NSP

MONTICELLO NUCLEAR GENERATING PLANT

Monticello, Minnesota

UNIT I

(USAEC DOCKET 50 - 263)

GASEOUS RADWASTE SYSTEM

MODIFICATION REPORT

REVISION C

OCTOBER 13, 1971

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA

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GASEOUS RADWASTE SYSTEM MODIFICATION REPORT

1.0 SUMMARY

This report describes a plant modification being undertaken by the Northern States Power Company at the Monticello Nuclear Generating Plant for the purpose of reducing the quantities of radioactive gaseous effluents released to the atmosphere at the plant site. The modification consists basically of the addition of equipment to increase the holdup time of the non-condensible gases removed by the main condenser air ejectors from 30 minutes to a minimum of 50 hours during normal plant operations.

The design objective of this modification is to reduce the plant bounda' radioactive dose rates due to airborne releases from the air ejectors to about one percent of the dose rates that would be experienced without the modification. It is estimated that the modification will reduce the average annual release rate from the air ejectors from a maximum of 0.270 Ci/sec to a maximum of 0.012 Ci/sec. The average annual doses from the air ejector releases at the worst off-site location following the modification are not expected to exceed 1.9 mrem/year whole body gamma and 0.5 mrem/year beta skin dose, including all noble gas, particulate, and halide sources. The total "fence post" doses from all gaseous releases from the plant, including the air ejectors, are not expected to exceed
C 4.5 mrem/year whole body gamma and 1.3 mrem/year beta skin dose, following this modification. These dose values are small when compared to the natural background dose rates of about 100 mrem/year which existed at the site prior to construction of the plant. The dose values are also well within the recent AEC Guideline of 10 mrem/year.

Northern States Power Company will maintain and use the equipment described in this report in such a manner as to reduce the release of radioactive materials to the atmosphere to the lowest practicable levels. This, it is expected, will limit gaseous releases from the plant to even less than the above mentioned rates. At the same time, certain flexibility of operation is required compatible with consideration of health and safety to assure that the public is provided a dependable source of power, even under the unusual operating conditions which may temporarily result in releases higher than those described above, but still well within the limits specified in 10 CFR Part 20.

The proposed changes to the Technical Specifications which would be associated with this modification are contained in the attachment to this report.

2.0 INTRODUCTION

The gaseous radwaste system initially installed in the Monticello plant provides for disposal of potentially radioactive gases through the plant stack, with appropriate monitoring, dilution, and automatic shutoff facilities. There are normally three sources discharged to this stack: offgas from the main steam condenser air ejectors, offgas from the main steam turbine gland seal system, and dilution air from the turbine building ventilation system. During plant startup the condenser mechanical vacuum pump is also discharged to the stack, and during some operating conditions offgas from the HPCI turbine and the SGTS systems may be discharged to the stack, as described in the Final Safety Analysis Report, USAEC Docket 50-263. Very small quantities of radioactive gases may also be released with ventilation air from the non-contained portions of the plant, but these releases are monitored and controlled, and are rarely significant when compared to the stack releases.

Operating experience with plants similar to the Monticello plant design has shown that most of the radioactive gases discharged come from the main steam condenser air ejectors. These gases are currently delayed for a minimum of 30 minutes prior to their release at Monticello and at other similar plants. The radioactivity of these gases and the resultant boundary dose rates can be further reduced by retaining the gases for an additional period of time. This report describes modifications being undertaken voluntarily by Northern States Power Company at the Monticello Plant to retain the radioactive gases from the main steam condenser air ejectors for an additional period of time, so as to reduce the plant boundary doses to the lowest practicable levels.

3.0 DESIGN BASIS

The gaseous radwaste system initially installed in the Monticello plant was designed to collect, process, store, monitor and dispose of radioactive gaseous wastes generated in the operation of the plant. The system was designed such that radioactive gases could be discharged without exceeding the annual environs radiation dose rate as set forth in 10 CFR 20.

The modified system as described herein is designed to further reduce the gaseous radioactivity release rates to the lowest practicable levels commensurate with the state of technology, the economics as they are related to the degree of public benefit, and the availability and reliability of the process and the equipment for timely incorporation into an operating power plant.

Four processes for krypton and xenon radioactivity reduction were considered for application to this modification: removal by cryogenic distillation, removal by fluorocarbon absorption, selective retention by charcoal adsorption, and total gas retention by compressed storage. The first two of these processes were eliminated from further consideration for incorporation into an operating plant based on the state of those technologies, or more specifically, on the absence of operating experience with the proposed equipment in radioactive service of this nature. The two remaining processes for retention of radioactive gases were judged essentially identical with regard to environmental effects, based on dose-
C equivalent retention times, with both processes capable of effectively decaying all of the noble gas isotopes except Krypton 85.

The length of compressed storage time required was determined by computation of the potential annual average, routine whole body gamma dose at the nearest plant boundary. The computation was based on the Technical Specification limit of 0.27 Ci/sec at the air ejectors, measured after 30-minute sample decay. The result of this computation, which is for a diffusion mixture, is shown graphically in Figure 1.

This evaluation revealed that by modification of the air ejector offgas system to obtain a minimum equivalent of 50 hours holdup, the typical whole body gamma dose would be less than 1% of the typical dose from the air ejector prior to such a modification. This dose would be about 0.002 Rem/year and should occur only if and when the following events occurred simultaneously:

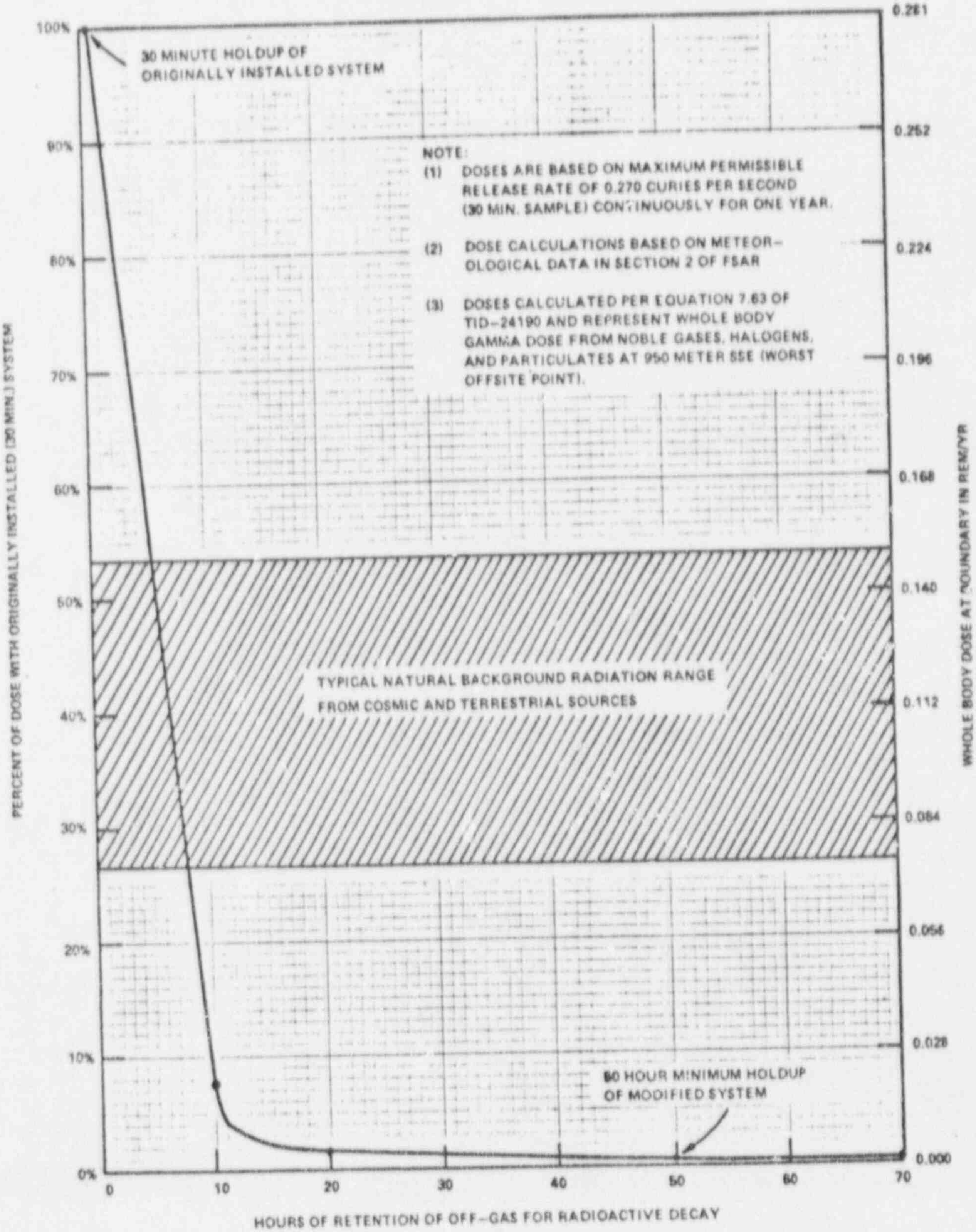
- Maximum fuel clad failure condition at which the plant could be operated sustained for one year.
- Continuous presence of the dose recipient at the nearest plant boundary for one year.

It was noted that under these extreme conditions the dose received from the air ejector release would constitute only about 2% of the total dose from natural sources.

Based on the foregoing considerations, a minimum retention time of 50 hours was selected as a design basis for a compressed storage modification of the air ejector offgas system. For a charcoal adsorption modification, the design basis was a system operating at near ambient pressure and temperature with 30-35 tons of activated charcoal, as this yielded an equivalent dose reduction. Modification of the systems handling offgases from sources other than the air ejectors was concluded to be unnecessary because of the relatively low dose rate contributions from these sources when compared to the air ejector offgas releases or to natural background levels.

FIGURE 1

EFFECT OF MONTICELLO OFF-GAS SYSTEM MODIFICATION ON RADIATION DOSE CONTRIBUTION AT PLANT BOUNDARY FROM PLANT AIR EJECTORS



Both the charcoal and compressed storage processes were found to require hydrogen-oxygen recombination to eliminate combustion hazards and to reduce component sizes to the most economical ranges. In the final analysis, the compressed gas storage process was selected, based on the following additional considerations:

- Gas storage is a passive process involving methods and equipment which represent a highly developed state-of-the-art.

- Performance of a compressed gas retention process for radioactive decay can be accurately predicted for all conceivable operating conditions and is not subject to significant variation due to component configuration or leakage characteristics, nor is it subject to deterioration with use.

- Design information, performance characteristics, and component reliability data were all freely available from U.S. manufacturers for gas storage system components.

- Positive segregation of the offgas in separate tanks in a passive state permits any short-term releases of higher-than-normal radioactivity levels to be selectively decayed for longer periods of time, without unavailability of generating capacity.

- Positive segregation of the offgas in separate tanks provides an opportunity, under abnormal operating conditions, for more complete analyses of the gases prior to their release.

- The compressed gas storage process is the least subject to possible degradation from gaseous contaminants that could be present in the air leaked into the condenser.

- The compressed gas storage system could be designed and installed in less time than was required for the other processes.

The design objective for the modification is a reduction of the maximum air ejector offgas release rate from 0.27 Ci/sec to 0.012 Ci/sec, with a resulting reduction of the boundary dose rate from the air ejectors to less than 0.002 Rem/year. These rates are based on air ejector discharge rate of 0.27 Ci/sec (30 minute sample decay) with a condenser in-leakage rate of 28 scfm.

4.0 SYSTEM MODIFICATION DESCRIPTION

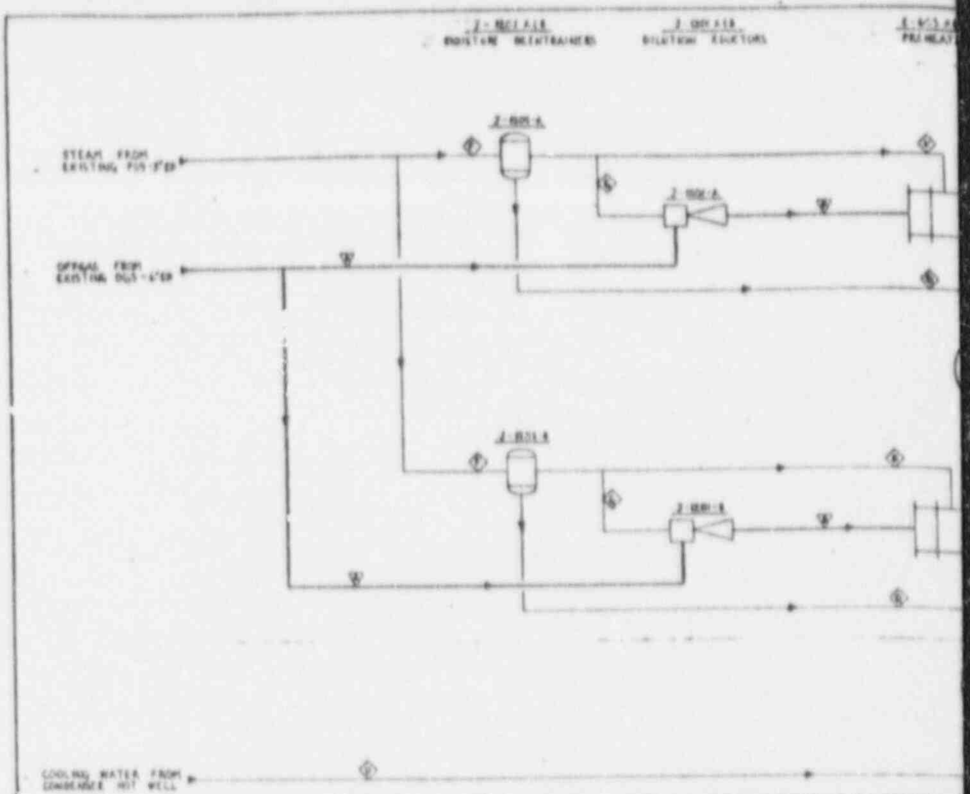
4.1 Summary

The modification to the originally installed offgas system consists of a hydrogen dilution and recombiner sub-system added in the 6" offgas line from the condenser air ejectors immediately upstream of the 30 minute holdup pipe, and a gas compressor and storage tank sub-system added at the outlet to the holdup pipe. Drawings NF-51133, 4, 5 are P&ID of this modification. The originally installed system, as depicted in the FSAR Figure 9-3-1, P&ID Offgas System, will be otherwise unchanged except for the electrical signal to the emergency shut-off valves in the offgas line to the stack, which is discussed below.

4.2 Hydrogen Dilution and Recombiner Sub-System

This sub-system consists of two parallel flow paths for hydrogen dilution and recombination, each capable of operating independently of the other and each capable of handling the condenser combined offgas and vapor startup design flow rate of 1600 lb/hr and the normal design flow rate of 361 lb/hr (166 cfm at 130°F). The major components of each flow path are a steam jet eductor, a preheater, a hydrogen-oxygen recombiner, and a desuperheating condenser. Pertinent design and operating parameters for the sub-system are given in Drawing NF-51131.

The steam jet eductor is designed to dilute the hydrogen content of the mixture to a value below the flammable limit. The preheater downstream of the eductor is used to assure that the vapor entering the recombiner is slightly superheated for effective operation of the recombiner, which is a ceramic catalyst type.



POINT	SERVICE	'A' TRAIN - NORMAL OPERATION PSIA	°F	LB/HR/TRAIN AIR	H2O	N2	O2	TOTAL	VOLUME % H2	'B' TRAIN - STANDBY PSIA	°F	LB/HR/TRAIN AIR	H2O	N2	O2	TOTAL	ST… PSIA	°F	AIR
A	— OFFGAS TO EDUCTOR	14.6	130	115	63	21	165	362	45.8	—	—	—	—	—	—	—	15.0	140	1414
B	— DILUTED OFFGAS	14.6	340	115	6469	21	165	6768	2.8	14.2	500	—	8000	—	—	8000	15.0	342	1414
C	— PREHEATED OFFGAS	13.5	373	115	6465	21	165	6766	2.8	13.5	430	—	8000	—	—	8000	16.0	293	1414
D	— RECOMBINED OFFGAS	15.0	750	109	6653	—	—	6762	—	15.0	430	—	8000	—	—	8000	11.0	658	1440
E	— RESIDUAL OFFGAS	12.5	170	109	62	—	—	171	—	12.5	170	—	—	—	—	—	15.0	190	1440
F	— SUPPLY STEAM	315	422	—	6839	—	—	6839	—	315	422	—	8088	—	—	8088	90	320	—
G	— DILUTION STEAM	50	338	—	6400	—	—	6400	—	50	338	—	8000	—	—	8000	50	290	—
H	— PREHEATER STEAM	315	422	—	340	—	—	340	—	315	422	—	56	—	—	56	90	320	—
I	— 'B' TRAIN COND. COOLANT-IN	—	—	—	—	—	—	—	—	460	92	—	440,000	—	—	440,000	—	—	—
J	— 'B' TRAIN COND. COOLANT-OUT	—	—	—	—	—	—	—	—	450	93	—	440,000	—	—	440,000	—	—	—
K	— 'A' TRAIN COND. COOLANT-IN	445	93	—	440,000	—	—	440,000	—	—	—	—	—	—	—	—	445	92	—
L	— 'A' TRAIN COND. COOLANT-OUT	435	111	—	440,000	—	—	440,000	—	—	—	—	—	—	—	—	435	104	—
M	— VAPORS FROM FLASH TANK	6.0	183	—	88	—	—	88	—	6.0	183	—	48	—	—	48	6.0	183	—
N	— CONDENSER - CONDENSATE	12.5	204	—	6591	—	—	6591	—	12.5	206	—	8000	—	—	1000	170	215	—
O	— PREHEATER CONDENSATE	315	422	—	240	—	—	240	—	315	422	—	56	—	—	56	90	320	—
P	— LIQUID FROM FLASH TANK	6.0	183	—	6749	—	—	6749	—	6.0	183	—	[illegible]	—	—	1040	6.0	183	—
R	— STEAM TRAP DRAINAGE	8.0	295	—	199	—	—	199	—	8.0	295	—	32	—	—	32	8.0	260	—
[illegible]	— DRAIN COOLER DISCHARGE	8.0	100	—	6749	—	—	6749	—	6.0	130	—	1040	—	—	1040	6.0	100	—
S	— DRAIN COOLER COOLANT-IN	460	92	—	30,295	—	—	30,295	—	460	92	—	30,295	—	—	30,295	460	92	—
T	— DRAIN COOLER COOLANT-OUT	450	111	—	30,295	—	—	30,295	—	450	95	—	30,295	—	—	30,295	450	108	—
U	— COOLANT SUPPLY (COMMON)	465	92	—	520,590	—	—	520,590	—	COMMON WITH LINE A							465	92	—
V	— COOLANT RETURN (COMMON)	450	110	—	520,590	—	—	520,590	—	SEE AT LEFT							450	105	—

SI
APERTURE
CARD

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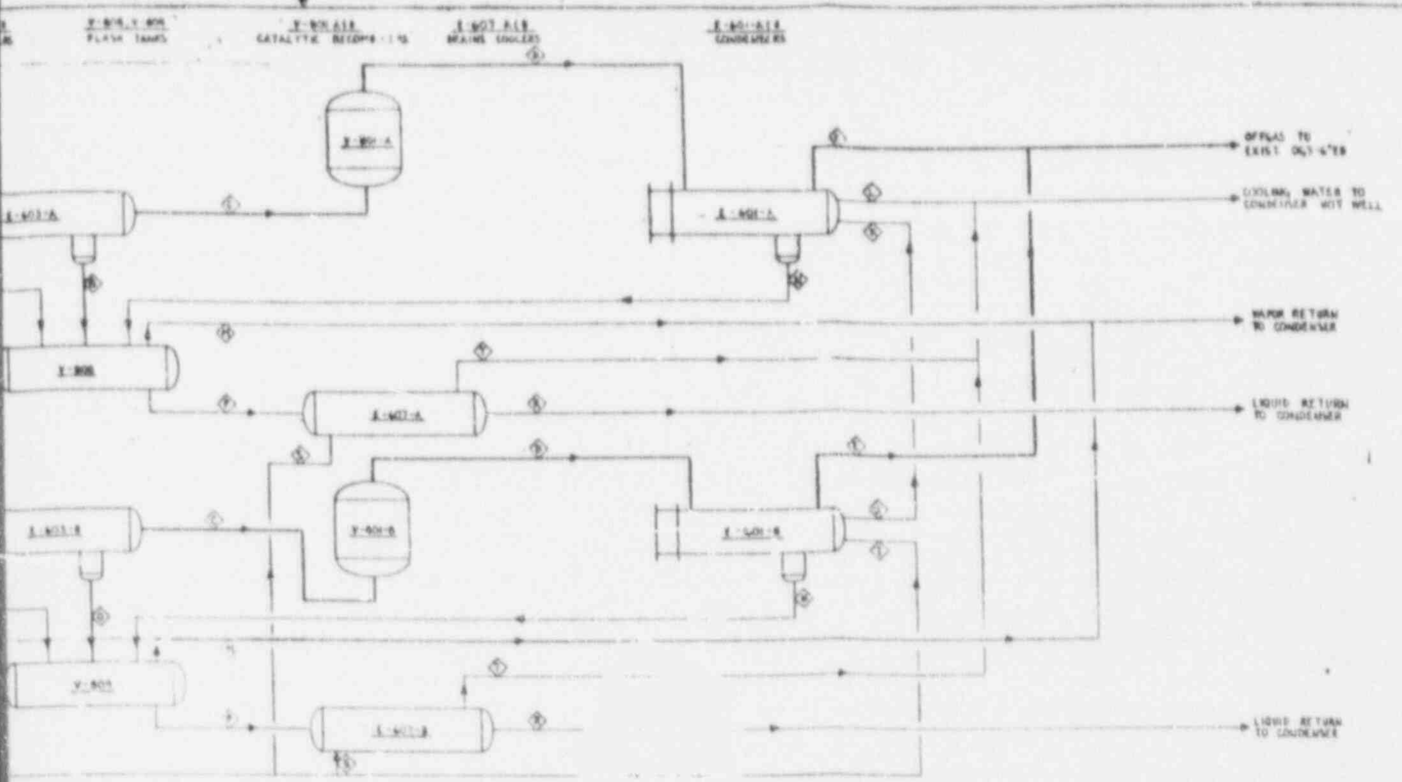

…RT - UP

	H_2	O_2	TOTAL	VOLUME % H_2
…3	21	165	7783	14.2
…3	21	165	7883	3.4
…83	21	165	7883	3.4
…73	—	—	7883	0
…83	—	—	7993	0
…85	—	—	6385	—
…00	—	—	6400	—
…99	—	—	99	—
—	—	—	—	—
—	—	—	—	—
…,000	—	—	460,000	—
…,000	—	—	460,000	—
…59	—	—	359	—
…90	—	—	3,990	—
…96	—	—	46	—
…16	—	—	5916	—
…86	—	—	186	—
…16	—	—	5916	—
…295	—	—	30,295	—
…295	—	—	30,295	—
…590	—	—	560,590	—
…2	—	—	560,590	—

PREPARED BY
SUNTAC NUCLEAR CORPORATION
1000 WALNUT STREET
PHILADELPHIA PENNSYLVANIA 19103

MONTICELLO NUCLEAR GEN. PLANT - MONTICELLO, MINN.
OFF GAS MODIFICATION
MATERIAL BALANCE TABLE
AND PROCESS FLOW DIAGRAM

NORTHERN STATES POWER COMPANY
ENGINEERING DEPARTMENT
MINNEAPOLIS

NF-51131 B

NF-51131-B

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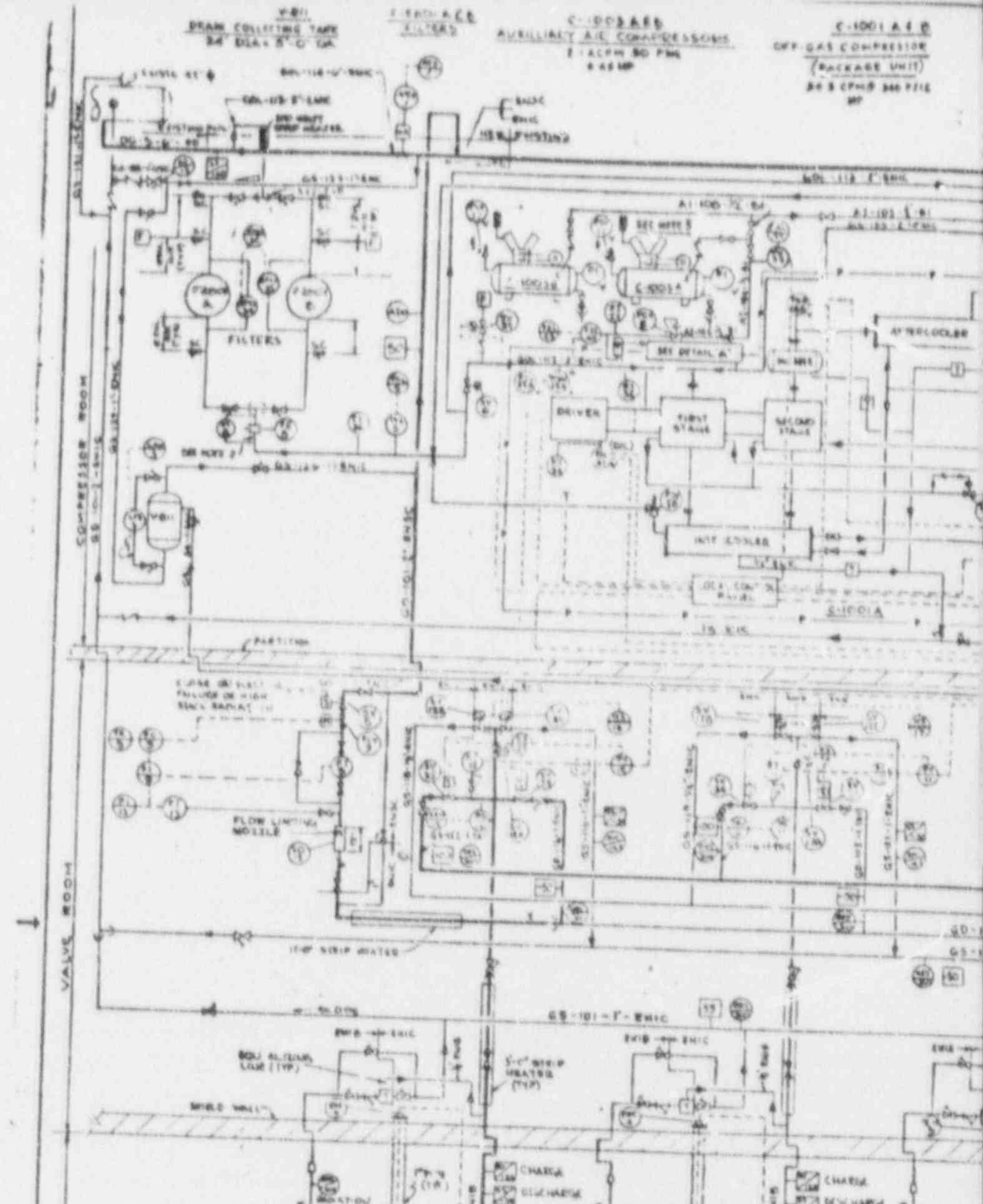

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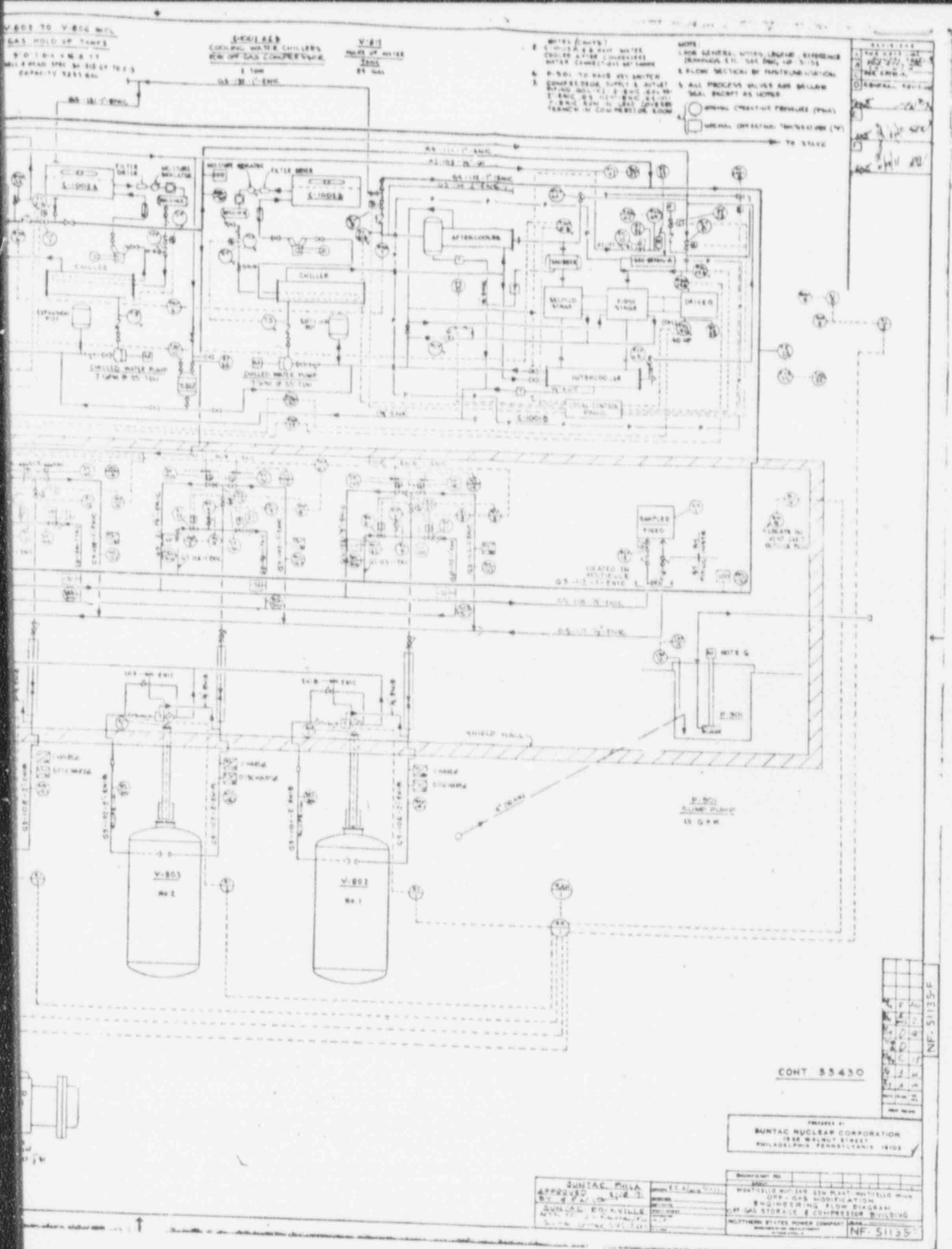

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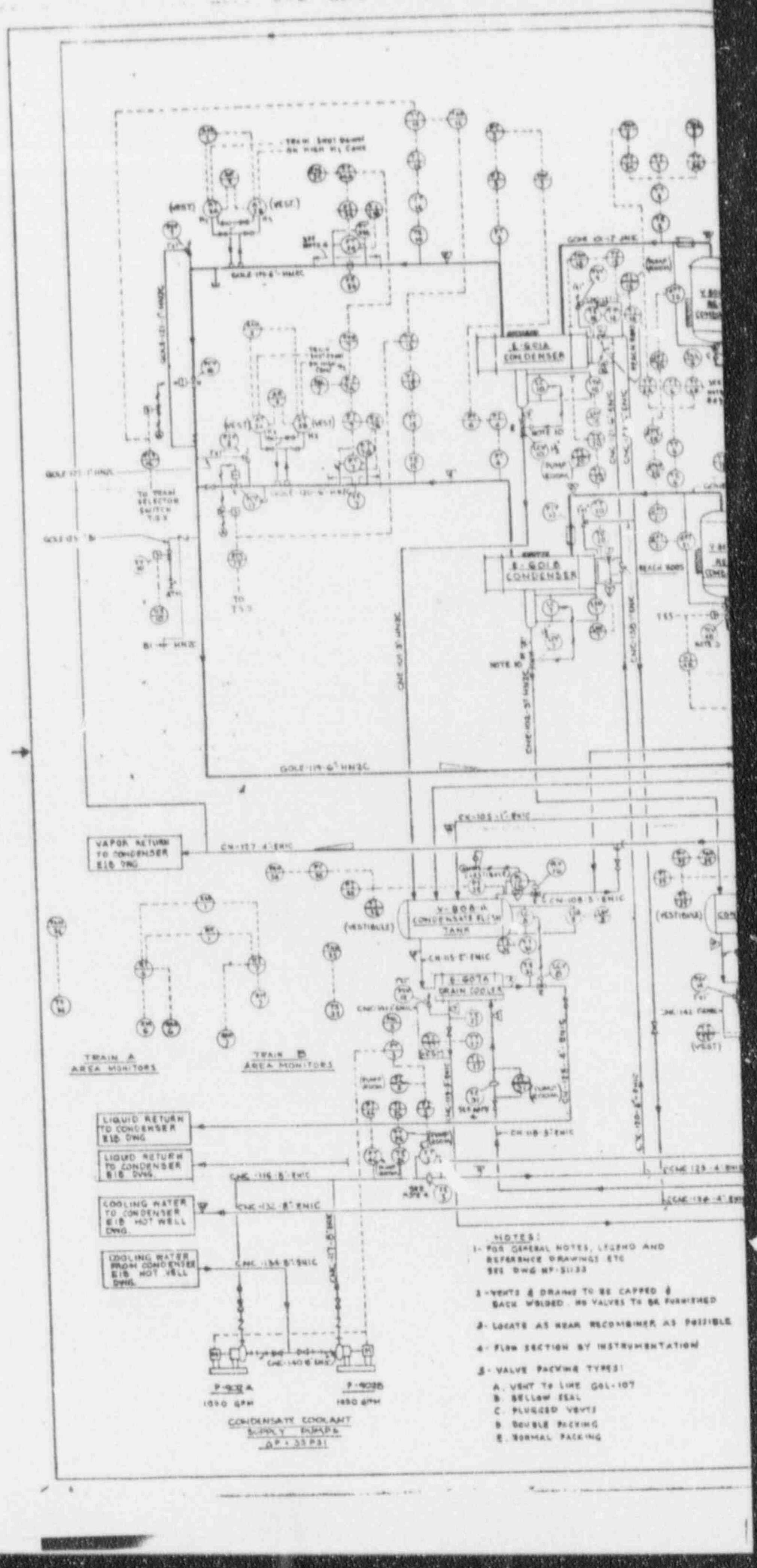

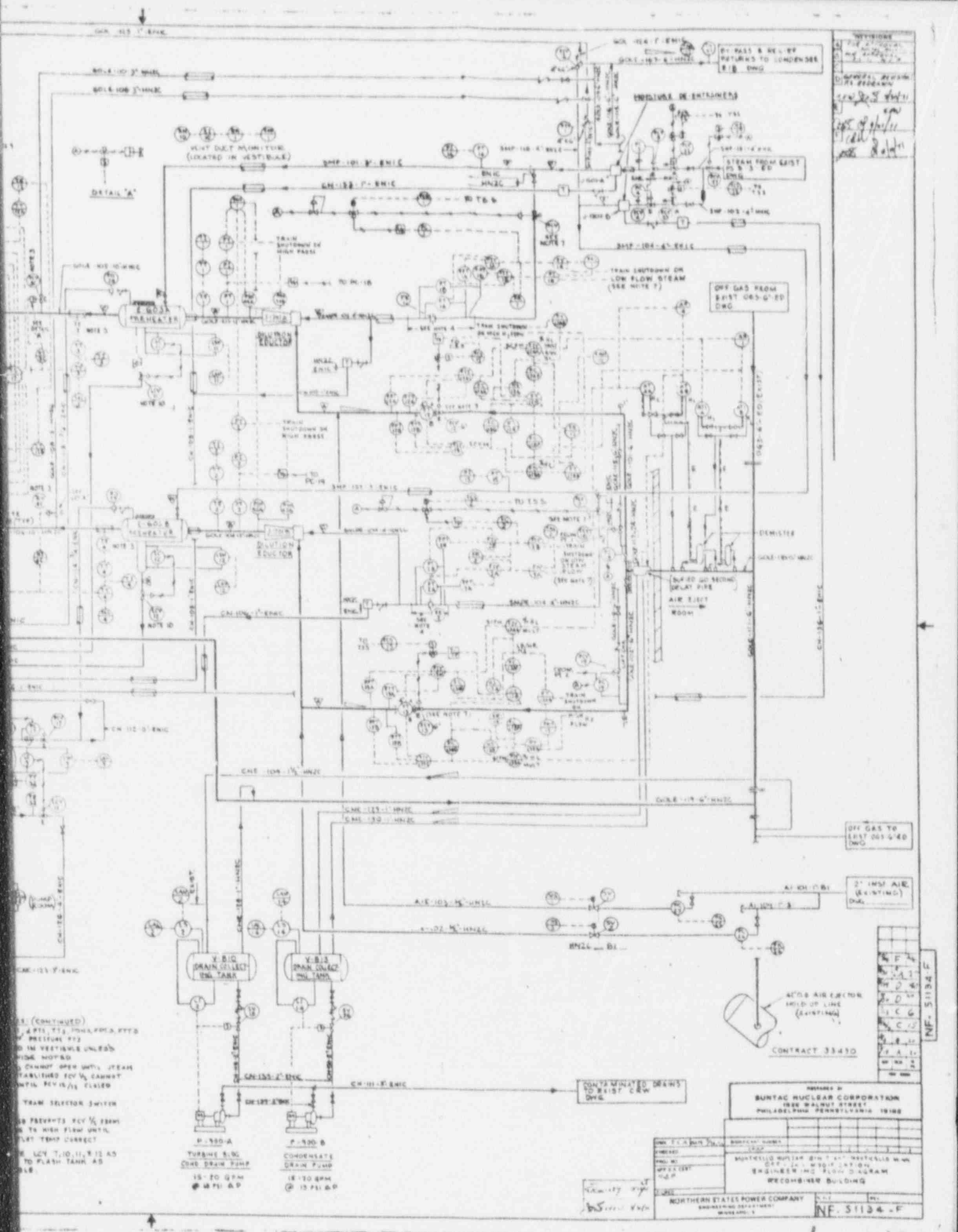

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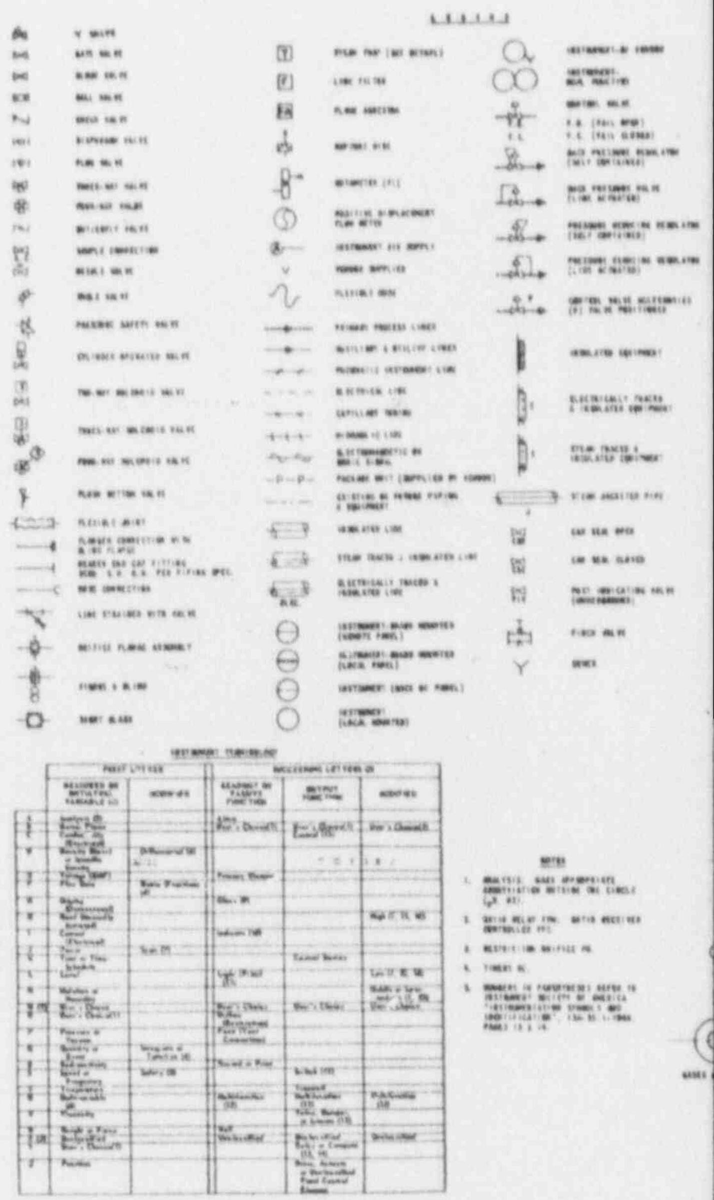

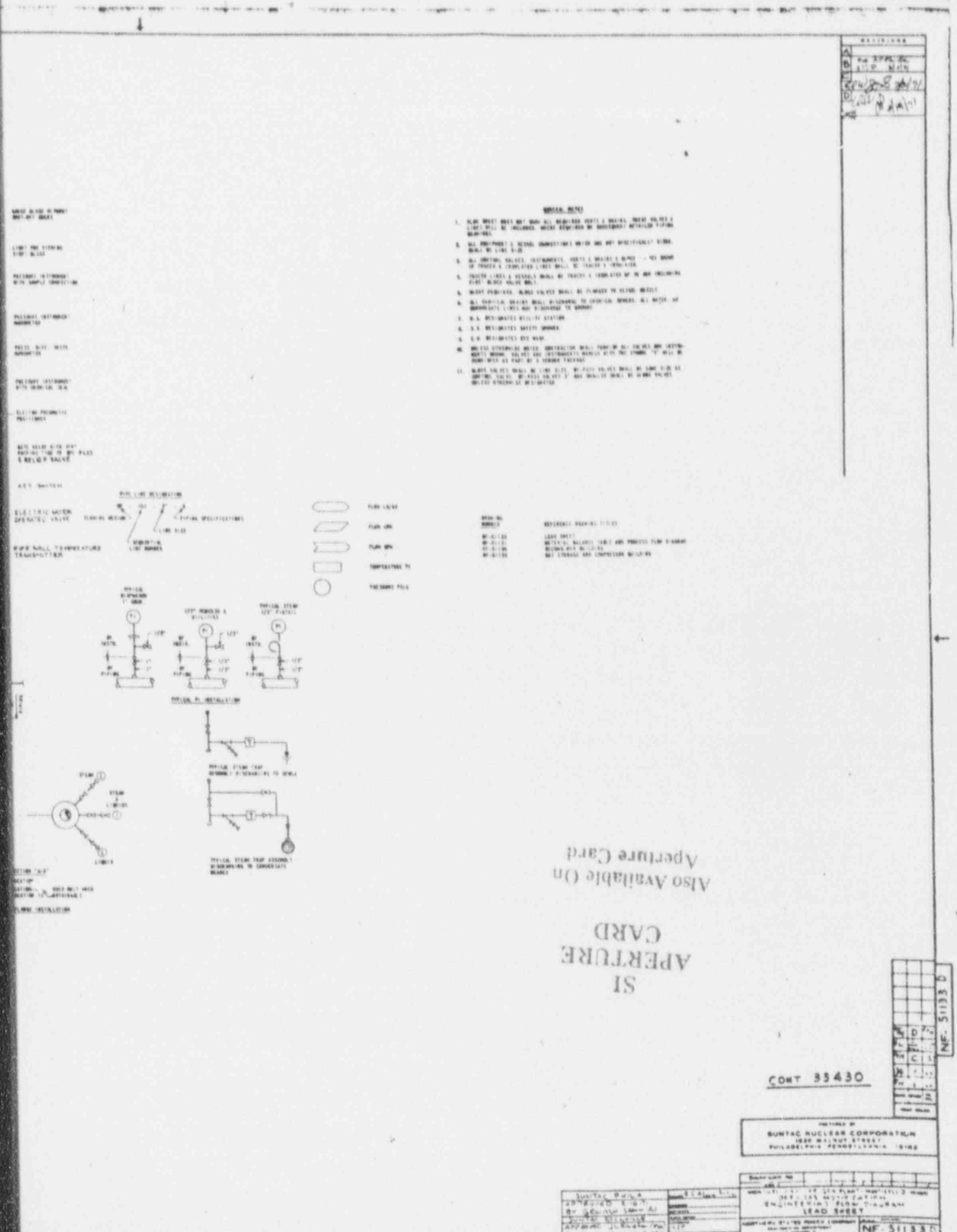

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The desuperheating condenser is designed to remove the heat of recombination and to condense the diluent vapor from the stream. The condensers discharge the offgas into the originally installed underground holdup pipe. This entire sub-system will be operated at sub-atmospheric pressures to prevent out-leakage of radioactive gases.

4.3 Gas Compressor and Storage Tank Sub-System

This sub-system consists of two parallel gas compressors and five parallel gas storage tanks, with sampling facilities and a controlled rate discharge station. The gas compressors are multi-stage piston-type with zero out-leakage provisions. Each compressor is capable of handling the system normal operating design flow rate, and one compressor is normally maintained in standby. The five tanks are located in a building located near the plant stack. All normally pressured valves are either hermetically sealed or capped to reduce leakage. The compressors are rated over 30 scfm each at 300 psig discharge pressure. The tanks are designed for 350 psig at 480°F.

Redundant HEPA filters and charcoal iodine traps are provided in the compressor suction header. Special filter elements are also provided for the offgas HEPA filters located in the stack, which include charcoal iodine traps.

4.4 Instrumentation and Control

Each recombiner train is equipped with sufficient remote instrumentation and control equipment to permit remote operation from the reactor control room. Alarms are provided to alert the control room operator to any abnormal condition in the recombiner train, as indicated on the P&ID. The offgas will

be automatically diverted back to the main steam condenser if the inlet superheat is insufficient. The train will be automatically shut down if the hydrogen mass flow rate to the recombiner exceeds 21 lb/hr, if the diluent steam flow rate drops below 6100 lb/hr, if the hydrogen content at the train outlet exceeds 2% by dry volume, of if the train static pressure exceeds 20 psia. If the radioactivity level of the offgas at the air ejector exceeds the Technical Specification limit, the recombiner train offgas inlet valves will be closed.

The gas compressors may be operated in parallel or with either unit in standby. They automatically maintain the pressure in the 30 minute pipe between 10 and 12 psia during normal operation. A signal is received in the reactor control room when the pressure of the storage tank being filled approaches 300 psig, and the operator remotely diverts the flow to another tank. Alarms are sounded in the control room for high and low compressor suction pressure and high discharge pressure or temperature.

Each gas storage tank is remotely monitored for pressure and radioactivity level. Interlocks are provided to prevent simultaneous filling and discharge of any one tank. Tank discharge rate is remotely set from the reactor control room and automatically controlled and recorded.

The previously installed radiation monitors in the air ejector offgas header will be reconnected to close the recombiner train inlet valves. The stack monitors will be reconnected to close the stack isolation valves, the gas storage tank discharge header valve (to prevent blowing the loop seals), and to sound an alarm in the reactor control room. If the Technical Specification release rate limits are exceeded at either the air ejector or the stack, the associated isolation will occur automatically. Alarms will sound in the control room when the high alarm settings are reached by these monitors.

Area radiation monitors will be provided in the new buildings and continuous air monitors will also be installed in the ventilation discharge ducts from these buildings. All radiation monitors will have both local and remote (reactor control room) alarms.

4.5 Arrangement, Structures, and Ventilation

The recombiner trains will be located in a new building situated near the air ejector room. The building will be divided by a shield wall so that one train can be maintained while the other is operating. The offgas will be brought from the air ejector room and returned there after recombination for entry into the existing 30 minute pipe. Ventilation from the building will be designed to maintain the recombiner building at a slightly negative pressure and will discharge into the condenser space of the turbine building. Doors to the recombiner building will be kept locked except during maintenance operations or plant outages.

The outlet from the underground holdup pipe is diverted to a new gas storage building located near the base of the stack. There are four rooms in the building: the storage tank room is separated from the valve room by a radiation shield wall and the compressor room is shielded from the valve room and the filter room. Each compressor is locally shielded to permit access to the adjacent compressor for maintenance. The tank storage room will be accessible only by removal of a concrete roof slab. Ventilation from the building will be designed to maintain the storage building at slightly negative pressure. Air will be directed from the compressor room, to the valve room, and then to the tank room. Ventialtion air will be discharged to the plant stack.

C

4.6 Codes and Standards

All pressure vessels, heat exchangers, pumps, valves, and piping (except the compressors and the storage tanks) which are normally part of the off-gas flow path will be designed, fabricated, and installed per July 1971 ASME Code Section III, Class 3. The compressors and storage tanks were purchased prior to July 1971. The tanks were purchased per the 1968 ASME Code Section III, Class C with addenda. Compressors were purchased with USAS B-31.7 Class III piping and ASME Code Section VIII pressure containing vessels with 100 percent radiography per paragraph UW-2a.

The recombiner building is designed for Class I seismic conditions, 939.2 feet above MSL flood conditions, and tornado wind loads and missiles. The piping and components added in this sub-system which will normally contain offgas mixtures are designed for Class I seismic conditions and to withstand a hydrogen detonation without breach of system integrity. Supporting systems handling radioactive fluids will meet July 1971 ASME Code Section III, Class 3 requirements. Supporting non-radioactive systems design will conform to the codes and standards of the systems of which they are a part.

The offgas storage building is designed for Class I seismic conditions, 939.2 feet above MSL flood conditions and for tornado wind loads and missiles. The piping and components associated with the offgas storage tanks which are not normally isolated nor remotely isolable from the tanks will be per July 1971 ASME Code Section III, Class 2 and will be designed for Class I seismic conditions. Isolable piping will be per July 1971 ASME Code Section III, Class 3.

Quality control will be consistent with that required by the codes and with that employed for previously installed portions of the same systems. The prime contractor for system design is Suntac Nuclear Corporation, 1528 Walnut Street, Philadelphia, Pennsylvania.

5.0 SYSTEM OPERATION

During normal operation, the hydrogen dilution and recombiner sub-system will receive noncondensible offgases from the main condenser air ejectors at a maximum design flow rate of 146 scfm per train and at slightly sub-atmospheric pressure. A steam jet eductor will immediately dilute the off-gas with about 6500 lb/hr of steam. The eductor will exhaust the gas-vapor mixture at near saturation temperature and about 14 psia, with a hydrogen concentration of less than 4% by volume. The vapor will be heated to about 50 F degrees superheat in the preheater and delivered to a recombiner. The recombiner will reduce the dry hydrogen content to a nominal 0.1% (maximum 2%), while heating the mixture to a maximum temperature of $850^{\circ}F$. This mixture will then enter a condenser where the majority of the vapor will be removed, leaving a maximum design gas flow of about 28 scfm at 12.5 psia and $200^{\circ}F$. The other dilution and recombiner train will be in hot standby condition with reduced steam flow.

Should main condenser in-leakage decrease to less than 5 scfm, instrument air will be bled manually into the offgas stream upstream of the recombiners to assure a sufficient supply of oxygen for complete recombination and to prevent excessive concentration of the radioactive gases following recombination.

The 28 scfm offgas flow will then enter the previously installed 30 minute holdup pipe, but due to the decreased design flow resulting from H_2-O_2 recombination, the pipe holdup time will be increased to about 2 hours (about 5 hours with condenser air in-leakage at 10 scfm). Following this holdup, the offgas is compressed to 300 psig by the operating compressor and delivered to one of the five 1250 ft^3 holdup tanks.

Under design operating conditions, each tank will undergo a minimum charging period of 12 hours (5 to 285 psig) followed by 36 hours of dead storage, and will then be released with approximately 12 hours of discharge time. This yields a minimum mean holdup time of 48 hours in the tanks, plus over two hours in the holdup pipe. This holdup time will be increased to about 140 and 280 hours for condenser in-leakage rates of 10 and 5 scfm, respectively.

Under actual operating conditions, the tank with the lowest activity will be discharged, and the discharge flow rate will be selected to be only slightly greater than the rate of offgas flow after recombination. The discharge will be initiated from the reactor control room by opening the appropriate tank discharge solenoid valve, followed by remote adjustment of the motor-operated throttle valve to achieve the desired discharge flow rate. A flow limiting nozzle limits the maximum discharge flow rate to about 150 scfm in the event of reducing valve failure. The charging solenoid valves are also opened from the reactor control room, following a signal indicating that the previous tank is fully charged. Interlocks prevent simultaneous opening of both the charging and discharge valve on the same tank or discharge of a tank with less than 12 hours of decay time. Discharge flow can be terminated from the reactor control room by closing the tank solenoid valve or by tripping the motor operated throttle valve.

Startup of the modified offgas system from cold conditions requires local operator action. The main steam condenser is evacuated to 5"-10" Hg absolute with the mechanical vacuum pump. As soon as reactor steam is available, the piping and components upstream of the recombiners are heated by diverting the diluent steam back to the main condensers. Cooling water (main condensate) flow is then established to the recombiner

condensers and drain coolers, and the recombiner bypasses are closed and flow is established through both recombiner trains. The compressor and storage tank bypass valve at the outlet to the 30-minute holdup pipe is opened directly to the stack filters and the stack. The main condenser steam jet air ejectors are then brought on the line and the suction lines to the eductors are opened. The main steam condenser vacuum is then pulled down to the operating level and as soon as the offgas flow drops to within compressor capacity at the recombiner outlet, the bypass around the compressors and storage tanks is closed and both compressors are started. The reactor power can then be increased to significant levels. The recombiner system should reach normal operating vacuum in less than one hour after the bypass valve is closed. There is no opportunity for out-leakage past the bypass valve to the stack during reactor power operation because of the sub-atmospheric pressure in the 30 minute holdup pipe, which will be achieved in less time than would be required for flow of radioactive gases through the holdup pipe following closure of the bypass valve.

Bypass of the compressors and storage tanks will not be permitted until the 30 minute delay pipe has been purged with at least one volume of air and a sample taken at the compressor outlet header and shown to contain less than 0.010 Ci/ft^3. This is to prevent the gases remaining in the 30 minute pipe from being pushed out by the air ejector startup (initial discharge rate of about 400 scfm) at a release rate in excess of 0.27 Ci/sec. Failure to observe this procedural limitation would result in closure of the stack isolation valves by the stack radiation monitoring system if the limits of the Technical Specifications were exceeded.

Offgas sampling will be performed at the air ejectors in accordance with the Technical Specifications. The quantities of the isotopes released will be recorded based on the average storage time of each tank and the most recent isotopic analysis.

6.0 SYSTEM PERFORMANCE

The modified offgas system is designed to provide holdup of the offgas from the condenser air ejectors for between 50 and 280 hours, depending upon the quantity of condenser air in-leakage experienced. Figure 1 shows the site boundary dose reduction as a function of holdup time. The quantities of activation gases released from the modified system are insufficient to affect total release rates or the boundary dose rates.

Based on an offgas release rate at the air ejector discharge which would produce the Technical Specification limit of 0.27 Ci/sec after 30 minute delay with a diffusion mixture, the estimated annual average activity discharged to the stack will be 0.012 Ci/sec at the maximum condenser air in-leakage of 28 scfm. The estimated gaseous nuclide release rates prior to the stack filters are presented in Table I-A for both the originally installed and the modified offgas systems. The stack release rates of particulates with half lives in excess of eight days and halogens of interest from Table I-A are presented in Table I-B. Iodine release rates are based on a reactor coolant to offgas distribution factor of 2×10^{4}, plus 90% each removal in the charcoal traps located at the compressor suction and at the stack. Particulate release rates are based on 90% plateout in the buried pipe, plus 99% each removal in the compressor and stack HEPA filters.

Northern States Power Company will maintain and use the equipment described in this report in such a manner as to reduce the release of radioactive materials to the atmosphere to the lowest practicable levels. This, it is expected, will limit gaseous releases from the plant air ejectors to even less than the above mentioned rates. At the same time, certain flexibility of operation is required compatible with consideration of health and safety to assure that the public is provided a dependable source

of power, even under the unusual operating conditions which may temporarily result in higher than those described above, but still within the limits specified in 10 CFR Part 20.

TABLE I-A

ACTIVITY TO THE OFF-GAS SYSTEM

Isotope	Activity - μCi/sec No Decay	30 Min Decay	50 Hr Decay
Noble Gases			
Kr-83m	8.15×10^3	6.76×10^3	6.60×10^{-5}
Kr-85m	1.69×10^4	1.56×10^4	6.40
Kr-85	2.01×10^1	2.01×10^1	2.02×10^1
Kr-87	5.49×10^4	4.17×10^4	7.20×10^{-8}
Kr-88	5.23×10^4	4.62×10^4	2.21×10^{-1}
Kr-89	4.77×10^5	7.19×10^2	---
Kr-90	1.23×10^6	---	---
Kr-91	1.64×10^6	---	---
Kr-92	2.19×10^6	---	---
Kr-93	1.32×10^6	---	---
Kr-94	8.13×10^5	---	---
Xe-131m	4.03×10^1	4.02×10^1	3.56×10^1
Xe-133m	5.03×10^2	4.99×10^2	2.65×10^2
Xe-133	1.35×10^4	1.34×10^4	1.03×10^4
Xe-135m	8.53×10^4	2.24×10^4	---
Xe-135	4.85×10^4	4.84×10^4	1.18×10^3
Xe-137	5.49×10^5	2.65×10^3	---
Xe-138	2.44×10^5	7.16×10^4	---
Xe-139	1.04×10^6	---	---
Xe-140	1.33×10^6	---	---
Xe-141	1.46×10^6	---	---
Xe-143	2.72×10^5	---	---

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TABLE I-A
(continued)

ACTIVITY TO THE OFF-GAS SYSTEM

Isotope	Activity - μCi/sec No Decay	30 Min Decay	50 Hr Decay
Activation Gases			
N-16	7.0×10^{7}	---	---
N-17	1.14×10^{3}	---	---
N-13	8.1×10^{3}	1.0×10^{3}	---
O-19	4.2×10^{5}	---	---
A-41	2.8	2.3	1.7×10^{-8}
H-3 Note (1)	5.0×10^{-5}	5.0×10^{-5}	5.0×10^{-5}
Halogens	Note (2)	Note (2)	Note (3)
I-131	7.8×10^{-1}	7.8×10^{-1}	6.5×10^{-2}
I-132	4.6	3.9	1.1×10^{-7}
I-133	4.6	4.5	9.3×10^{-2}
I-134	6	4.1	---
I-135	6	5.2	4×10^{-3}
I-136	6×10^{-1}	2.2×10^{-2}	---
I-137	4.6×10^{-1}	---	---
I-138	1.8×10^{-1}	---	---
Br-83	5.5×10^{-1}	4.6×10^{-1}	3×10^{-9}
Br-84	7×10^{-1}	3.7×10^{-1}	---
Br-85	4.2×10^{-1}	4.2×10^{-4}	---
Br-87	4.2×10^{-1}	5.3×10^{-12}	---
Br-88	2.3×10^{-1}	---	---

Notes:

(1) Based on amount of water vapor in 28 scfm of off-gas 55°F (anticipated delay pipe exit temperature) and a tritium concentration of 1.3×10^{-2} μCi/ml.

(2) Based on iodine concentration in reactor coolant from Table I-B corresponding to a stack discharge rate of 0.27 Ci/sec after 30 minute decay and a reactor coolant to off-gas distribution factor of 2×10^{4} for halogens.

(3) Based on a 90% removal of halogens in the off-gas air compressor charcoal filter.

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TABLE I-B

COMPARISON OF ANNUAL AVERAGE CONCENTRATIONS AND AEC GUIDELINES HALOGENS AND PARTICULATES WITH $T_{\frac{1}{2}} > 8$ DAYS

Isotope	Estimated Release Rate µc/sec (1)(2)	Annual Average Concentration-950M µc/cc	AEC Guideline 10 CFR 20/100,000 µc/cc
I-131	1.3×10^{-2}	5.7×10^{-16}	1×10^{-15}
I-132	2.3×10^{-8}	1.0×10^{-21}	4×10^{-15}
I-133	1.86×10^{-2}	8.1×10^{-16}	4×10^{-15}
I-135	8.04×10^{-4}	3.5×10^{-17}	1×10^{-14}
Br-83	6.05×10^{-9}	2.6×10^{-22}	1×10^{-15}
Cs-137	7.8×10^{-6}	3.4×10^{-19}	5×10^{-15}
Sr-89	5.2×10^{-4}	2.3×10^{-17}	3×10^{-15}
Sr-90	4.6×10^{-7}	2×10^{-20}	3×10^{-16}
Y-91	3×10^{-5}	1.3×10^{-18}	1×10^{-14}
Ba-140	1.7×10^{-4}	7.4×10^{-18}	1×10^{-14}
Ce-141	9.8×10^{-6}	4.3×10^{-19}	5×10^{-14}
Pr-143	1.4×10^{-6}	6.1×10^{-20}	6×10^{-14}

(1) Halogen release rates include 90% removal of halogens in the charcoal filter in the offgas stack; source term 50 hour decay estimate from Table I-A.

(2) Particulate release rates include 90% plateout in 30 minute delay pipe, 99% removal in the compressor suction HEPA filters, and further 99% removal in the stack HEPA filters.

7.0 SAFETY ANALYSES

7.1 Accident Analysis

The maximum release to the environs from the modified offgas system would result if all five storage tanks were assumed to undergo simultaneous discharge at ground level immediately after being filled to capacity with the plant operating at the Technical Specification annual average activity limit (0.270 Ci/sec after 30 minute sample decay) at the condenser air ejectors and with maximum condenser air in-leakage (28 scfm). The calculated whole body (beta and gamma) dose at the nearest boundary for such a release occurring instantaneously is 0.45 rem, but if the release is assumed to occur more slowly so there is no diffusion due to the energy release, the dose rises to 0.86 rem. If release of the particulates is considered, these doses are increased to about 0.76 and 1.5 rem, respectively. If the halides are not assumed to be effectively removed by the recombiners, the thyroid doses for the instantaneous and slow release of the tank contents are 0.017 and
C 0.032 rem, respectively. These results are summarized in Table II.

The calculated dose is based on a tank fill time of 15.7 hours (0 to 300 psig) with 28 scfm air in-leakage at the condenser and complete recombination of the radiolytic hydrogen. This dose was found to be higher than that resulting from longer holdup time (lower condenser in-leakage), because of the greater dose contribution from the shorter lived isotopes. Release was assumed to occur immediately after filling the fifth tank, with credit taken for decay in the previously installed holdup pipe, for decay during the filling operation, and for dead storage time in the first four tanks.

Doses were computed using finite cloud dimensions, Class F stability, one meter per second wind speed, 500 meter distance to site boundary, and no credit for storage building wake factor. The tank activities were based on the data presented in Table I-A.

C

TABLE II

ESTIMATED DOSES FROM OFF-GAS SYSTEM ACCIDENTS

	Whole Body Noble Gas Dose	Whole Body Particulate Gas Dose	Thyroid Dose
Case 1 - Rapid depressurization of five tanks that results in an initial cloud of finite size and a virtual source correction. $X/Q = 1.13 \times 10^{-3}$ sec/m^3	0.45 rem	0.31 rem	1.7×10^{-2} rem
Case 2 - Slow release of five tanks contents giving a point release with no source correction. $X/Q = 2.12 \times 10^{-3}$ sec/m^3	0.88 rem	0.58 rem	3.2×10^{-2} rem

7.2 Hydrogen Handling

The possibility of a hydrogen explosion throughout the proposed system is considered incredible because the proposed control and instrumentation system has been designed to prevent an explosive mixture of hydrogen from propagating beyond the recombiner system; i.e. an explosive mixture of hydrogen will never exist in the large, 30 minute decay pipe or the storage tanks.

This is accomplished by providing fully redundant hydrogen analyzers on the outlet from the recombiner system that initiate recombiner system shutdown and terminate all offgas flow if the hydrogen concentration at the system outlet exceeds 2% by volume (the hydrogen flammability limit is 4% by volume and the detonation limit is ~15% by volume). These sensor and shutdown systems are designed with sufficient redundant equipment so that no one undetected fault will render the systems inoperable, and the systems will be periodically tested to confirm continued operability. During an automatic shutdown, three main stream process valves close to isolate the recombiner system. Additionally, the recombiner bed temperatures and recombiner outlet temperature provide insight into recombiner performance to insure that flammable hydrogen mixtures do not get beyond the recombiner.

Should a number of unlikely events occur, it would be hypothetically possible for a hydrogen explosion to occur in the recombiner system and this system has been designed to withstand an explosion. Such an explosion within the recombiner system could result in an airborne shock wave propagating into the large, 30 minute decay pipe. There would not be an explosion in the decay pipe, and the shock wave from the recombiner system would be attenuated to about 1/10 of its initial value by the effects of expansion into the large, 30 minute (5000 ft^3) decay pipe and subsequent

C propagation through the filters. The compressor suction has been designed to withstand this attenuated shock wave, and it would shield the storage tanks from any effects whatsoever.

7.3 Shielding

The storage room of the new waste gas storage building will not be accessible when any of the tanks are pressurized. The shield wall between the storage room and the compressor room will be designed to maintain less than 5.0 mrem/hr within two feet of the compressor room side of the wall. The building will be partially underground with sufficient shielding or area access restriction to assure personnel protection.

The new recombiner building will be designed to limit radiation levels on contact with outside walls to a maximum of 2 mrem/hr. An inside shield wall between the trains will permit limited occupancy for maintenance of one train while the other train is operating.

PROPOSED CHANGES

TO

TECHNICAL SPECIFICATIONS

Attachment

to

Gaseous Radwaste System

Modification Report

Monticello Nuclear Generating Plant
Unit No. 1

Northern States Power Company
Minneapolis, Minnesota

3.0 LIMITING CONDITIONS FOR OPERATION	4.0 SURVEILLANCE REQUIREMENTS

B. Emergency Core Cooling Subsystems Actuation

When irradiated fuel is in the reactor vessel and the reactor water temperature is above 212°F, the limiting conditions for operation for the instrumentation which initiates the emergency core cooling subsystems are given in Table 3.2.2.

C. Control Rod Block Actuation

The limiting conditions of operation for the instrumentation that initiates control rod block are given in Table 3.2.3.

A-1

D. Off-Gas System

At least one stack radiation monitor shall be operating at any time off-gas is being discharged from the plant from sources other than the ventilation system. The trip settings for the stack monitors shall be set at a value not to exceed the instantaneous value associated with the 15-minute release limit specified in Specification 3.8.1.

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A-1

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3.0 LIMITING CONDITIONS FOR OPERATION	4.0 SURVEILLANCE REQUIREMENTS
D. Off-Gas System (con't) Both off-gas radiation monitors in the common discharge line from the condenser air ejectors shall be operable or operating during power operations. The trip settings for the monitors shall be set at a value not to exceed the 15 minute release limit specified in Specification 3.8.A.1. The time delay setting for closure of the off-gas inlet valves to the recombiner subsystem shall not exceed 15 minutes.	

A-2

Table 4.2.1 - Continued

Minimum Test and Calibration Frequency For Core Cooling
Rod Block and Isolation Instrumentation

A-3

Instrument Channel	Test (3)	Calibration (3)	Sensor Check (3)
3. Steam Line Low Pressure	Note 1	Once/3 months	None
4. Steam Line High Radiation	Once/week (5)	Note 6	Once/shift
<u>HPCI ISOLATION</u>			
1. Steam Line High Flow	Note 1	Once/3 months	None
2. Steam Line High Temperature	Note 1	Once/3 months	None
<u>RCIC ISOLATION</u>			
1. Steam Line High Flow	Note 1	Once/3 months	None
2. Steam Line High Temperature	Note 1	Once/3 months	None
<u>REACTOR BUILDING VENTILIATION</u>			
1. Radiation Monitors (Plenum)	Note 1	Once/3 months	Once/shift
2. Radiation Monitors (Refueling Floor)	Note 1	Once/3 months	(4)
<u>OFF GAS ISOLATION</u>			
1. Radiation Monitors	Notes (1,5,6)	Once/3 months	Once/shift

<u>Notes:</u>

(1) Initially once per month until exposure hours (M as defined on Figures 4.1.1) is 2.0×10^5, thereafter according to Figure 4.1.1, with an interval not greater than three months.

Bases Continued:

3.2 For effective emergency core cooling for the small pipe break the HPCI or Automatic Pressure Relief system must function since for these breaks, reactor pressure does not decrease rapidly enough to allow either core spray or LPCI to operate in time. The arrangement of the tripping contacts is such as to provide this function when necessary and minimize spurious operation. The trip settings given in the specification are adequate to assure the above criteria is met. Reference Section 6.2.4 and 6.2.6 FSAR. The specification preserves the effectiveness of the system during periods of maintenance, testing, or calibration, and also minimizes the risk of inadvertent operation; i.e., only one instrument channel out of service.

Two air ejector offgas monitors are provided and when their trip point is reached the flow to the recombiners is terminated, resulting in subsequent reactor scram due to loss of condenser vacuum. This precludes operation of the plant at offgas rates in excess of plant design. Two stack monitors are provided and when their trip point is reached, discharge of offgas to the stack is terminated. This precludes discharges in excess of the limits of Specification 3.8 due to high flow rates from the offgas storage system or from the 30-minute pipe when the storage system is bypassed. In both locations, isolation is initiated on two high trips, two low trips, or one high and one low trip.

A-4

Four radiation monitors are provided which initiate isolation of the reactor building and operation of the standby gas treatment system. The monitors are located in the reactor building and ventilation plenum and on the refueling floor. Any one upscale trip will cause the desired action. Trip settings of 26 mr/hr for the monitors in the ventilation duct are based upon initiating normal ventilation isolation and standby gas treatment system operation so as not to exceed a dose rate of five percent of the dose rate allowed by 10 CFR 20 at the most restrictive site boundary. Trip settings of 100 mr/hr for the monitors on the refueling floor are based upon initiating normal ventilation isolation and standby gas treatment system operation so that none of the activity released during the refueling accident leaves the reactor building via the normal ventilation stack but that all the activity is processed by the standby gas treatment system.

Although the operator will set the set points within the trip settings specified on Tables 3.2.1, 3.2.2, 3.2.3, and 3.2.4, the actual values of the various set points can differ appraciably from the value the operator is attempting to set. The deviations could be caused by inherent instrument error, operator setting error, drift of the set point, etc. Therefore, these deviations have been accounted for in the various transient analyses and the actual trip settings may vary by the following amounts.

4.2 Continued:

4.2 The most likely case would be to stipulate that one channel be bypassed, tested, and restored, and then immediately following the second channel be bypassed, tested, and restored. This is shown by Curve No. 4. Note that there is no true minimum. The curve does have a definite knee and very little reduction in system unavailability is achieved by testing at a shorter interval than computed by the equation for a single channel.

The best test procedure of all those examined is to perfectly stagger the tests. That is, if the test interval is four months, test one or the other channel every two months. This is shown in Curve No. 5. The difference between Cases 4 and 5 is negligible. There may be other arguments, however, that more strongly support the perfectly staggered tests, including reductions in human error.

The conclusions to be drawn are these:

1. A 1 out of n system may be treated the same as a single channel in terms of choosing a test interval; and
2. More than one channel should not be bypassed for testing at any one time.

A-5

The radiation monitors in the ventilation plenum and on the refueling floor which initiate building isolation and standby gas treatment operation are arranged in two 1 out of 2 logic systems. The bases given above for the rod blocks applies here also and were used to arrive at the functional testing frequency.

The air ejector and stack offgas radiation monitor channel logic is so arranged that a closure of the off-gas line or the stack isolation valves, respectively, is initiated by two upscale, two downscale, or one upscale and one downscale trip signals. Based on experience at other nuclear power plants with instruments of similar design, a testing interval of once every three months has been found to be adequate. However, for additional margin a test interval of once per month will be used initially until a trend is established and thereafter according to Figure 4.1.1 (see Section 3.1/4.1) with an interval not greater than three months.

The automatic pressure relief instrumentation can be considered to be a 1 out of 2 logic system and the discussion above also applies.

3.0 LIMITING CONDITIONS FOR OPERATION	4.0 SURVEILLANCE REQUIREMENTS

1. The annual average release rates of gross beta-gamma activity, except halogens and particulates with half lives longer than eight days, shall not exceed:
   Average Annual Rate (Q in curies/sec):

$$\frac{Q1}{0.27} + \frac{QRS}{0.021} \leq 1$$

   Any one fiften minute period per hour (Q in curies/sec):

$$\frac{Q1}{2.7} + \frac{QRS}{0.21} \leq 1$$

   In addition to the above limits, the effluent rate at the air ejector monitors, except halogens and particulates with half lives longer than eight days, shall not exceed an annual average rate of 0.27 Ci/sec or an instantaneous rate of 2.7 Ci/sec for more than 15 minute per hour, based on 30 minute sample decay.

A-6

1. Station records of gross stack release rate of gaseous activity shall be maintained on an hourly basis to assure that the specified rates are not being exceeded, and to yield information concerning general integrity of the fuel cladding. Records of isotopic analysis shall be maintained. The off-gas stack and reactor building monitoring systems shall be functionally tested and calibrated in accordance with Specification 4.2, Table 4.2.1.

   Within one month of initial commercial serv[illegible] of the unit, an isotopic analysis will be made of the gaseous activity release rate. From this sample a ratio of long-lived and short-lived activity will be established. Weekly samples of off-gas will be taken and gross ratio of long-lived and short-lived activity determined. When the weekly samples indicate a change of greater than 20% from the previous isotopic analysis, a new isotopic analysis will be performed. An isotopic analysis of off-gas will be performed at least quarterly. Gaseous release of tritium shall be calculated on a monthly basis from measured data.

Release of noble gas radioisotopes will be calculated from the isotopic samples taken at the air ejectors, based on the recorded decay times prior to release of the gas to the atmosphere.

The HEPA and charcoal filters located in the suction lines to the offgas compressors and in the offgas stack shall be surveyed whenever a filter is changed, whenever work is performed that could affect the filter system efficiency, and at intervals not to exceed six months; it shall be demonstrated that:

(1) For a new filter or following work that could affect the filter efficiency, the removal efficiency is not less than 99% for particulate matter larger than 0.3 micron based on a DOP test, or not less than 99% for freon based on a freon test.

(2) For a filter in service, the removal efficiency is not less than 99% for particulate matter in the offgas stream, based on cross-filter samples removing particles of ≤ 0.3 micron size and larger or DOP test; or 99% for iodine present in the offgas or for freon based on a freon test.

A-7

3.0 LIMITING CONDITIONS FOR OPERATION	4.0 SURVEILLANCE REQUIREMENTS
3. Two independent samples of each tank shall be taken and analyzéd for gross beta-gamma activity and the valve line-up checked prior to discharge of liquid effluents.	3. The performance and results of independent samples and valve checks shall be logged.
4. If the limits of 3.8.C cannot be met, radioactive liquid effluents shall not be released.	
D. Radioactive Waste Storage	D. Radioactive Waste Storage
The maximum amount of radioactivity in liquid storage in the Waste Sample Tanks, Floor Drain Sample Tanks, Waste Surge Tanks and the Condensate storage tanks shall not exceed 2 curies. If this condition cannot be met, the liquids in these tanks shall be recycled to tanks within the radwaste facility until the specification is met.	(1) A sample from each of the Waste Sample, Floor Drain, Condensate Storage and Waste Surge Tanks shall be taken, analyzed and recorded every 72 hours. If no additions to one of the above tanks has occurred since the last sample, that tank need not be sampled until the next addition.
E. General	
The releases of radioactive material in all effluents will be kept at small fractions of the limits specified in 20.106 of 10 CFR Part 20. Radioactive effluents in gaseous releases will be maintained below the design objective of an annual average rate of	

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3.0 LIMITING CONDITIONS FOR OPERATION	4.0 SURVEILLANCE REQUIREMENTS
E. General (cont.)	E. General
12,100 μCi/sec, except during periods c abnormal or emergency operation of the plant when such releases may approach the limits of 3.8. At the same time the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power even under unusual operating conditions which may temporarily result.	Operating procedures shall be developed and used, and equipment which has been installed to maintain control over radioactive materials in gaseous and liquid effluents produced during normal reactor operations, including expected operational occurrences, shall be maintained and used, to keep levels of radioactive material in effluents released to unrestricted areas as low as practicable.

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(3) Percentage of the maximum annual limit released and MPC value.
(4) Results of all isotopic analyses and estimates total curies of each identified nuclide released.
(5) Such other information as may be required by the Commission to estimate maximum potential annual radiation doses to the public resulting from effluent releases.
(6) Specific information will be reported if quantities of radioactive materials released during the reporting period are significantly above design objectives.

g. Solid Radioactive Waste

(1) Total volume (in cubic feet) of solid waste generated.
(2) Gross curie activity involved.
(3) Dates and disposition of the materials if shipped off-site.

h. Environmental Monitoring

(1) A narrative summary, including correlation with effluent releases of the results of off-site environmental surveys performed during the report period.
(2) Tabulation of the results of the environmental monitoring program, including a figure showing location of the monitoring stations.
(3) For any Samples which indicate statistically significant levels of radioactivity above established background levels, a comparison with applicable 10 CFR 20 limits shall be provided.

E. Special Reports (in writing to the Director, Division of Reactor Licensing, USAEC, Washington D. C. 20545):

1. In the event a redundant component (or system) covered by these Technical Specifications is determined to be out of service for periods longer than those specified in other sections, it shall be the subject of a special maintenance report. This report shall be submitted within seven days of the above determination and shall describe:

a. The nature of the problem and the specific steps to be taken to remedy the situation

b. An estimate of the time required to return the component (or system) to an operable condition.