogen with sample pump	Local and Control Room alarms and indication	Intermediate Building 620'

TABLE 11.5-1 (Continued)

Radiation Monitor	Sample Point	Instrument Channels	Function	Location
1D17K780 2D17K780 Unit Vent Exhaust	Isokinetic sample from Plant Vent Autokinetic sampler	3-Channel, Gas-Halogen-Particulate, scintillation type with sample pump	Local and Control Room alarms and indication	Intermediate Building 682'
1D17K850 2D17K850 Turbine Building - Heater Bay	Isokinetic sample from HB/TB stack Autokinetic sampler	3-Channel, Gas-Halogen-Particulate, scintillation type with sample pump	Local and Control Room alarms and indication	Heater Bay Equipment House 667'
1D17K830 2D17K830 Off-Gas Vent	Isokinetic sample from Off-Gas Vent pipe	3-Channel, Gas-Halogen-Particulate, scintillation type with sample pump	Local and Control alarms and indication	Turbine Building 620'
1D17K840 2D17K840 Steam Packing Exhauster	Steam packing exhauster effluent line	In-line gas scintillation channel	Control Room alarms and indication	Turbine Building 624'

NOTE:

1. Tag numbers with 1D17K--- are associated with Unit 1, 2D17K--- are associated with Unit 2, and D17K--- are common to Unit 1 and Unit 2.

TABLE 11.5-2

PROCESS AND EFFLUENT RADIATION MONITORING SYSTEM CHARACTERISTICS

Monitoring Systems	Number of Units (1)	Detector Sensitivity	Instrument Range (Scale)	No. of Trips Upscale - Downscale	High (Trip) Setpoint (3)	Prealarm Setpoint (3)
Main Steam Lines	4-IC	3.7 x 10^{-10} amp/R/hr (2)	1 to 10^{6} mr/hr	2-1	Technical Specification	Above Full Power Background
Off-Gas Pretreatment	1-GM	-	1 to 10^{6} mr/hr	2-1	NA	Technical Specification
Off-Gas Post-Treatment	2-GM	10^{-6} μCi/cc counts/min.	10 to 10^{6}	2-1	Technical Specification	Above Background
Carbon Bed Vault	2-GM	-	1 to 10^{6} mr/hr	1-1	NA	Above Background
Containment Ventl. Exhaust	4-GM	-	.01 to 100 mr/hr (each channel)	2-1	Technical Specification	Above Background
Annulus Exhaust	1-GSP	10^{6} μCi/cc (Kr-85)	10 to 10^{6} counts/min.	2-1	Technical Specification	Variable
Unit Vent Exhaust	1-GSP 1-PSP 1-HSP	10^{-6} μCi/cc (Kr-85) 2.7 x 10^{-11} (Cs-137) 1.6 x 10^{-11} μCi/cc (I-131)	10 to 10^{6} counts/min. (each channel)	2-1	Technical Specification (4)	Variable
Turbine Bldg. - Heater Bay	1-GSP 1-PSP 1-HSP	10^{-6} μCi/cc (Kr-85) 2.7 x 10^{-11} μCi/cc (Cs-137) 1.6 x 10^{-11} μCi/cc (I-131)	10 to 10^{6} counts/min. (each channel)	2-1	Technical Specification (4)	Variable

TABLE 11.5-2 (Continued)

Monitoring Systems	Number of Units (1)	Detector Sensitivity	Instrument Range (Scale)	No. of Trips Upscale - Downscale	High (Trip) Setpoint (3)	Prealarm Setpoint (3)
Off-Gas Vent	1-GSP 1-PSP 1-HSP	10^{-6} μCi/cc (Kr-85) 2.7×10^{-11} μCi/cc (Cs-137) 1.6×10^{-11} μCi/cc (I-131)	10 to 10^6 counts/min. (each channel)	2-1	Technical Specification (4)	Variable
Steam Packing Exhauster	1-GSP	2×10^{-6} μCi/cc (Xe-133)	10 to 10^6 counts/min.	2-1	Technical Specification	Variable
Emergency Service Water Loop A	1-LSP	1×10^{-6} μCi/cc (Cs-137)	10 to 10^6 counts/min	1-1	7×10^3 cpm (5)	-
Emergency Service Water Loop B	1-LSP	1×10^{-6} μCi/cc (Cs-137)	10 to 10^6 counts/min.	1-1	7×10^3 cpm (5)	-
Nuclear Closed Cooling Water	1-LSP	1×10^{-6} μCi/cc (Cs-137)	10 to 10^6 counts/min.	1-1	10^4 cpm (5)	-
Plant Radwaste Discharge - ESW Discharge	1-LSP	1×10^{-6} μCi/cc (Cs-137)	10 to 10^6 counts/min.	1-1	Technical Specification (4)	-
Plant Radwaste Discharge - Sanitary Waste	1-LSP	1×10^{-6} μCi/cc (Cs-137)	10 to 10^6 counts/min	1-1	Technical Specification (4)	-
Underdrain	1-LSP	1×10^{-6} μCi/cc (I-131)	10 to 10^6 counts/min.	2-1	Technical Specification	Variable (5)

TABLE 11.5-2 (Continued)

NOTES:

1. Types of detectors are designated as follows:

   GM - Geiger-Muller detector
   IC - Ion chamber detector
   GSP - Gas chamber scintillator-photomultiplier detector
   PSP - Particulate filter scintillator-photomultiplier detector
   HSP - Halogen cartridge scintillator-photomultiplier detector
   LSP - Liquid scintillator-photomultiplier detector

2. Physical orientation and installation shall determine relative sensitivity and setpoint.

3. Setpoints to be revised as required to be compatible with limits established and current calibrated sensitivity of the applicable channel.

4. Basis for setpoint calculations:

   a. Calculation based on perimeter limits for unrestricted areas as per Table II of 10 CFR 20

   b. Average long term release limits based on mixing and diffusion factors in FSAR

   c. Setpoints for high set point to include total error

   d. As low as practicable quantities to be determined by laboratory analysis for reporting quantities, i.e., laboratory analysis of filters and samples

5. Initial setpoint at twice background.

TABLE 11.5-3

LIQUID PROCESS AND EFFLUENT RADIATION MONITORS

Radiation Monitor(1)	Sample Point	Instrument Channels	Function	Location
1D17K604 - 2D17K604 Emergency Service Water Loop A	ESW - Loop A downstream of RHR Heat Exchanger	Gamma - scint., offline with sample pump	Control Room indication and alarm	Auxiliary Building 568' - East and West
1D17K605 - 2D17K605 Emergency Service Water Loop B	ESW - Loop B downstream of RHR Heat Exchanger	Gamma - scint., offline with sample pump	Control Room indication and alarm	Auxiliary Building 568' - West and East
D17K607 Nuclear Closed Cooling System	Downstream of nuclear closed Cooling Heat Exchangers	Gamma - scint., offline with sample pump	Control Room indication and alam	Control Complex 599'
D17K606 Radwaste Effluent to ESW - Discharge	Raowaste line downstream of discharge valves PCV-F153 and PCV-155	Gamma - scint., offline with sample pump	Control Room and Radwaste PNL indication and alarm. Close discharge valve on high trip.	Auxiliary Building 620' - East
D17K608 Radwaste Effluent to Sanitary Waste	Radwaste line downstream of discharge valve PCV-F158	Gamma - scint. offline with sample pump	Control Room and Radwaste PNL indicator and alarm. Close discharge valve on high trip.	Control Complex 599'
D17K820 A&B Underdrain System	Gravity Drain System discharge lines	Gamma - scint., INLINE	Control Room indication and alarm. Stop underdrain pumps on high trip.	Gravity Drain System Manhole No. 20 & 23, 608'

NOTE:

1. Tag numbers with 1D17K--- associated with Unit 1, 2D17K--- associated with Unit 2, and D17K--- are common to Unit 1 and Unit 2.

TABLE 11.5-4

RADIOLOGICAL ANALYSIS SUMMARY OF LIQUID PROCESS SAMPLES

	Sample Description	Grab Sample Frequency	Analysis	Sensitivity (μ Ci/ml)	Purpose
1.	Reactor Coolant				
	Filtrate	Daily(1)	Gross Gamma	10^{-6}	Evaluate reactor water activity
	Crud	Daily(1)	Gross Gamma	10^{-6}	Evaluate crud activity
	Filtrate	Weekly(2)	I-131, I-133	5×10^{-7}	Evaluate fuel cladding integrity
	Crud and Filtrate	Weekly	Gamma Spectrum	5×10^{-7}	Determine radionuclides present in system
2.	Reactor Water Cleanup System	Biweekly	Gross Gamma	10^{-6}	Evaluate cleanup efficiency
3.	Condenser Demineralizer				
	Influent	Monthly	Gross Gamma	10^{-6}	Evaluate carryover
	Effluent	Monthly	Gross Gamma	10^{-6}	Evaluate demineralizer performance
4.	Condensate Storage Tank A	Weekly	Gross Gamma	10^{-6}	Tank inventory
5.	Condensate Storage Tank B	Weekly	Gross Gamma	10^{-6}	Tank inventory
6.	Fuel Pool Filter - Demineralizer				
	Inlet and Outlet	Periodically	Gross Gamma	10^{-6}	Evaluate system performance
7.	Waste Collector Tank	Periodically	Gross Gamma	10^{-6}	Evaluate system performance
8.	Floor Drain Collector Tank	Periodically	Gross Gamma	10^{-6}	Evaluate system performance

TABLE 11.5-4 (Continued)

	Sample Description	Grab Sample Frequency	Analysis	Sensitivity (μ Ci/ml)	Purpose
9.	Chemical Waste Tank	Periodically	Gross Gamma	10^{-6}	Evaluate system performance
10.	Evaporator Bottoms	Periodically	Gross Gamma	10^{-6}	Comparison of activity with that determined by drum readings
11.	Evaporator Distillate Tanks (2)	Periodically	Gross Gamma	10^{-6}	Evaluate evaporator performance
12.	Nuclear Closed Cooling	Periodically	Gross Gamma	10^{-6}	Evaluate system integrity

NOTES:

1. Daily means five times per week.

2. Performed more frequently if increase noted on daily gross gamma count.

TABLE 11.5-5

RADIOLOGICAL ANALYSIS SUMMARY OF GASEOUS PROCESS SAMPLES

	Sample Description	Sample Frequency	Analysis	Sensitivity ($\mu Ci/cm^3$)	Purpose
1.	Off-gas Monitor (SJAE) Sample	Monthly	Gamma Spectrum	10^{-4}	Determine off-gas activity
2.	Post-Treatment Sample	Monthly	Gamma Spectrum	10^{-4}	Determine off-gas system cleanup performance

TABLE 11.5-6

RADIOLOGICAL ANALYSIS SUMMARY OF LIQUID EFFLUENT SAMPLES

	Sample Description	Sample Frequency	Analysis	Sensitivity ($\mu Ci/cm^3$)	Purpose
1.	Floor Drain Sample Tank	Batch(1)	Gamma Spectrum	5×10^{-7}	Effluent discharge record
2.	Waste Sample Tanks (2)	Batch(1)	Gamma Spectrum	5×10^{-7}	Effluent discharge record
3.	Detergent Drain Tank (2)	Batch(1)	Gamma Spectrum	5×10^{-7}	Effluent discharge record
4.	Liquid Radwaste Effluents				
	Composite of all tanks discharged	Monthly	Gamma Spectrum Tritium Gross Alpha Dissolved Gas(2)	5×10^{-7} 5×10^{-5} 10^{-7} 10^{-5}	
		Quarterly	Sr-89/90	5×10^{-8}	
5.	Circulating Water Deccant Line	Weekly grab of continuously collected proportional sample	Gross Gamma Tritium	5×10^{-7} 5×10^{-5}	Effluent discharge record (backup sample)
6.	Underdrain sump	Weekly	Gross Gamma	5×10^{-7}	Effluent discharge record

NOTES:

1. If tank is to be discharged, analyses will be performed on each batch. If tank is not to be discharged, analyses will be performed periodically to evaluate equipment performance.

2. If no discharge event occurs during the week, frequency shall be so adjusted.

TABLE 11.5-7

RADIOLOGICAL ANALYSIS SUMMARY OF GASEOUS EFFLUENT SAMPLES

Sample Description	Sample Frequency	Analysis	Sensitivity ($\mu Ci/cm^3$)	Purpose
1. Plant vents, heater bay/turbine building vents, off-gas vent pipe	Weekly	Principal gamma emitters (1) for at least I-131 and Ba-La-140	10^{-11}	Effluent Record
		I-131 (2)	10^{-12}	
	Monthly	Principal gamma emitters (3)	10^{-4}	
		Gross Alpha (1)(2)	10^{-11}	
		I-133 and 135	10^{-10}	

NOTES:

1. On particulate filter

2. On charcoal cartridge

3. Gas samples

TABLE 11.5-8

PROCESS SAMPLING SYSTEM

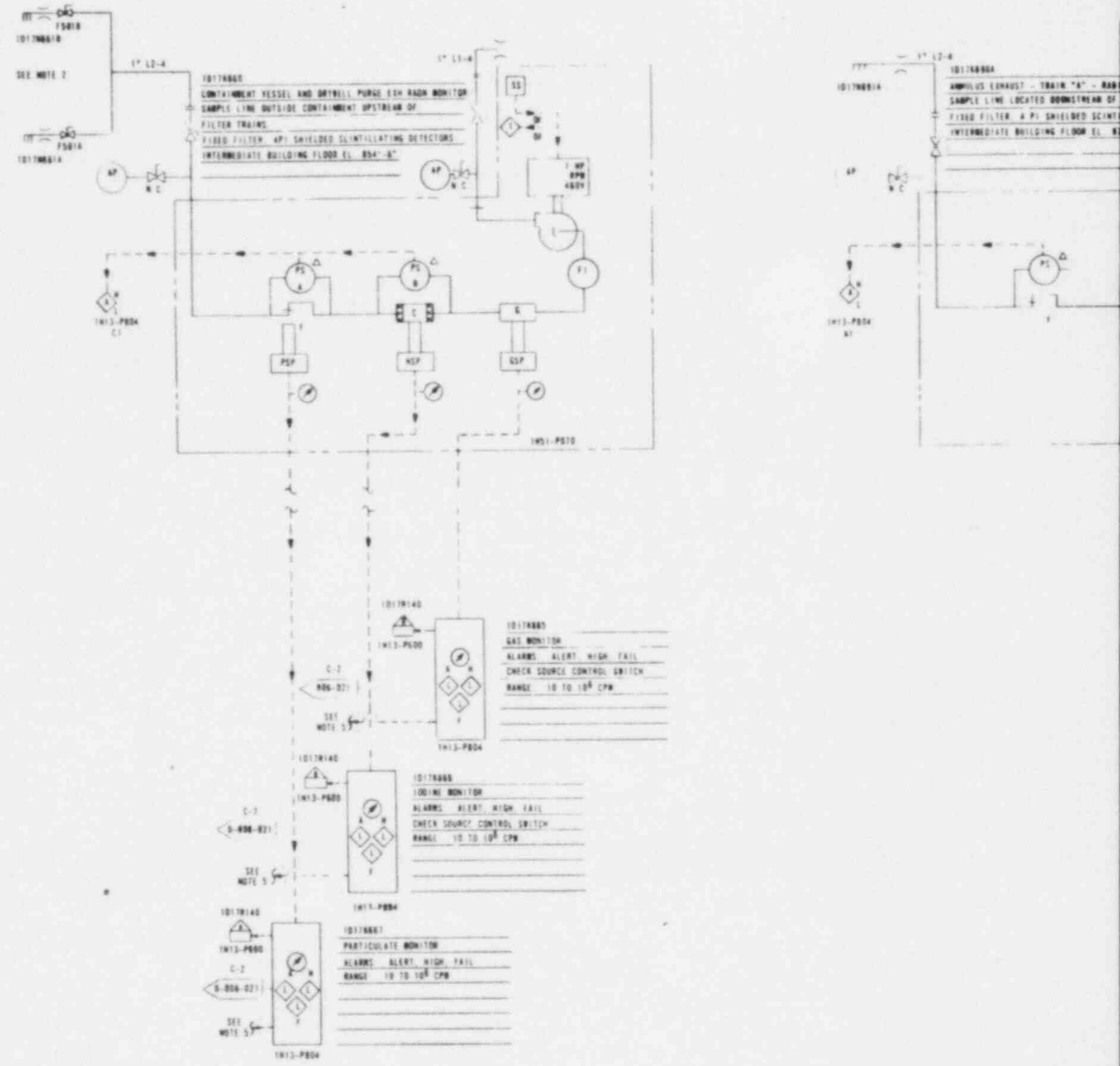
Description	Location	Purpose
a. Reactor Steam Supply System		
Reactor Water	Recirculation Pump Discharge	Reactor Water Quality
Main Steam	Main Steam Line	Carryover/Moisture
b. Reactor Water Cleanup System		
Filter/Demineralizer Influent	Inlet Line	Reactor Water Quality
Filter/Demineralizer Effluent	Outlet Line	Filter Efficiency
c. Fuel Pool Cooling and Cleanup System		
Filter Influent	Inlet Line	Fuel Pool Water Quality
Filter Effluent	Outlet Line	Filter Efficiency
Demineralizer Effluent	Outlet Line	Demineralizer Efficiency
d. Containment Vessel and Turbine Building Closed Loop Cooling Water Systems		
Cooling Water Sample	Outlet of Each Major Heat Exchanger	Monitor Head Exchanger Leaks
e. Condensate System		
Condensate	Condensate Pump Discharge	Condensate Quality and Tube Leaks
Condensate Demineralizer Effluent	Demineralizer Outlet Pipe	Treated Condensate Quality
Condensate	Hotwell	Tube Leaks

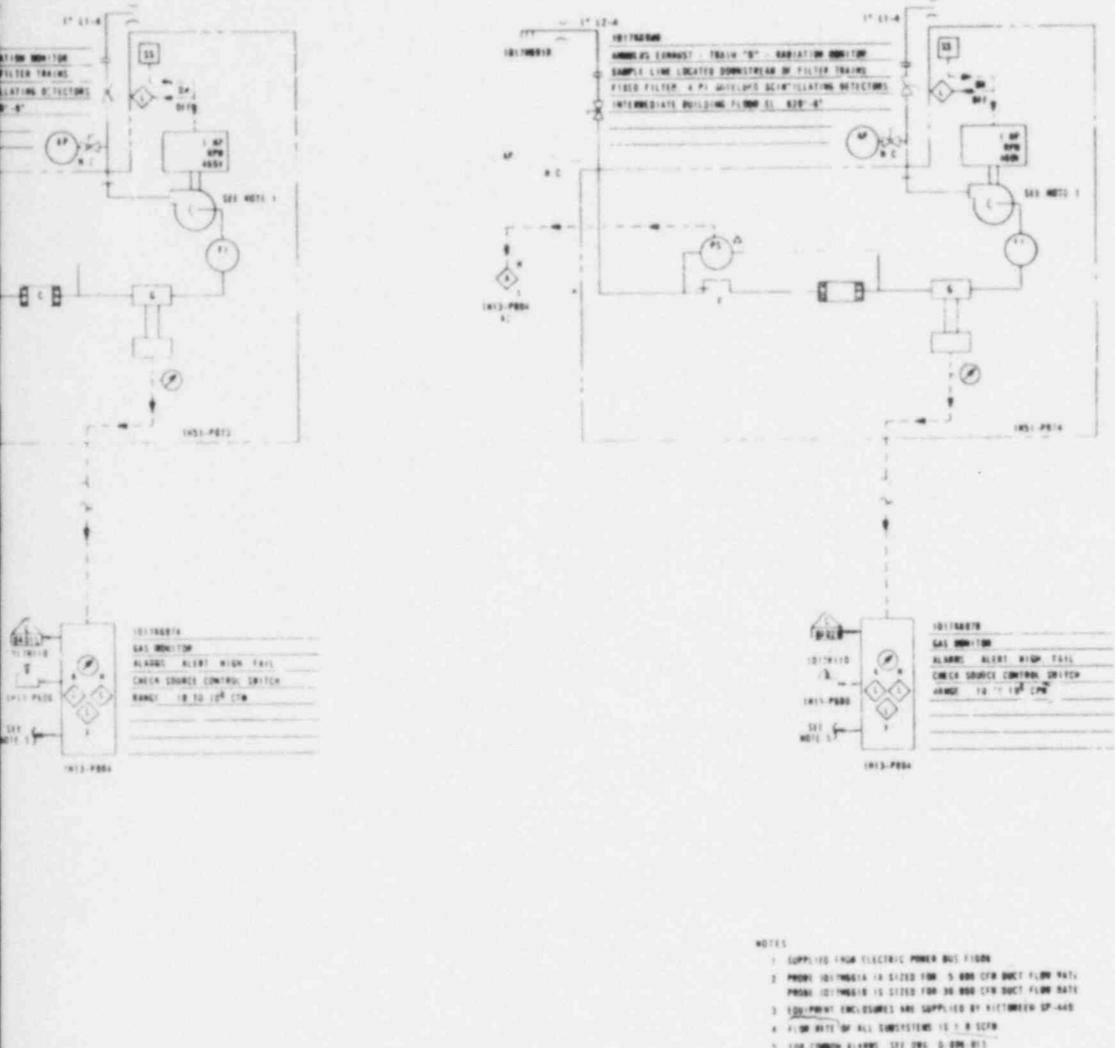
TABLE 11.5-8 (Continued)

	Description	Location	Purpose
f.	Emergency Service Water System		
	RHR Cooling, Loop A - Outlet of RHR Heat Exchanger		Tube Leaks/Activity
	RHR Cooling, Loop B - Outlet of RHR Heat Exchanger		Tube Leaks/Activity
g.	Main Condenser Circulating Water System		
	Influent	Discharge of Circulating Water Pump	Determine Background
	Effluent	Discharge Canal	Monitor added activity of discharge
h.	Radwaste System		
	Regenerant Evaporator Feed Tank	Recycle Line	Process Data
	Regenerant Evaporator Bottoms Tank	Recycle Line	Process Data
	Waste Collector Tank	Recycle Line	Process Data
	Floor Drain Collector Tank	Recycle Line	Process Data
	Radwaste Filter Effluent	Outlet Line	Filter Efficiency
	Radwaste Demineralizer Effluent	Outlet Line	Demineralizer Efficiency
	Floor Drain Filter Effluent	Outlet Line	Filter Efficiency
	Waste Evaporator Bottoms	Recycle Line	Process Data
	Waste Evaporator Sample Tank	Recycle Line	Process Data
	Discharge Sample Tank	Recycle Line	Water Quality
	Recovery Sample Tank	Recycle Line	Water Quality

TABLE 11.5-8 (Continued)

	Description	Location	Purpose
	Discharge Control	Discharge Line	Water Quality and Monitor Station Liquid Activity Releases
i.	SJAE Off-Gas System		
	Off-gas Sample	Upstream of Final SJAE	Evaluate Gas Composition and Isotopic Composition of off-gas
	Off-gas Sample	Downstream of Off-gas Condenser	Evaluate Recombiner Performance and subsystem DF, isotopic composition
	Off-gas Sample	Upstream of Charcoal Adsorber	Evaluate Gas Dryer Performance and DF
	Off-gas Sample	Downstream of 1st Charcoal Adsorber	Evaluate Charcoal Noble Gas Delay
	Off-gas Sample	Downstream of Final Charcoal Adsorber	Evaluate Charcoal Noble Gas Delay, isotopic composition

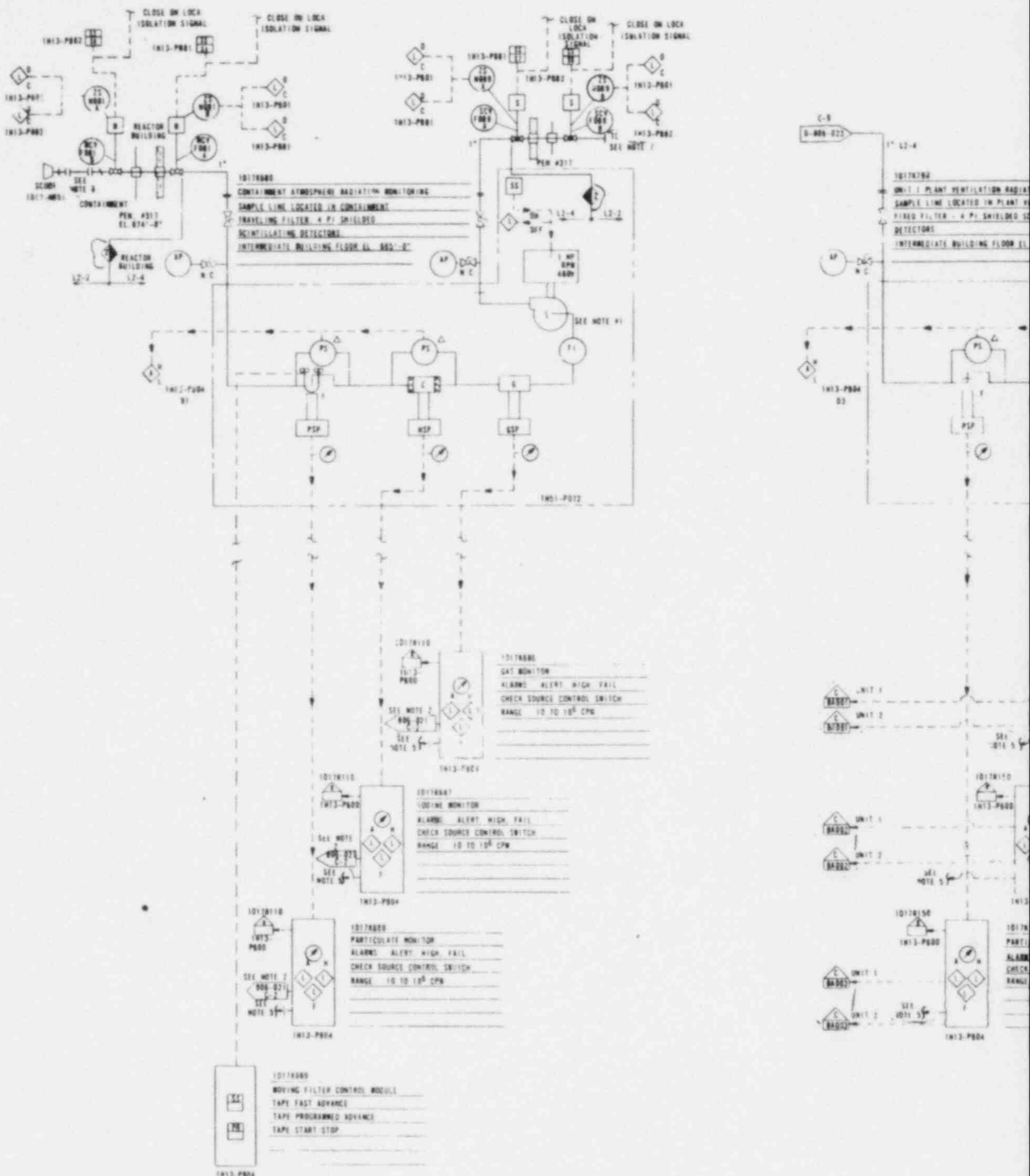

SEE NOTE 2
1" L2-4
CONTAINMENT VESSEL AND DRYWELL PURGE EXH RADN MONITOR
SAMPLE LINE OUTSIDE CONTAINMENT UPSTREAM OF
FILTER TRAINS
FIXED FILTER, 4PI SHIELDED SCINTILLATING DETECTORS
INTERMEDIATE BUILDING FLOOR EL 854'-6"
1" L1-4
SS
N C
PSP
HSP
GSP
1H51-P870
GAS MONITOR
ALARMS ALERT, HIGH, FAIL
CHECK SOURCE CONTROL SWITCH
RANGE 10 TO 10⁶ CPM
IODINE MONITOR
ALARMS ALERT, HIGH, FAIL
CHECK SOURCE CONTROL SWITCH
RANGE 10 TO 10⁶ CPM
PARTICULATE MONITOR
ALARMS ALERT, HIGH, FAIL
RANGE 10 TO 10⁶ CPM
SEE NOTE 5
1H13-P804
1H13-P600
ANNULUS EXHAUST - TRAIN "A"
SAMPLE LINE LOCATED DOWNSTREAM OF
FIXED FILTER, 4 PI SHIELDED SCINTI
INTERMEDIATE BUILDING FLOOR EL



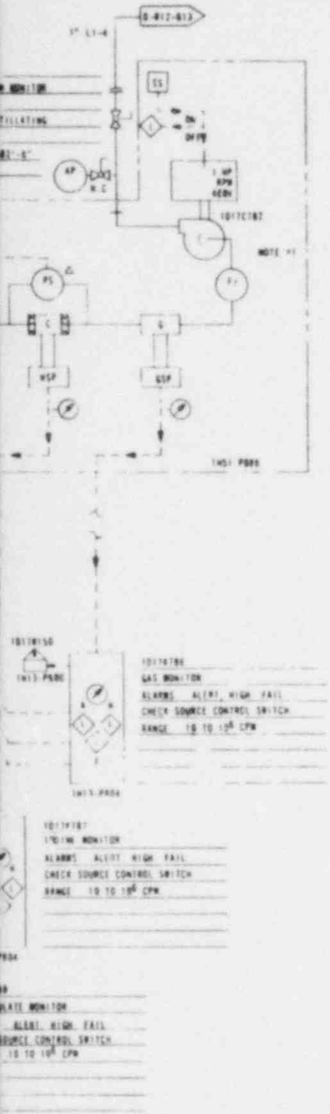
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

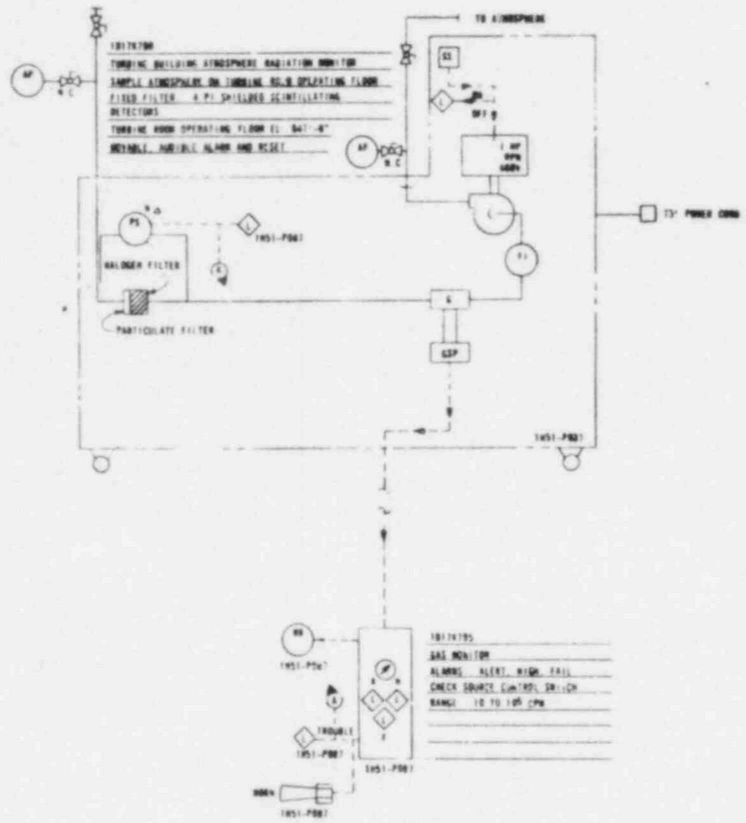
Plant Radiation Monitoring

Figure 11.5-1 (Sheet 1 of 12)
(GAI Dwg. D-806-006)



CLOSE ON LOCA ISOLATION SIGNAL
REACTOR BUILDING
CONTAINMENT
CONTAINMENT ATMOSPHERE RADIATION MONITORING
SAMPLE LINE LOCATED IN CONTAINMENT
TRAVELING FILTER. 4 PI SHIELDED
SCINTILLATING DETECTORS
SEE NOTE 4
1H51-P072
GAS MONITOR
ALARMS ALERT HIGH FAIL
CHECK SOURCE CONTROL SWITCH
IODINE MONITOR
PARTICULATE MONITOR
1H13-P804
MOVING FILTER CONTROL MODULE
TAPE FAST ADVANCE
TAPE PROGRAMMED ADVANCE
TAPE START STOP





NOTES

1. SUPPLIED FROM ELECTRIC POWER BUS F1000
2. ANY HIGH ALARM FROM 1D17K605 CONTAINMENT ATMOSPHERE RADIATION MONITOR WILL ALARM THE DRYWELL CONTAINMENT EVACUATION ALARM SYSTEM
3. EQUIPMENT ENCLOSURES ARE SUPPLIED BY VICTOREEN SP-440
4. FLOW RATE OF ALL SUBSYSTEMS IS 1.0 SCFM
5. FOR COMMON ALARMS SEE DWG D-806-013
6. REMOVABLE SPOOL PIECE FOR LEAK TEST
7. LEAVE OPEN AFTER LEAK TEST

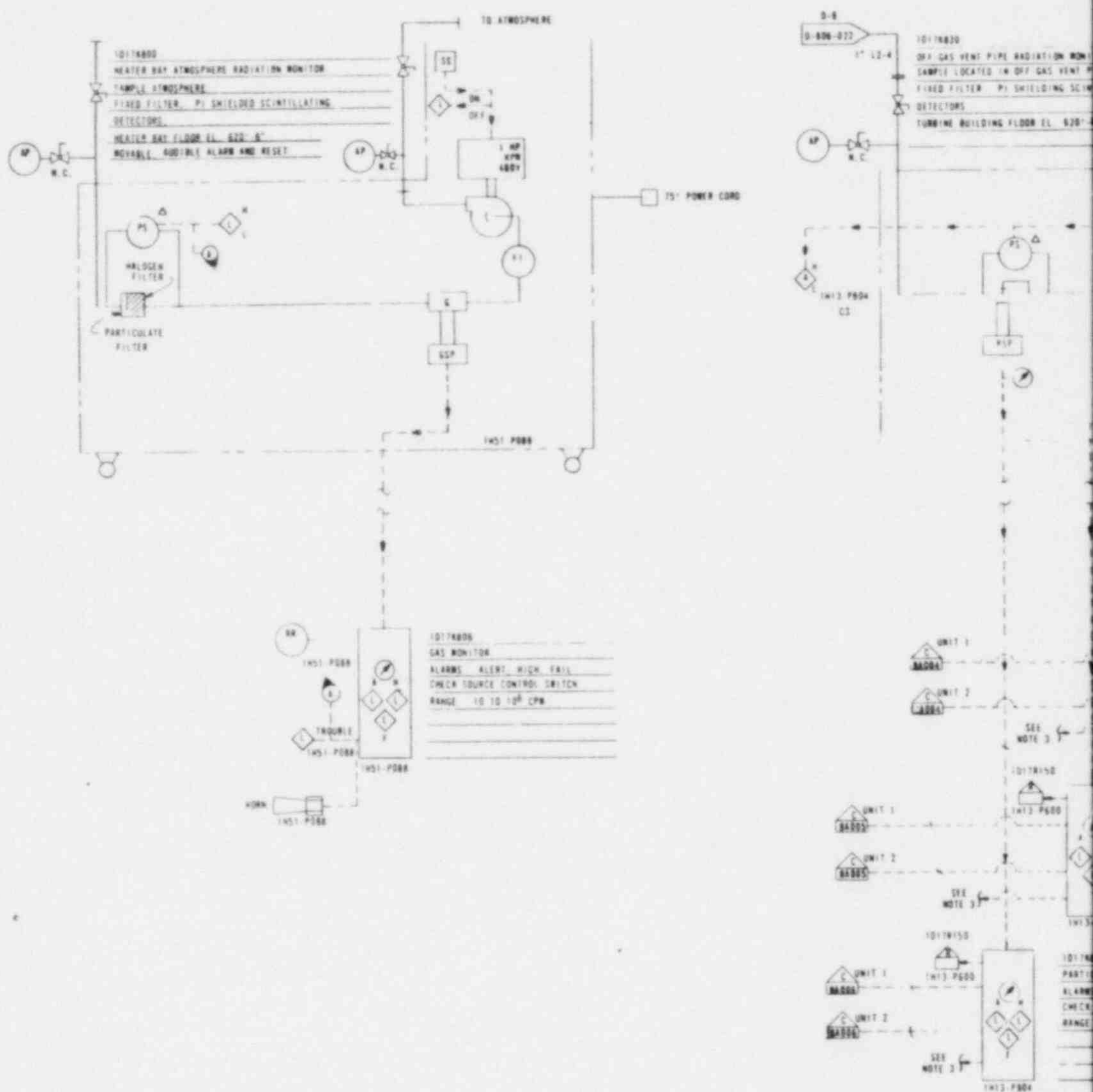
REFERENCES

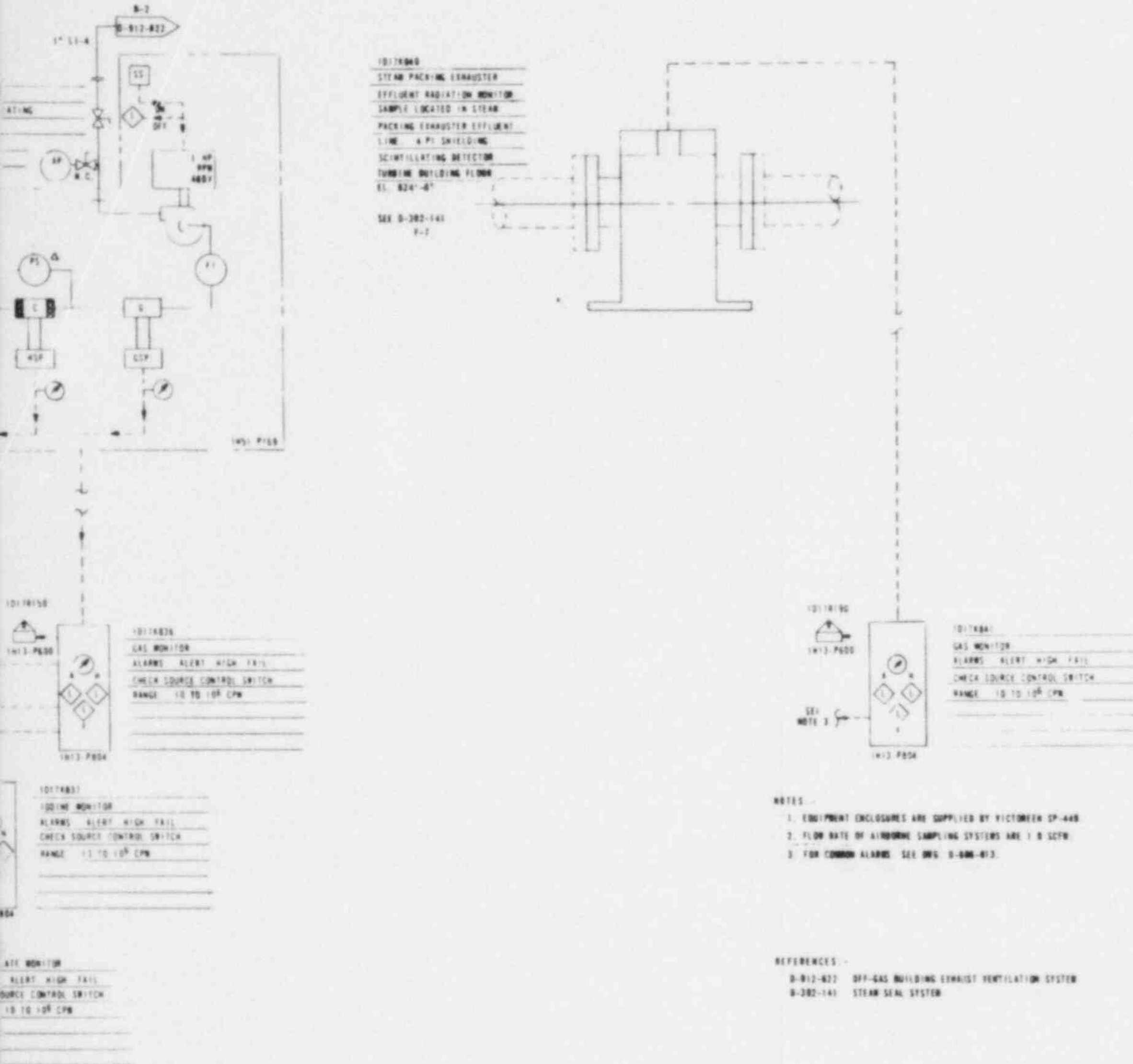
D-812-613 INTERMEDIATE BUILDING VENTILATION SYSTEM

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 2 of 12)
(GAI Dwg. D-806-007)


TO ATMOSPHERE
1D17N800
HEATER BAY ATMOSPHERE RADIATION MONITOR
SAMPLE ATMOSPHERE
FIXED FILTER, PI SHIELDED SCINTILLATING
DETECTORS.
HEATER BAY FLOOR EL. 620'-6"
MOVABLE, AUDIBLE ALARM AND RESET
AP
N.C.
SS
ON
OFF
1 HP
480V
75' POWER CORD
PS
HALOGEN
FILTER
PARTICULATE
FILTER
GSP
1H51-P088
RR
1D17N806
GAS MONITOR
ALARMS: ALERT, HIGH, FAIL
CHECK SOURCE CONTROL SWITCH
RANGE: 10 TO 10^6 CPM
TROUBLE
HORN
1H13-P804
C3
PSP
UNIT 1
UNIT 2
SEE
NOTE 3
1D17N150
1H13-P600
1D17N820
OFF GAS VENT PIPE RADIATION MON
SAMPLE LOCATED IN OFF GAS VENT P
FIXED FILTER. PI SHIELDING SCIN
DETECTORS
TURBINE BUILDING FLOOR EL. 620'
D-6
D-806-022
1" L2-4



NOTES:-

1. EQUIPMENT ENCLOSURES ARE SUPPLIED BY VICTOREEN SP-448
2. FLOW RATE OF AIRBORNE SAMPLING SYSTEMS ARE 1.0 SCFM
3. FOR COMMON ALARMS SEE DWG D-806-013.

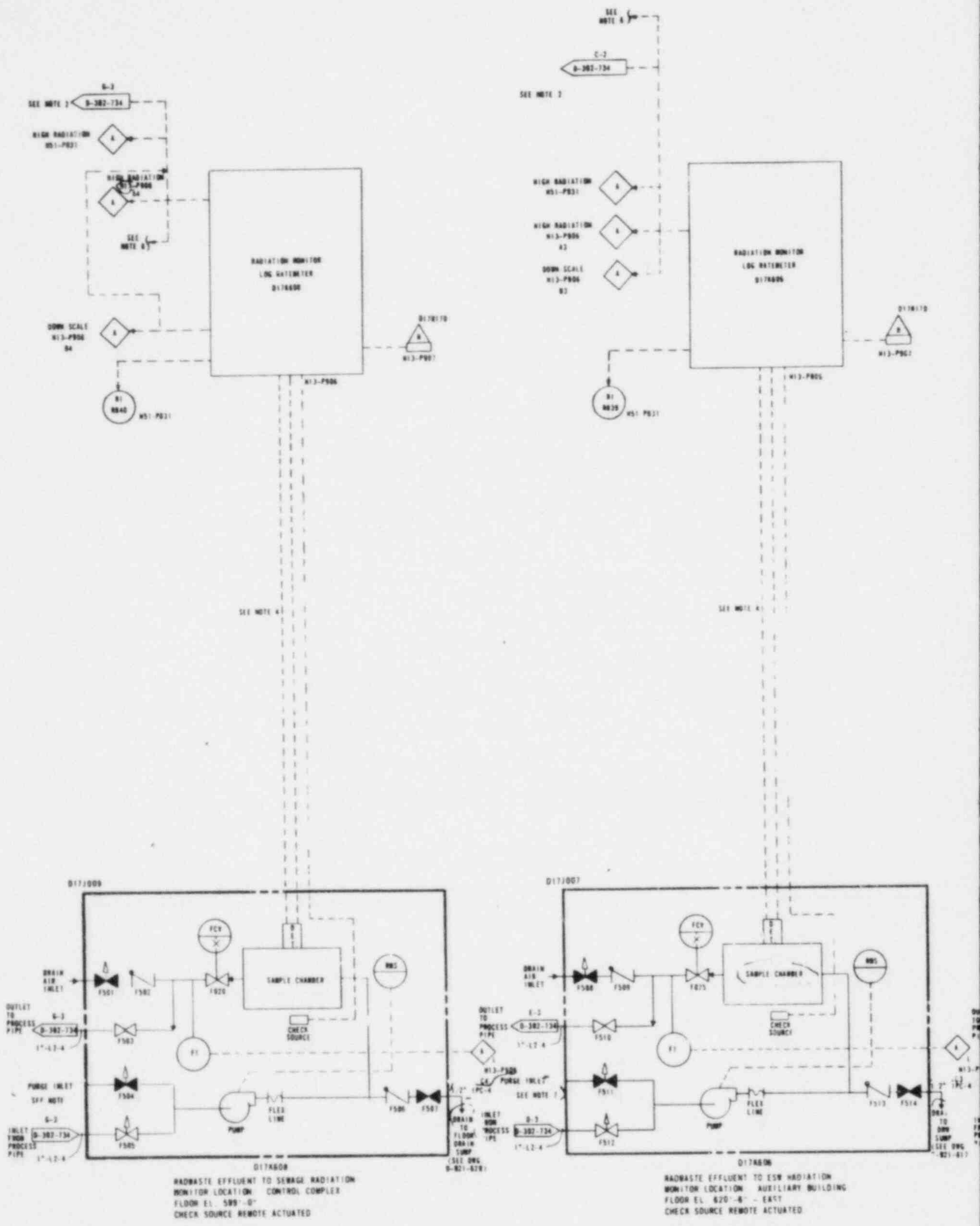
REFERENCES:-

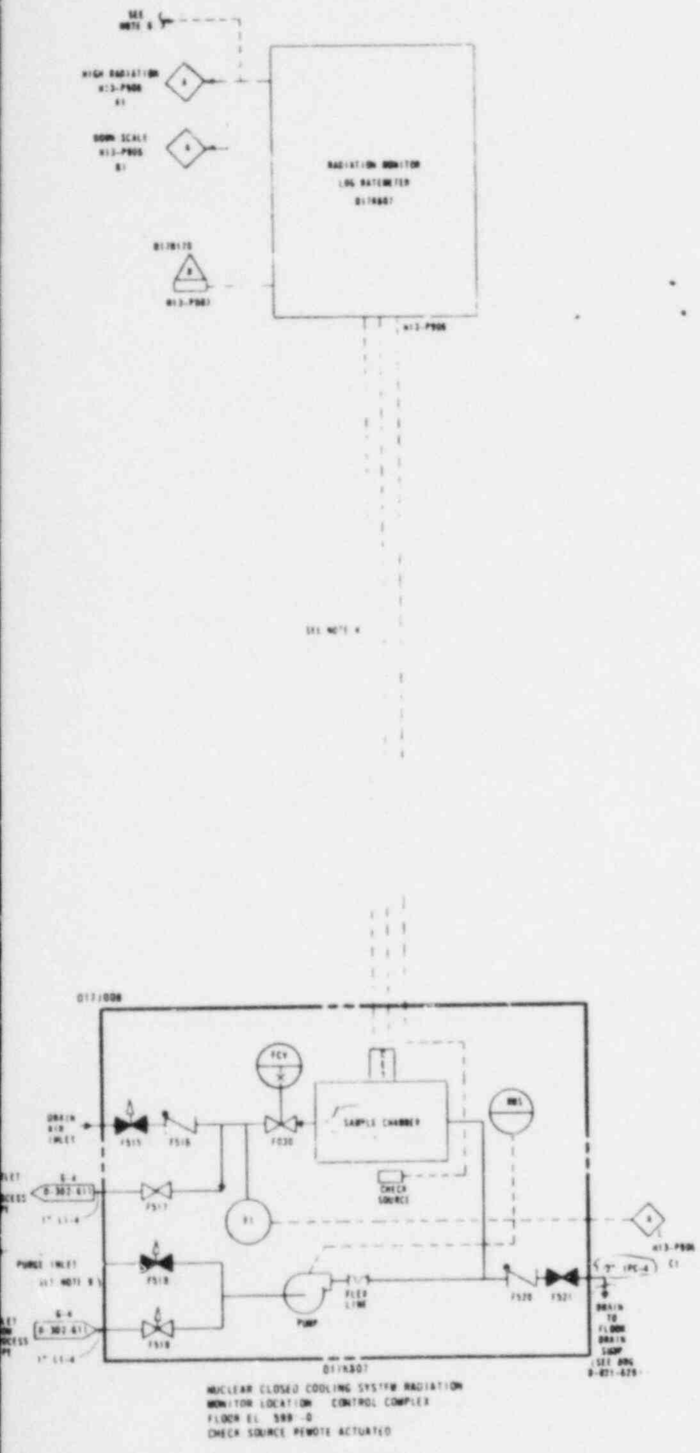
D-912-622 OFF-GAS BUILDING EXHAUST VENTILATION SYSTEM
D-302-141 STEAM SEAL SYSTEM

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 3 of 12)
(GAI Dwg. D-806-008)


RADIATION MONITOR
LOG RATEMETER
D17K600
HIGH RADIATION
DOWN SCALE
SEE NOTE 4
SAMPLE CHAMBER
CHECK SOURCE
PUMP
FLEX LINE
DRAIN AIR INLET
OUTLET TO PROCESS PIPE
PURGE INLET
INLET FROM PROCESS PIPE
D-302-734
D17J009
D17J007
D17K608
D17K606
RADWASTE EFFLUENT TO SEWAGE RADIATION
MONITOR LOCATION CONTROL COMPLEX
FLOOR EL. 599'-0"
CHECK SOURCE REMOTE ACTUATED
RADWASTE EFFLUENT TO ESW RADIATION
MONITOR LOCATION AUXILIARY BUILDING
FLOOR EL. 620'-6" - EAST
CHECK SOURCE REMOTE ACTUATED



NOTES

1. SEE G.E. DRAWING 763E410 SHEET 3 REVISION 7
2. HIGH RADIATION TRIP OR CHANNEL FAILURE SHUTS LIQUID DISCHARGE VALVES
3. ALARMS ARE ACTUATED BY RELAYS IN TRIP AUXILIARY UNIT
4. ALL CABLES SHALL COMPLY WITH G.E. SPECIFICATION 682-4010
5. EQUIPMENT INCLOSURE SUPPLIED BY GENERAL ELECTRIC SPECIFICATION SP-301
6. FOR COMMON ALARMS SEE DWG. D-806-020
7. FLUSH CAPABILITY PROVIDED AS SHOWN ON DWG. D-302-734 B-3. THIS CONNECTION NOT USED
8. FLUSH CAPABILITY PROVIDED AS SHOWN ON DWG. D-302-... G-2. THIS CONNECTION NOT USED
9. FLUSH WATER PROVISIONS ARE AVAILABLE FROM VALVE P21-F676 (SEE DWG. D-302-712 B-7) USING TEMPORARY HOSE HOOKUP

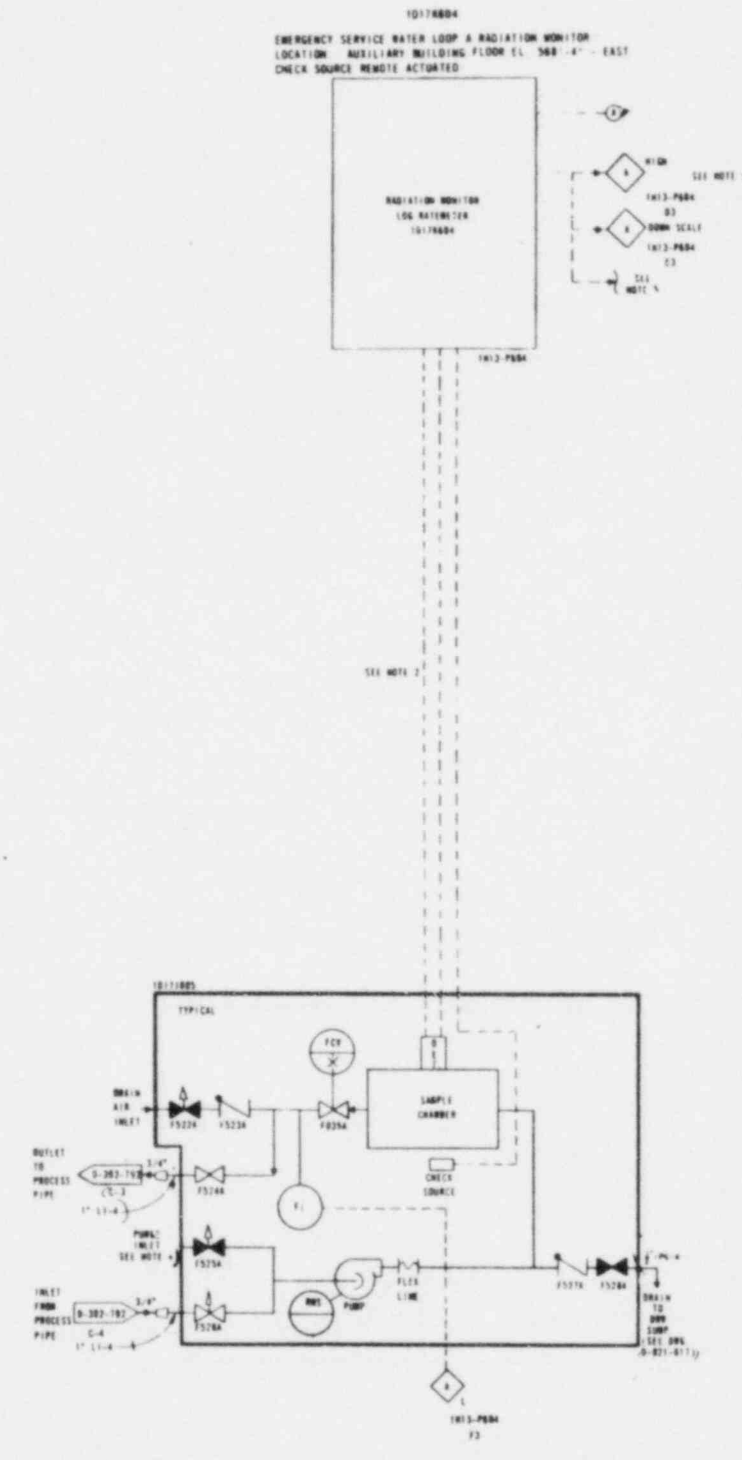
REFERENCES

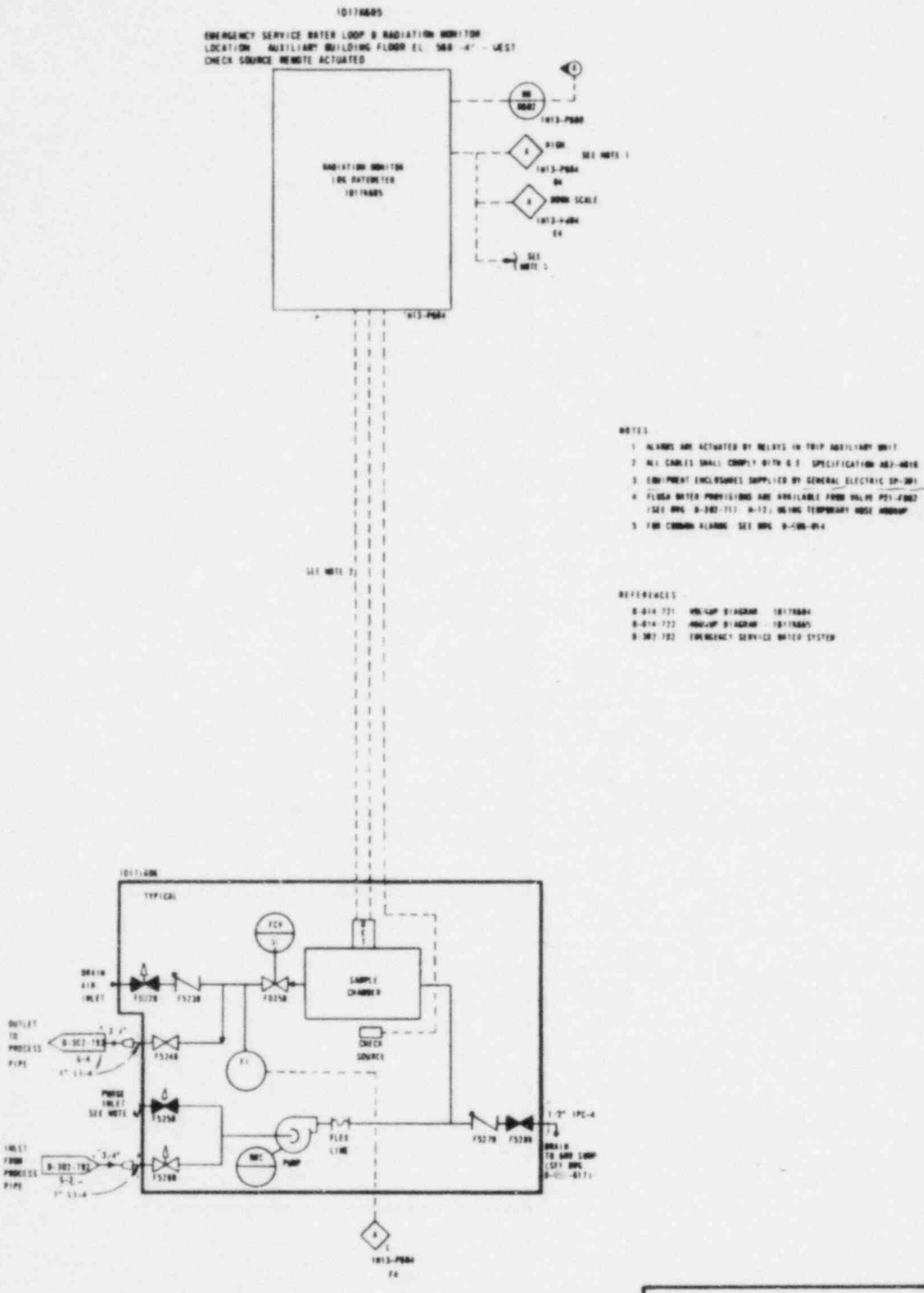
D-814-922 HOOKUP DIAGRAM - D17K607 AND D17K606
D-814-717 HOOKUP DIAGRAM - D17K606
D-302-734 LIQUID RADWASTE SYSTEM
D-302-611 NUCLEAR CLOSED COOLING SYSTEM

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 4 of 12)
(GAI Dwg. D-806-009)

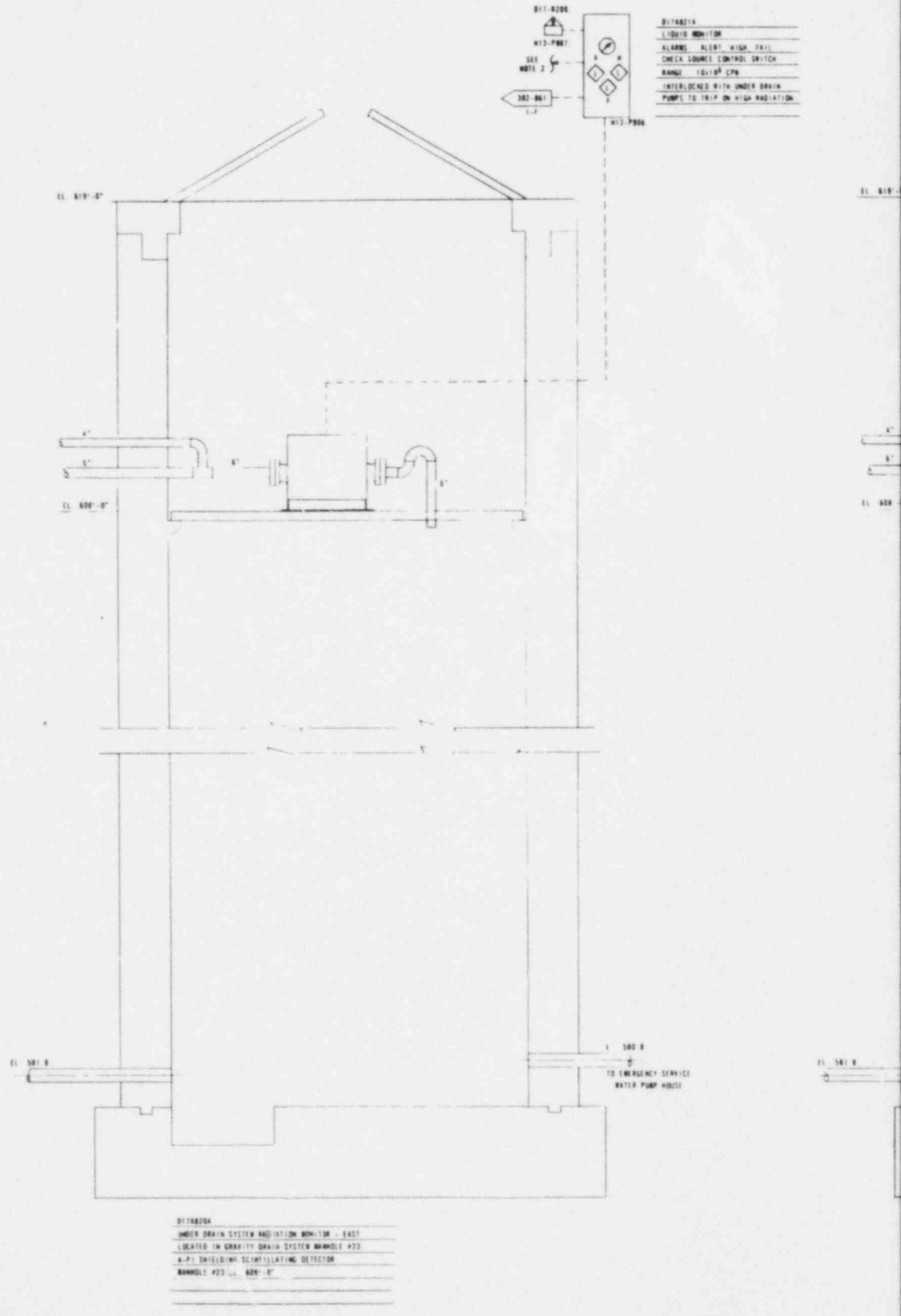

1D17N804
EMERGENCY SERVICE WATER LOOP A RADIATION MONITOR
LOCATION: AUXILIARY BUILDING FLOOR EL. 568'-4" - EAST
CHECK SOURCE REMOTE ACTUATED
RADIATION MONITOR
LOG RATEMETER
1D17N804
HIGH
SEE NOTE 1
1H13-P604
D3
DOWN SCALE
1H13-P604
E3
1H13-P604
SEE NOTE 2
TYPICAL
DRAIN
AIR
INLET
F523A
F028A
SAMPLE
CHAMBER
OUTLET
TO
PROCESS
PIPE
3/4"
F524A
CHECK
SOURCE
PURGE
INLET
F525A
INLET
FROM
PROCESS
PIPE
3/4"
F526A
PUMP
FLEX
LINE
F527A
F528A
DRAIN
TO
SUMP
1H13-P604
F3

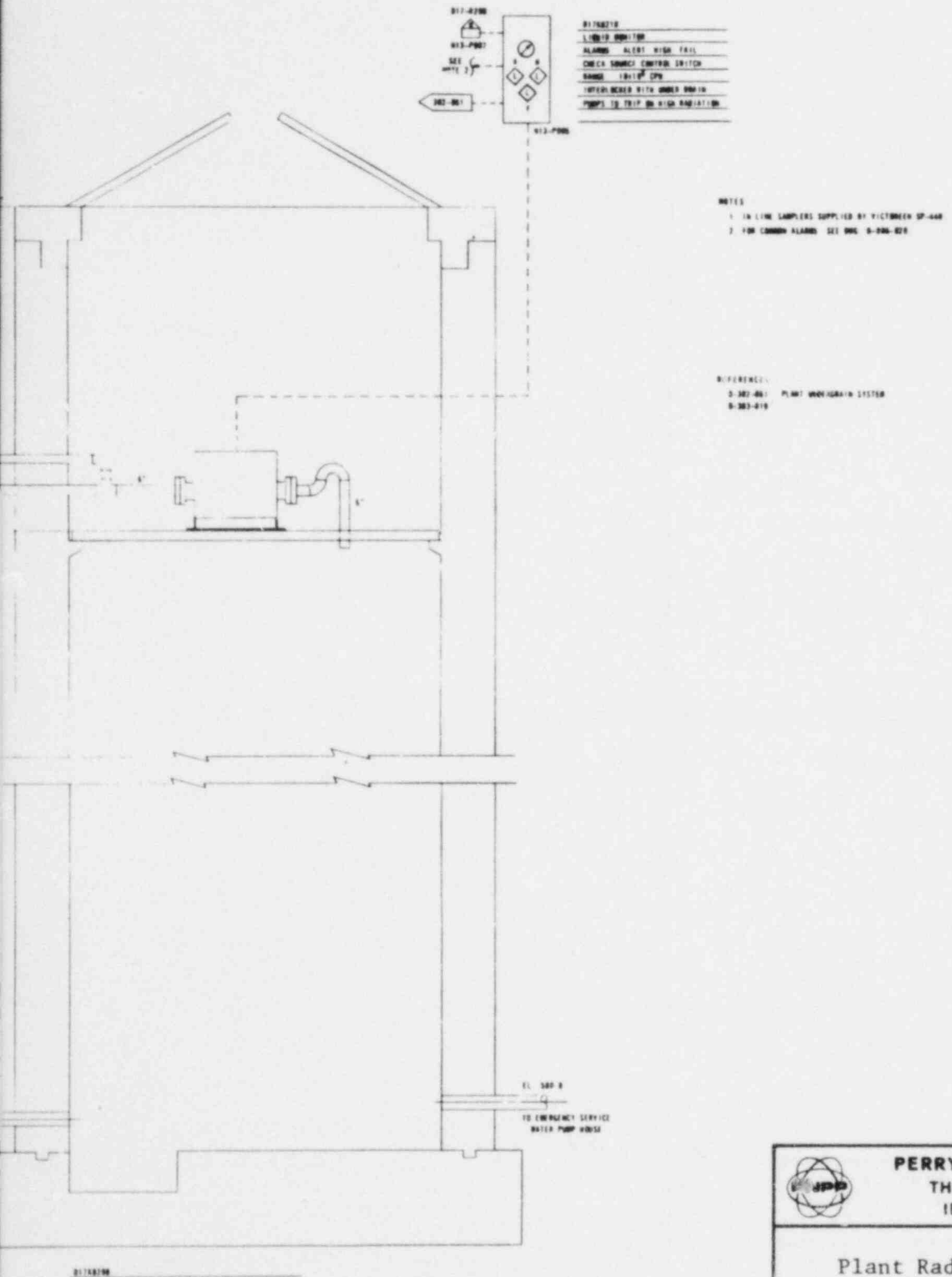


PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 5 of 12)
(GAI Dwg. D-806-010)

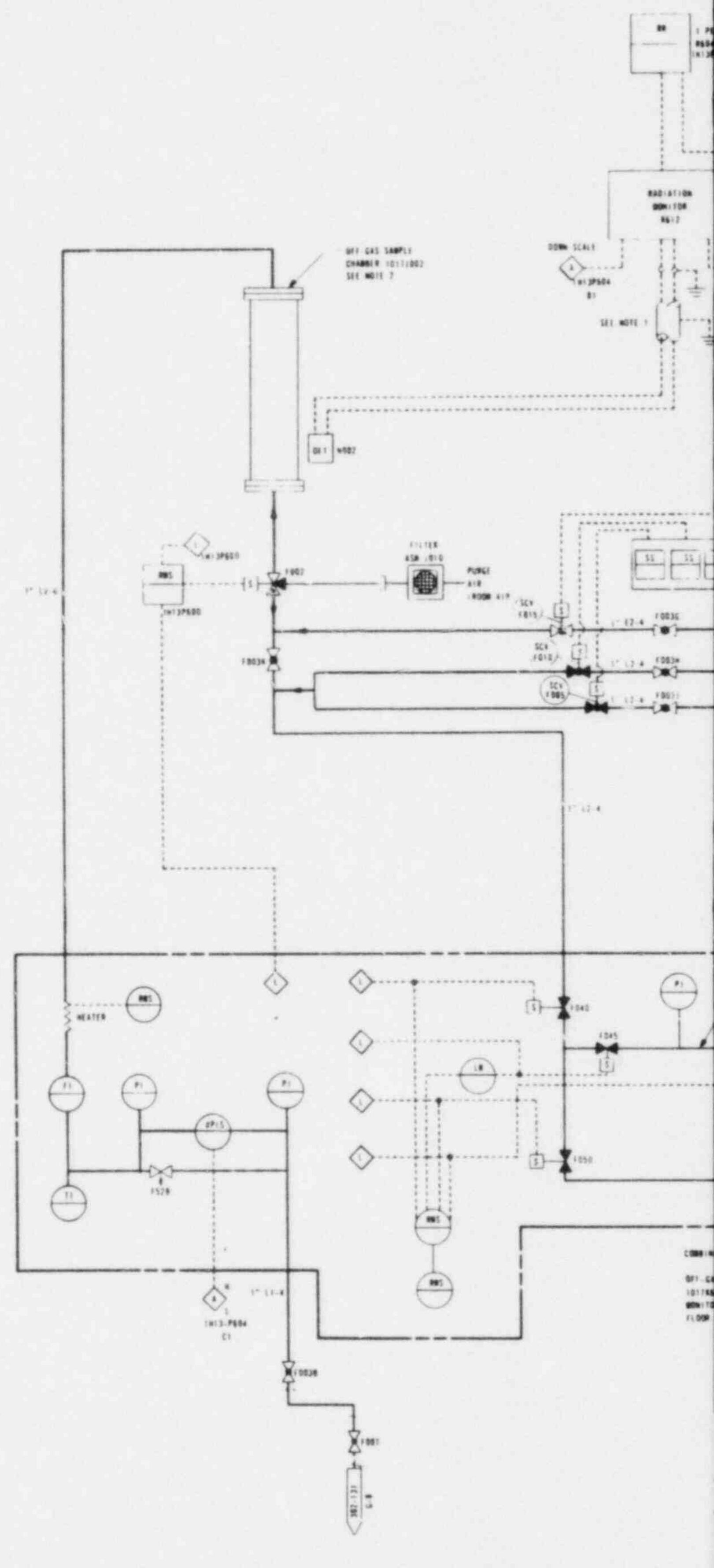

D17-R206
H13-P867
SEE
NOTE 2
302-861
H13-P806
D17K821A
LIQUID MONITOR
ALARMS ALERT, HIGH, FAIL
CHECK SOURCE CONTROL SWITCH
RANGE 10x10^6 CPM
INTERLOCKED WITH UNDER DRAIN
PUMPS TO TRIP ON HIGH RADIATION
EL 619'-0"
4"
6"
EL 608'-0"
EL 581 0
TO EMERGENCY SERVICE
WATER PUMP HOUSE
D17K820A
UNDER DRAIN SYSTEM RADIATION MONITOR - EAST
LOCATED IN GRAVITY DRAIN SYSTEM MANHOLE #23
4-PI SHIELDING SCINTILLATING DETECTOR
MANHOLE #23 EL 608'-0"



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 6 of 12)
(GAI Dwg. D-806-017)


RADIATION MONITOR
DOWN SCALE
FILTER
PURGE AIR
HEATER
DPIS
RMS
F529

NOTES

1. ALL CABLES SHALL COMPLY WITH G.E. ENGINEERING SPECIFICATION [illegible]
2. THE OFF-GAS SAMPLE CHAMBER SHALL BE MOUNTED VERTICALLY, AND THE TUBING SHALL SLOPE AWAY FROM THE CHAMBER SO THAT THE CONDENSATE WILL RETURN TO THE PROCESS.
3. SAMPLE PANEL [illegible] AND CHAMBER [illegible] SUPPLIED BY GENERAL ELECTRIC [illegible]

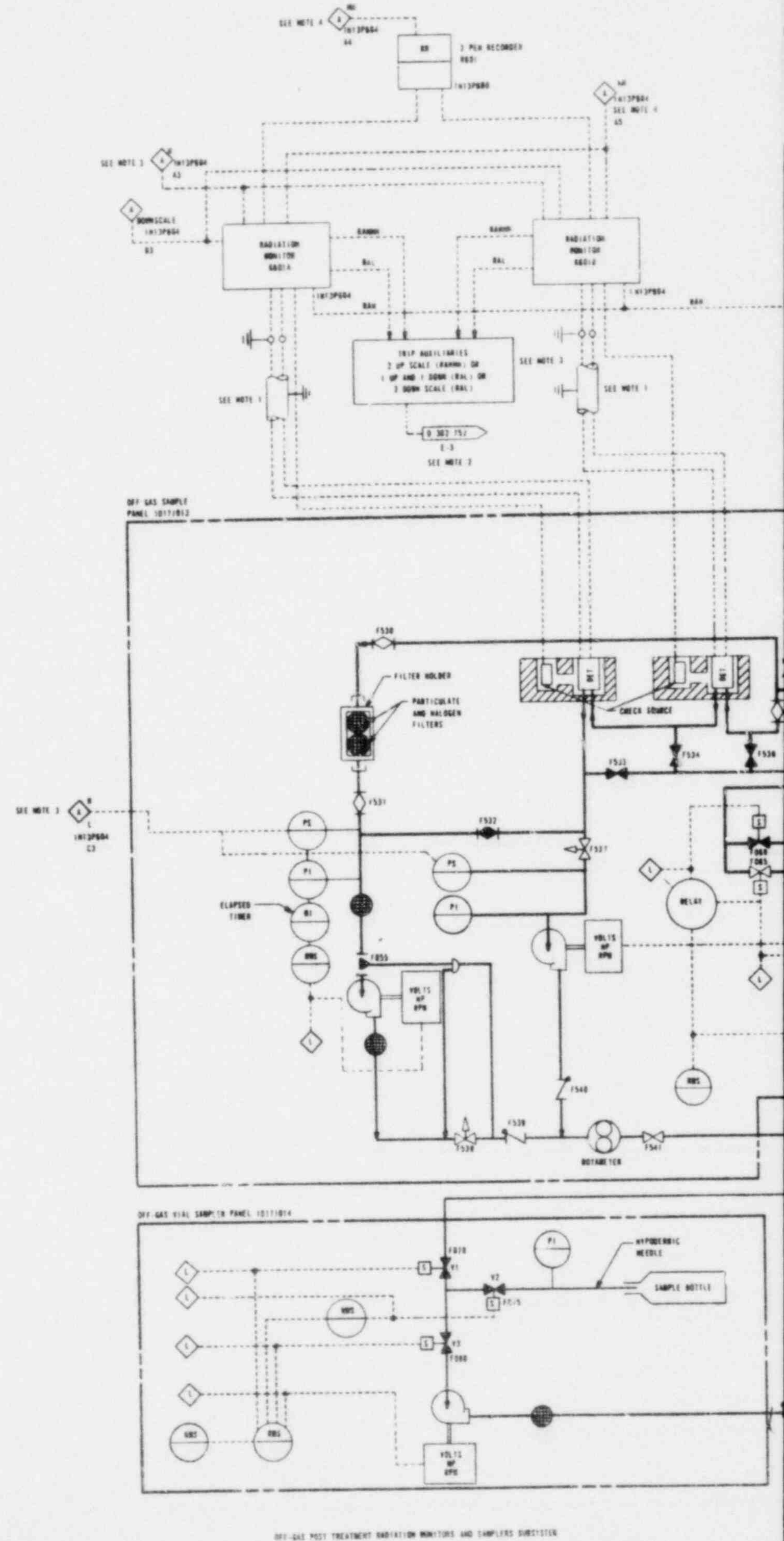
REFERENCES

[illegible] HOOKUP DIAGRAM [illegible]
D-302-131 CONDENSER AIR REMOVAL SYSTEM
D-302-751 OFF GAS SYSTEM

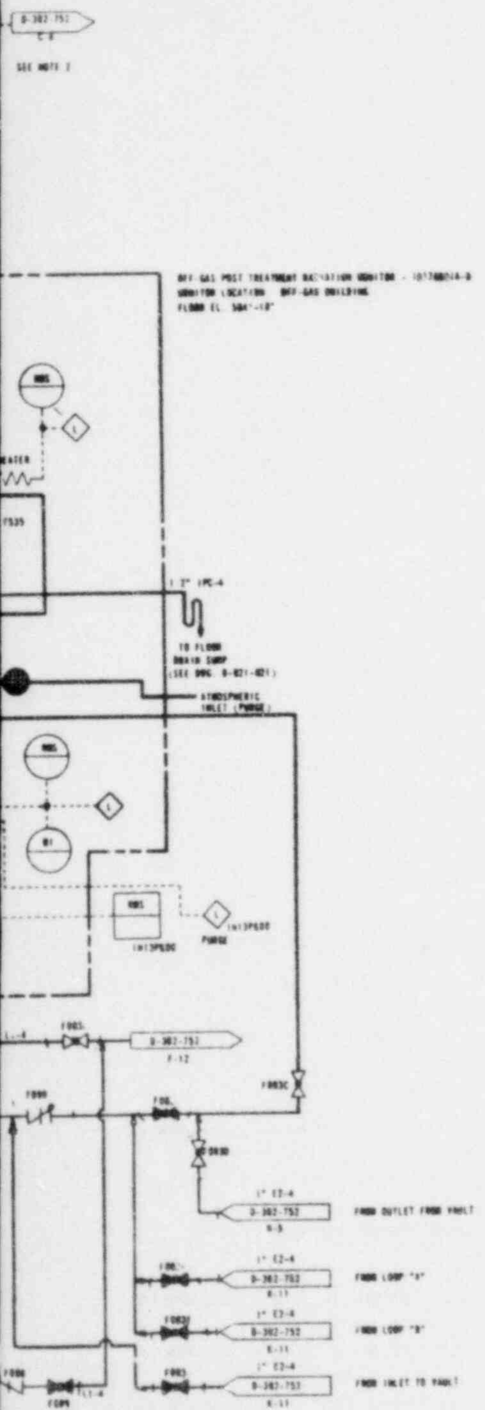
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 7 of 12)
(GAI Dwg. D-806-018)



OFF-GAS POST TREATMENT RADIATION MONITORS AND SAMPLERS SUBSYSTEM



NOTES

1. ALL CABLES SHALL COMPLY WITH G.E. ENGINEERING SPECIFICATION [illegible]
2. EACH RATEMETER HAS TWO UP-SCALE HIGH RADIATION TRIPS AND A DOWN-SCALE (INOPERATIVE) TRIP AS FOLLOWS
   a. ANY ONE TRIP WILL ALARM IN THE CONTROL ROOM
   b. ANY ONE UP-SCALE HIGH RADIATION TRIP CLOSES THE CARBON BED FILTER BYPASS VALVE, IF OPEN, AND OPENS THE OFF-GAS LINE TO THE CARBON BED, IF CLOSED
   c. TWO UP-SCALE HIGH-HIGH RADIATION TRIPS, OR ONE UP-SCALE HIGH-HIGH RADIATION TRIP AND ONE DOWN-SCALE TRIP, OR TWO DOWN-SCALE TRIPS, WILL ISOLATE THE OFF-GAS SYSTEM OUTLET AND DRAIN VALVES AFTER A PRESET TIME DELAY
3. ALARMS ARE ACTUATED BY RELAYS IN TRIP AUXILIARY UNIT.
4. [illegible] AND [illegible] SUPPLIED BY GENERAL ELECTRIC SPECIFICATION [illegible]

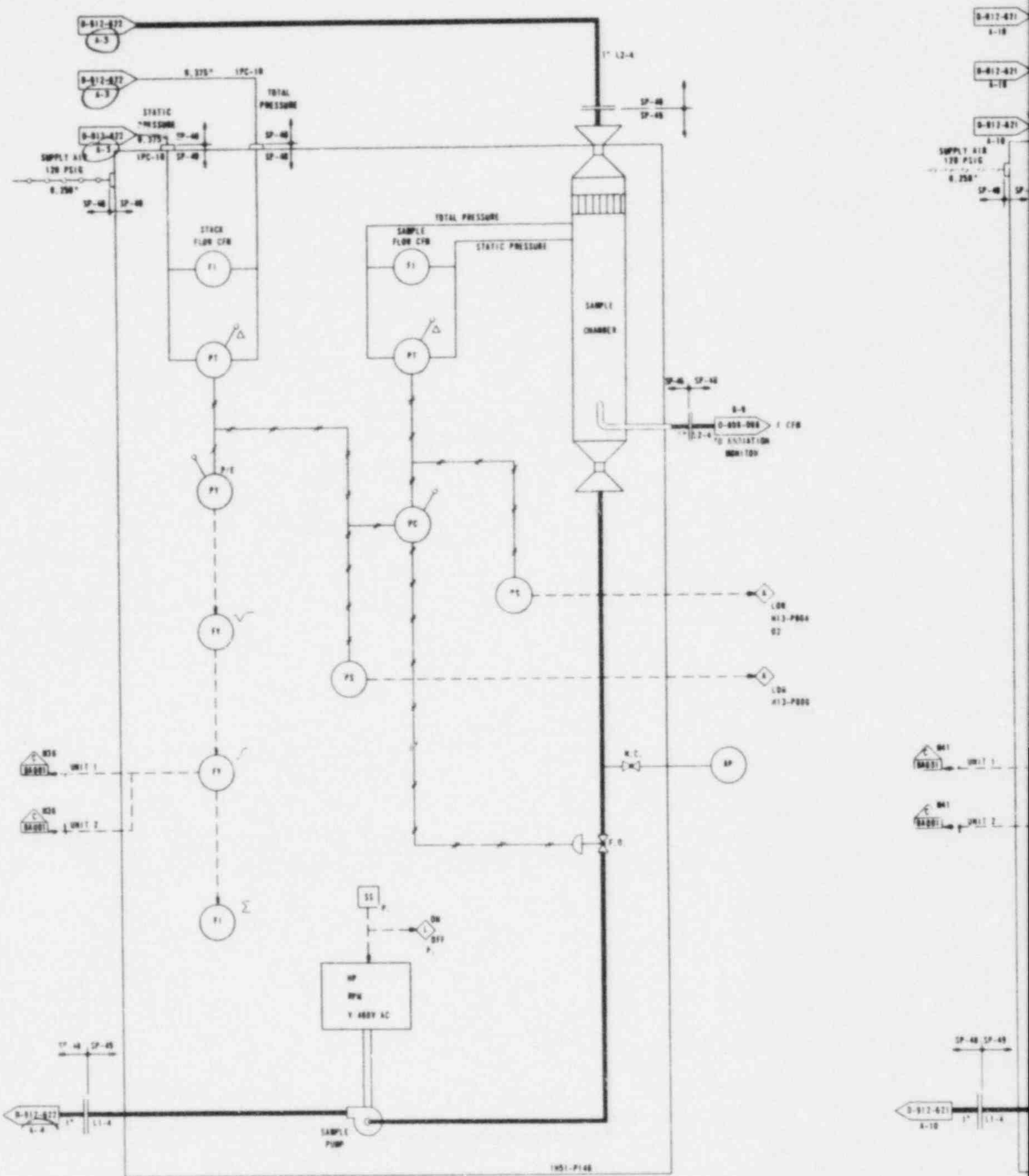
REFERENCES

D-814-208 HOOKUP DIAGRAM - [illegible]
D-302-752 OFF-GAS SYSTEM
D-821-821 TURBINE POWER COMPLEX AND PIPE TUNNEL - FLOOR AND EQUIPMENT DRAINS

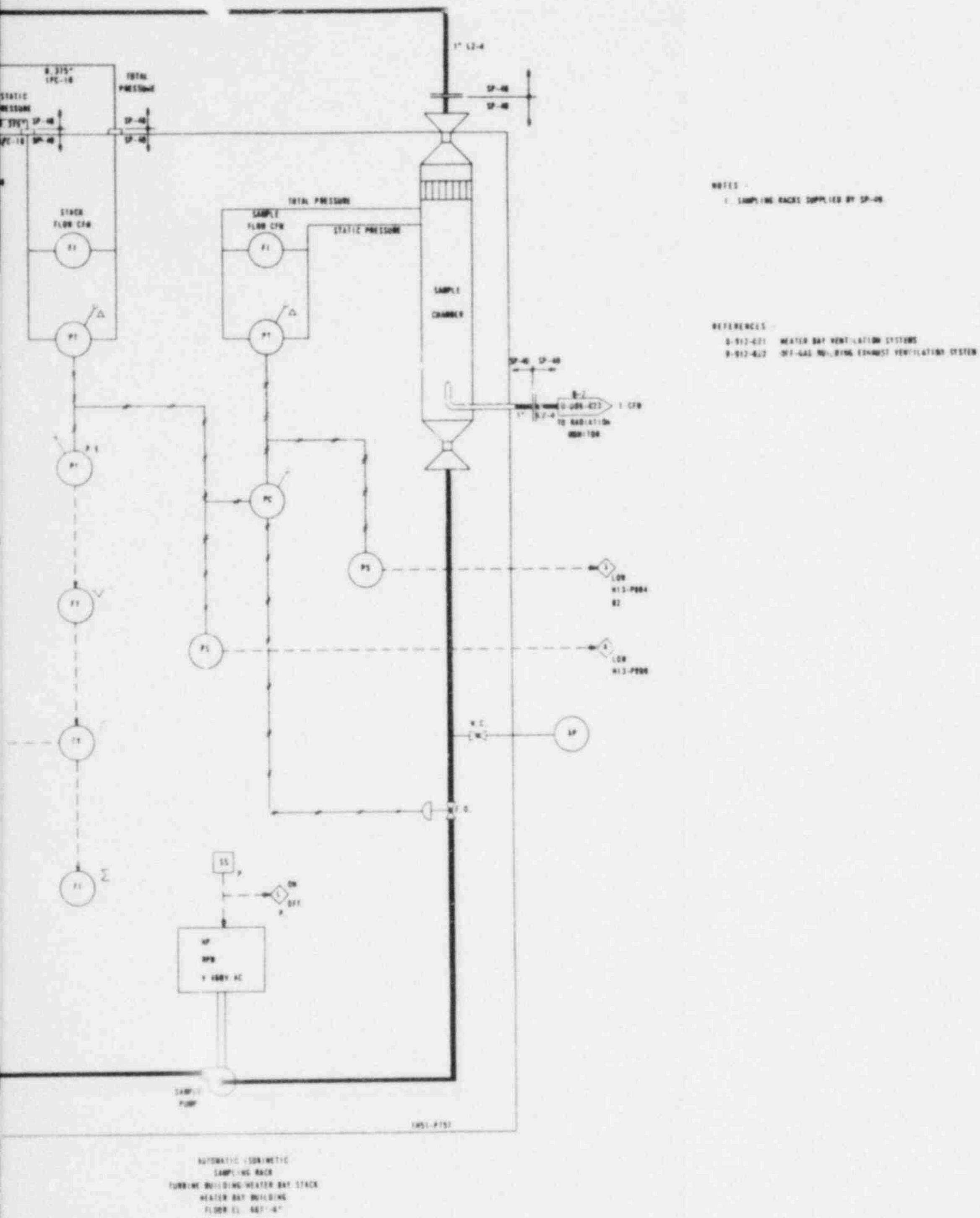
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 8 of 12)
(GAI Dwg. D-806-019)



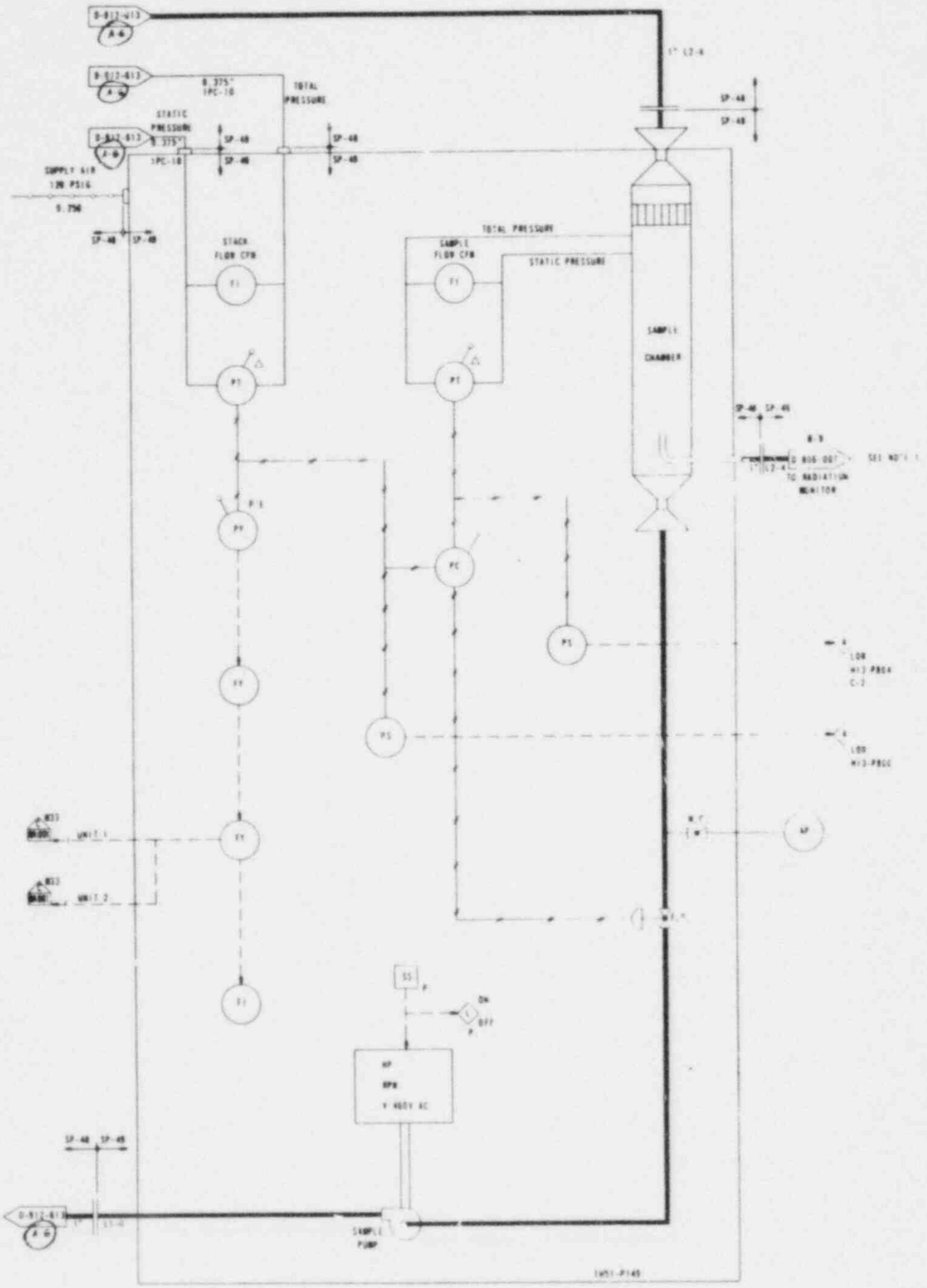
AUTOMATIC ISOKINETIC
SAMPLING RACK
OFF-GAS VENT PIPE
TURBINE BUILDING
FLOOR EL. 821'-6"



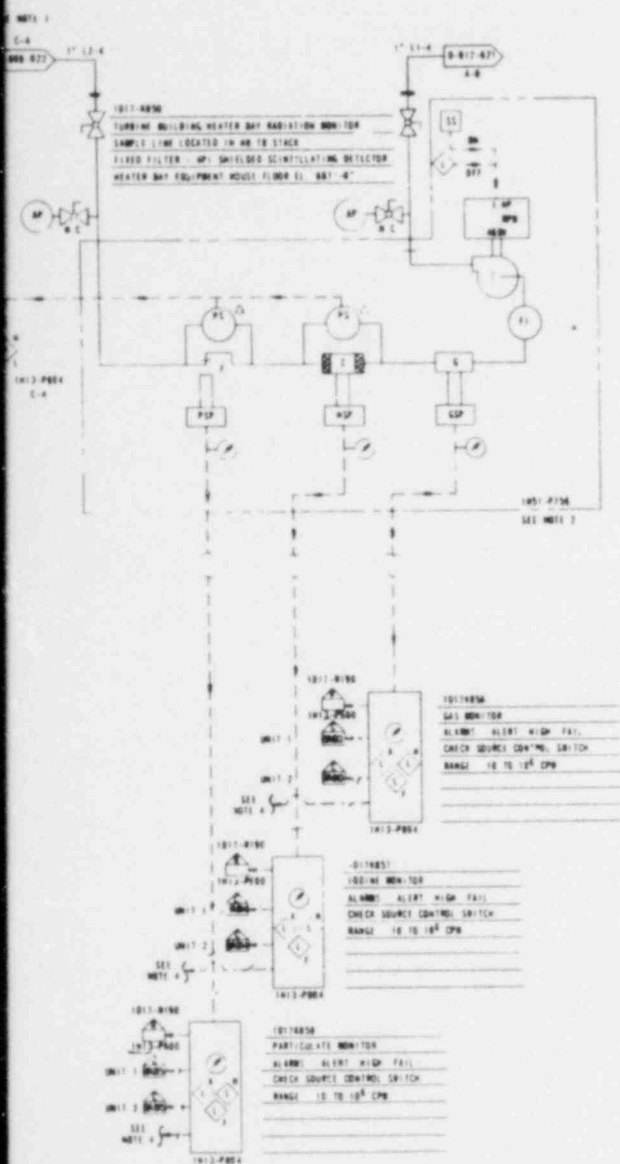
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 9 of 12)
(GAI Dwg. D-806-022)



AUTOMATIC ISOKINETIC
SAMPLING RACK
UNIT 1 PLANT VENT
INTERMEDIATE BUILDING
FLOOR EL. 682'-6"



NOTES:

1. FLOWRATE IS 1.0 SCFM
2. RADIATION MONITOR EQUIPMENT ENCLOSURE SUPPLIED BY VICTOREEN SP-44B
3. SAMPLING RACK SUPPLIED BY SP-49
4. FOR COMMON ALARM SEE DWG D-806-013

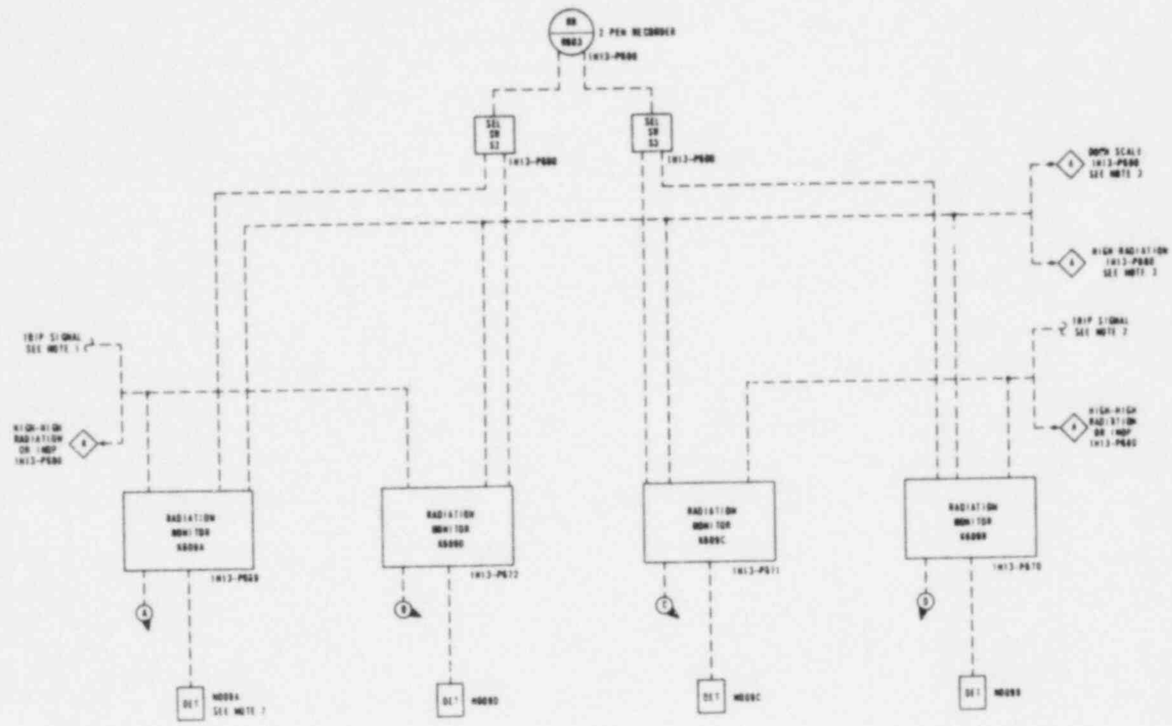
REFERENCES:

D-912-613 INTERMEDIATE BUILDING VENTILATION SYSTEM
D-912-621 HEATER BAY VENTILATION SYSTEM

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

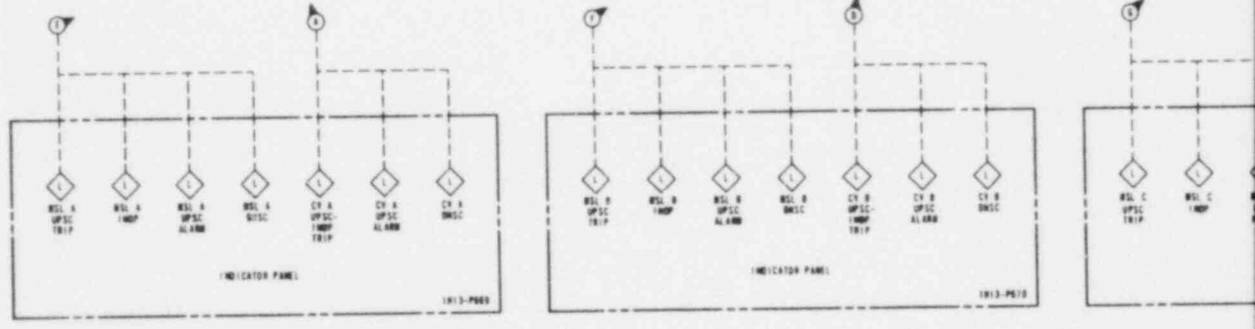
Plant Radiation Monitoring

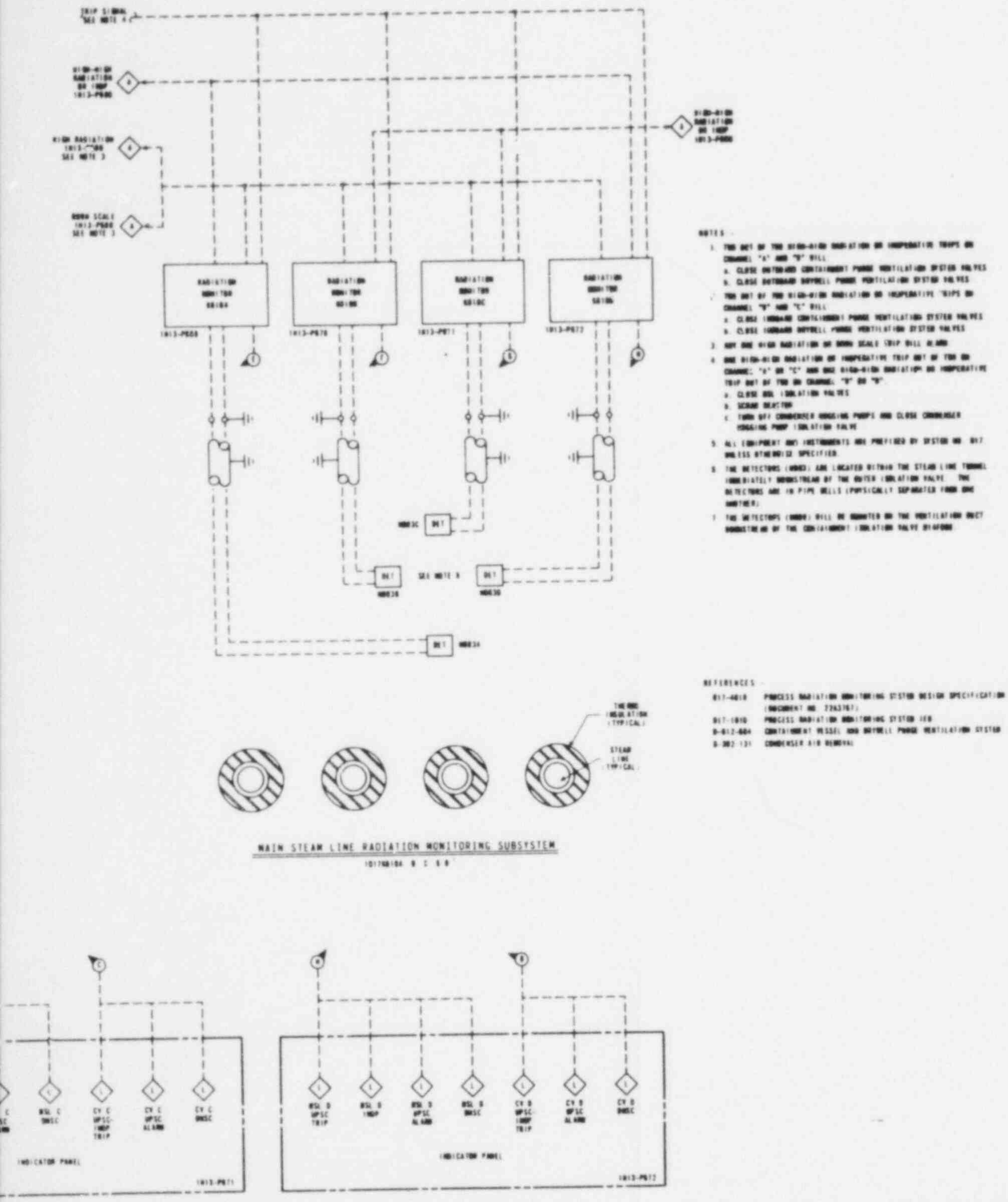
Figure 11.5-1 (Sheet 10 of 12)
(GAI Dwg. D-806-023)



CONTAINMENT VENTILATION EXHAUST RADIATION MONITORING SUBSYSTEM

SEE REFERENCE 3

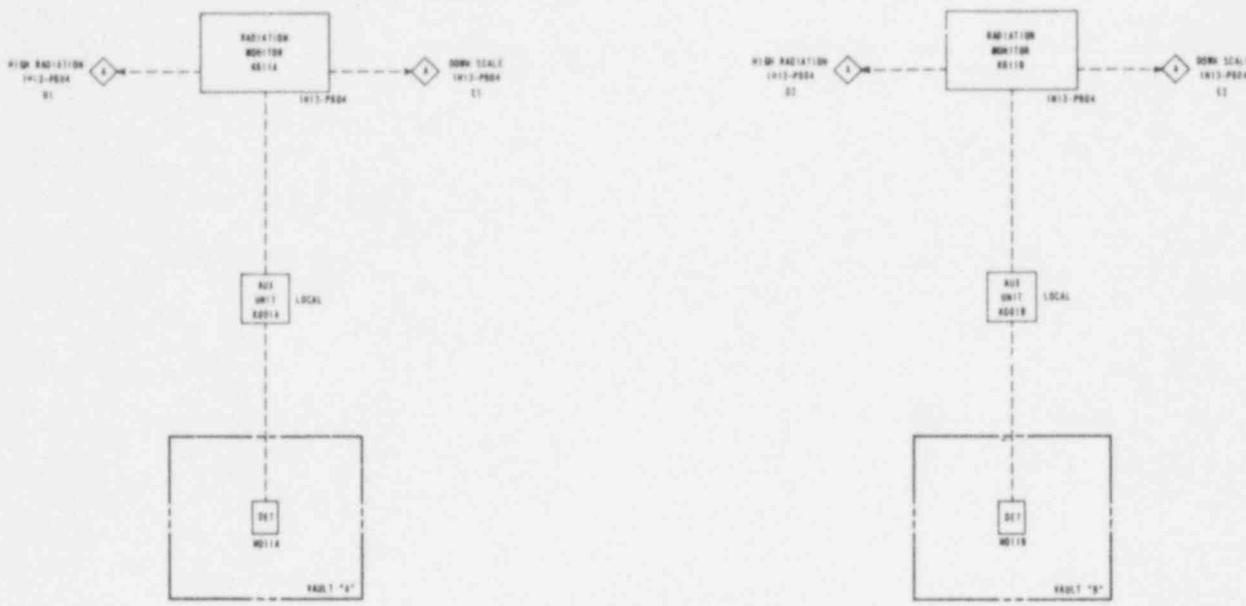




PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 11 of 12)
(GAI Dwg. D-806-024)



CARBON BED VAULT RADIATION MONITORING SUBSYSTEM

NOTES:-

1. ALL EQUIPMENT AND INSTRUMENT ARE PREFIXED BY SYSTEM NO. D17, UNLESS OTHERWISE SPECIFIED.

REFERENCES:-

D-911-201 OFF-GAS BUILDING

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Plant Radiation Monitoring

Figure 11.5-1 (Sheet 12 of 12)
(GAI Dwg. D-806-025)