MOG-DR-2
REVISION D
DATE 10/13/71

MONTICELLO NUCLEAR GENERATING PLANT

OFFGAS SYSTEM MODIFICATION DESIGN REPORT

MOG-DR-2

OPERATING CONCEPTS

Prepared by

SUNTAC NUCLEAR CORPORATION
1528 Walnut Street
Philadelphia, Pennsylvania 19102

for

NORTHERN STATES POWER COMPANY
Minneapolis, Minnesota

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TABLE OF CONTENTS

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I. RECOMBINER SUBSYSTEM

A. Basic Operating Concepts

1. Hydrogen Dilution Control

The recombiner subsystem controls are designed to assure that hydrogen concentrations in excess of 4% by volume cannot reach the recombiner. This assures that the design temperature of the recombiner subsystem will not be exceeded and that a flame front cannot be propagated even if a high temperature should be encountered due to some unforeseen occurrence.

Diluent steam flow will be controlled at a constant rate sufficient to dilute the maximum design hydrogen flow rate of 21 lb/hr (76 cfm, $130^{\circ}F$, 1 atm.) to about 3% volume concentration. Although experience indicates that the actual flow rate of hydrogen will normally be considerably less than design, it can be hypothesized that hydrogen might be drawn into the recombiners at rates higher than the generation rate for short periods of time.

To accommodate these possible variations in offgas inlet conditions, the recombiner subsystem measures the total gas flow rate and the hydrogen concentration and computes the mass flow rate of hydrogen. If the mass flow rate of hydrogen exceeds the 21 lb/hr design rate, the offgas flow control valve at the train inlet will close sufficiently to limit the hydrogen mass flow to this amount. Such flow limitation would be of short duration (if it occurs at all) during power operations as it is not theoretically possible to generate radiolytic hydrogen at rates in excess of 21 lb/hr. Flow limitation is not expected during startup because of the high percentage of air in the offgas and the low hydrogen generation rates during startup.

Diluent steam is taken from the source supplying the air ejectors. The pressure is reduced to 300 psig in the recombiner building. The steam is added via an eductor nozzle so as to create a slight vacuum in the offgas line from the air ejector after-condensers and also to drop the pressure of the diluted mixture immediately to about 14 psia. The nominal flow of diluent steam is about 6300 lb/hr.

2. Preheat

The eductor outlet mixture will be near dry saturation conditions (210°F), but must be superheated at least to 260°F to assure that the recombiner catalyst will not be wetted, as this would inhibit the recombination process. Superheat is achieved by passing the offgas mixture through the tube side of a heat exchanger (preheater) with the same 300 psig steam supply that feeds the eductor on the shell side. Steam flow is automatically regulated by the rate of condensation. The preheater is designed to provide about 100°F of superheat under normal operating conditions.

3. Recombination

The superheated mixture enters the recombiner where catalytic action will cause the hydrogen and oxygen to combine to form water vapor. The heat of recombination will raise the temperature of the mixture to a maximum of about 800°F.

4. Vapor Removal

The mixture then enters a desuperheating condenser where the diluent and recombination vapors are removed, leaving only the air from condenser

in-leakage and the fission product and activation gases. This air and gas mixture will normally have a flow rate of less than 28 scfm. The gases are drawn into the previously installed 30 minute delay pipe which is normally maintained at 10-12 psia by the compressors in the compressed storage subsystem.

Primary condensate cools the desuperheating condenser by flowing through the tubes at a constant, preset rate. The condensed liquid is fed into a drain flash tank along with condensate from the preheater and various steam traps. A portion of the liquid flashes due to the lower pressure in the flash tank. The flashed steam is returned directly to the main turbine condenser. The liquid drains are cooled to near the saturation temperature of the condenser to prevent two phase flow and are returned to the main turbine condenser by a separate line. The drain cooler is also cooled by primary condensate. Liquid level is maintained in the condenser, preheater, and the flash tank by automatic level control systems employing pneumatically operated valves.

5. Low Temperature Diversion

A line is provided ahead of the recombiner to return steam directly back to the main turbine condenser during warmup of the sys' , or at any time that the superheat is less than about $50^{\circ}F$. This is accomplished with temperature sensors in the steam line and on the pipe wall which control automatic valves in the piping system as shown in the P&ID.

6. Offgas Air Supplementation

To protect the recombiner against inadequate oxygen for recombination during low condenser leakage or if the radiolytic oxygen should be partially scavenged, provision is made to manually add instrument air at a remotely

controllable rate upstream of the eductors. This will also guard against off-gas concentrations in excess of shielding design if the condenser air inleakage should drop below 5 scfm. An alarm alerts the operator whenever the offgas outlet flow from the desuperheating condenser drops below 5 scfm, so he can actuate the air supplement.

7. Buried Pipe Drainage System

Both the one minute delay pipe upstream of the recombiner subsystem and the buried delay pipe (previously installed) to the stack will normally be operated under slight vacuums, thus tanks have been installed in the air ejector room to collect the liquid drainage from these pipes. Small pumps located in the mechanical vacuum pump room will automatically pump these drains to the closed radwaste (CRW) system whenever the tanks become full.

8. Off-Gas Return to Main Condenser

A line is connected upstream of the inlet isolation valves in each recombiner train for the purpose of returning all or part of the off-gas from the steam jet air ejectors to the main condenser. The flow control valves in this return line are closed during normal reactor plant power operations. However, at any time that the compressed storage system is connected to the recombiner system (bypass valve to the stack is closed) and the off-gas flow from the steam jet air ejectors exceeds the available compressor capacity, these valves will open sufficiently to return the excess off-gas to the main condenser. This condition should occur only during plant startup or following a transient increase in main condenser pressure. These valves will also open whenever the back pressure on the steam jet air ejectors exceeds about 15.5 psia to preclude the possibility of reversing the air ejectors. Such pressures are expected only during some startup (condenser hogging) conditions or when both recombiner train off-gas inlet valves are closed

simultaneously, as may occur momentarily following automatic shutdown of one train, but prior to establishment of operation of the standby train.

B. Startup Operations

The recombiner subsystem must be operating before the steam jet air ejectors can be started. As soon as steam is available from the reactor at about 75 psig and condensate (cooling water) flow to the condensers and drain coolers has been established, a recombiner train master control switch can be switched to the "startup-standby" condition. This will open the recombiner diversion valve, open the steam supply valve to admit steam to the preheaters and about 1000 lb/hr of steam to the eductors, and also open the offgas outlet valve to the buried pipe. After the system has warmed up sufficiently to achieve 50°F superheat at the recombiner inlet (probably about 10 minutes), the diversion valve will close and the valve in the recombiner inlet will open automatically.

As soon as steam is available at sufficient pressure to achieve design flow to the eductors (this pressure will be established during initial system testing and is expected to be around 150 psig at the reactor), the master control switch can be set at the "full steam flow" position. When full steam flow has been achieved and at least 50°F of superheat is measured at the recombiner outlet, the master control switch can be set at the "operate" position. This will open the offgas inlet valve and establish a vacuum of about 12 psia on the SJAE after-condensers. The air ejectors can then be started. The second train can be brought on-line similarly after reactor pressure reaches about 300 psig to provide maximum combined capacity of about 800 scfm to handle startup offgas flow.

C. Normal Operation

During normal operations, the recombiner subsystem is totally automatic. All abnormal conditions are alarmed and annunciated. Corrective action for each alarm will be specified in the operating procedures. If corrective action is not taken, if it is not effective, or if conditions deteriorate too rapidly, automatic shutdown of the system will result. The conditions resulting in automatic shutdown and in alarms are listed below:

Automatic Shutdown Signals

- Inlet hydrogen flow greater than 21 lb/hr (concentration after dilution greater than 4% by volume) as computed from inlet H_2 concentration and inlet gas flow
- Diluent steam flow less than 6100 lb/hr
- Pressure at preheater inlet greater than maximum design operating pressure
- High offgas radiation level in air ejector offgas header (previously installed detector) (closes offgas inlet valves only)
- Outlet hydrogen concentration above 2% by volume (dry basis)

Alarm Signals

- Approach to any automatic shutdown parameter listed above
- Low temperature at recombiner inlet
- Recombiner outlet temperature below $450^{\circ}F$ and below $225^{\circ}F$
- Recombiner bed differential pressure above normal
- Condenser outlet pressure above 12.5 psia
- Offgas flow at condenser outlet less than 5 scfm or more than 28 scfm (dry basis)
- Recombiner outlet temperature above $800^{\circ}F$
- Condenser offgas outlet temperature above $200^{\circ}F$
- Condenser cooling water flow rate below normal
- Condenser cooling water outlet temperature above normal
- Airborne radiation level above normal
- Area radiation monitor level above normal
- Building ambient temperature above normal
- Drain flash tank pressure above 8 psia
- High liquid level in preheater hotwell
- High liquid level in condenser hotwell
- High liquid level in drain flash tank
- High liquid level in drain collecting tank for buried pipes
- High temperature in relief - bypass return line to main condenser

Should a recombiner train be automatically shut down, the other train will normally be in standby condition and available for operation. A sequence-of-events recorder will show the operator what caused the shutdown. Auto-matic shutdown will result in closure of the offgas inlet valve, the recombiner inlet valve, the offgas outlet valve, and after a short delay, the diluent and preheater steam supply valve and the recombiner bypass valve.

D. Manual Shutdown

During the process of shutting down the power plant, it is necessary to keep the SJAE's in operation as long as possible. It will, therefore, be necessary to keep at least one recombiner train in operation. This will cause no problem as long as the steam pressure is sufficient to provide about 7500 lb/hr of flow to the recombiner subsystem. If the system is not manually shut down by placing the master control switch in the "shutdown" position a low dilution steam flow alarm will sound when steam pressure becomes inadequate (probably around 120 psig). This will be followed by automatic shutdown when diluent steam flow drops to 6100 lb/hr. The air ejector offgas will then be automatically recycled back to the main turbine condenser if the air ejectors should still be in operational. If a train is to undergo maintenance while shut down, it can be purged using the instrument air supplement and over-riding the offgas outlet valve closure.

E. Failure Effects

The effects of various failure modes for the major recombiner system components are presented in Appendix A.

II. COMPRESSED STORAGE SUBSYSTEM

A. Normal Operation

The offgas compressors will automatically cycle on and off to maintain the buried delay pipe between 10 and 12 psia. A selector switch in the reactor control room permits the operator to select either or both compressors for operation.

Normally, one tank will be filled and one will be simultaneously emptied. Upon completion of filling of a tank, an audible signal and visual annunciation will alert the control room operator. He will switch the compressor discharge to an empty tank and then review the tank radiation monitors and select the tank with the lowest activity level for discharge. This tank will be remotely opened to the discharge flow control header. The operator will then refer to the offgas flow rate meter at the recombiner after-condenser outlet to determine the current offgas flow rate into the buried delay pipe. He will remotely set the tank discharge rate control valve to a flow rate about 10% higher, so that the tank will be empty, or nearly so, by the time the next tank is filled.

Other than for periodic sampling and blowdown of drain collecting tanks, the compressed storage system is remotely operable during normal power operations. Abnormal conditions will be alarmed in the control room as follows:

- High or low compressor suction header pressure
- High differential pressure across HEPA filter in compressor suction
- Low compressor sealing fluid pressure
- Abnormally high pressure for each tank
- Compressed storage bypass valve open
- High discharge rate at stack monitor

- Low ambient temperature in tank room
- High level in drain collecting tank
- High area radiation monitor reading in compressor room
- High airborne radiation monitor reading in ventilation exhaust

Automatic shutdown of the offgas compressors and alarms in the control room will accompany the following conditions:

- High compressor discharge temperature
- Low compressor oil pressure

Automatic cessation of storage tank discharge will result from the following condition:

- High-high discharge rate at stack monitor

B. Plant Startup and Shutdown

During plant startup the SJAE's can exhaust air from the main turbine condenser and into a recombiner subsystem at flow rates as high as about 400 scfm. This is considerably in excess of the compressor capacity and the compressed storage subsystem must be bypassed until flow drops within compressor capacity (about 90 scfm with both operating), except in cases where there is sufficient time to permit startup with condenser offgas flow rates within compressor capacity.

The compressed storage system bypass valve is key-locked in the closed position and a sign warns the operator that the buried pipe must be purged and sampled prior to opening the bypass valve. This is necessary because the concentrated (by recombination of diluent $H_2 + O_2$) offgas cannot necessarily be exhausted to the atmosphere at 400 scfm without exceeding radioactivity discharge rate limits, even though it may have decayed considerably during shutdown.

Purging of the buried delay pipe is accomplished by remotely opening a vacuum break valve in the inlet line to the pipe and starting the compressors (they will start automatically when the vacuum is broken). The pipe volume is about 5000 cubic feet, so about one hour is required to purge a single pipe volume with both compressors operating. A sample is then taken at the inlet to the storage tank and a computation made of the activity that would be released if the delay pipe contents were released at 400 scfm. If this is satisfactory, the vacuum break valve is closed and plant startup can begin. Otherwise, additional purging is required. Purging will normally be accomplished immediately following shutdown to prevent delaying startup. If the plant shutdown is of limited duration and condenser vacuum is not lost, bypass may not be required.

Should the key-locked bypass valve be opened without purging of the buried pipe and should the flow rates and the radioactivity of the offgas be above the normal levels accompanying discharge from the storage system, the stack radiation detection equipment will sound a high radioactivity release alarm in the control room. If the radioactivity release approaches the Technical Specification limits, the high-high radioactivity release alarm will sound and the shutoff valves in the stack will be closed automatically.

C. Offgas Sampling

Vial samples of offgas may be taken from the storage tanks, using equipment and procedures similar to those used for sampling at the SJAE discharge. Normally, however, samples of offgas will be taken at the SJAE discharge and the inventory of releases to the atmosphere will be computed based on the subsequent delay prior to release. Storage time and release rates will be recorded automatically.

D. Failure Effects

The effects of various failure modes for the major compressed storage system components are presented in Appendix A.

APPENDIX A

TO MOD-DR-2

FAILURE MODES AND EFFECTS FOR MAJOR COMPONENTS

TABLE OF CONTENTS

APPENDIX A

FAILURE MODES AND EFFECTS FOR MAJOR COMPONENTS

I. OFFGAS PRESSURE BOUNDARY BETWEEN AIR EJECTORS AND EDUCTORS

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Small crack or other small opening in pressure boundary. (Less than 1/2" diameter hole or equivalent.)

Failure Effect (1) - Due to subatmospheric pressure, leakage would be into the recombiner system and would be detected as abnormally high flow on FE-24 and as difference between FE-1250 less H_2 and O_2 and FE-24, provided inleakage was greater than about 5 scfm. Offgas holdup time would be reduced but flow rates should be within compressor capacity.

Failure Mode (2) - Large crack or opening in pressure boundary. (Hole diameter 1/2" - 1" or equivalent.)

Failure Effect (2) - Recombiner inlet header vacuum would be reduced. High flow would be alarmed at recombiner condenser outlet. Offgas compressor capacity would probably be exceeded and plant shutdown would be necessary after not less than ten minutes of inleakage.

B. Prefailure Condition - Reactor plant being started up with air ejectors discharging at rates greater than offgas system capacity.

Failure Mode - Crack or opening of any significant size in pressure boundary.

Failure Effect - Slight leakage of offgas to the buildings would occur due to 15.5 psia offgas pressure and would be detected by area or ventilation duct monitors. Reactor plant shutdown would probably be required.

II. OFFGAS PRESSURE BOUNDARY BETWEEN EDUCTORS AND AIR COMPRESSORS

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Small crack or other small opening in pressure boundary. (Less than 1/2" diameter or equivalent.)

Failure Effect (1) - Due to subatmospheric pressure, leakage would be into the recombiner system and would be detected as abnormally high flow on FE-24 if upstream of that indicator, or would be detected as decreased tank fill time. Plant shutdown would be required for repair only if leakage occurred in a non-redundant portion of the offgas system.

Failure Mode (2) - Large crack or opening in pressure boundary. (Hole diameter 1/2" - 1" diameter or equivalent.)

Failure Effect (2) - System vacuum would be lost and would be alarmed by pressure transmitter PT-3. Plant shutdown would be required after several minutes to prevent outleakage of offgas.

B. Prefailure Condition - Reactor plant being started up at low power level with compressor bypass valve HCV-1 open.

Failure Mode - Crack or opening of any significant size in pressure boundary.

Failure Effect - Leakage of offgas to the buildings would occur due to positive offgas pressure and would be detected by area or ventilation duct monitors. Plant shutdown would probably be required.

III. OFFGAS PRESSURE BOUNDARY BETWEEN COMPRESSOR AND TANK OR TANK AND OFFGAS STACK

A. Prefailure Condition - Reactor plant operating normally at full power or in startup mode.

Failure Mode - Crack or opening of any significant size in pressure boundary.

Failure Effect - Leakage of offgas to the buildings would occur due to positive offgas pressure and would be detected by area or ventilation duct monitors. Plant shutdown would not be required if that portion of the system could be isolated for repairs.

IV. STEAM JET AIR EJECTOR

A. Prefailure Condition - Main condenser steam jet air ejectors operating normally.

Failure Mode - Steam jet air ejectors cease to evacuate main condenser due to loss of motive steam or other malfunction.

Failure Effect - Temperature sensor TE-5 in recombiner outlet will alarm on low outlet temperature due to absence of hydrogen; recombiner condenser outlet offgas flow transmitter FT-24 will alarm on low flow; main condenser vacuum will be lost and reactor scram will result.

V. HYDROGEN ANALYZER AT-1A ON THE OFFGAS INLET LINE TO THE RECOMBINER TRAIN

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Hydrogen analyzer AT-1A fails in a manner causing it to indicate less hydrogen than is actually present in the offgas.

Failure Effect (1) - The electronic auctioneer circuitry designed to select the signal from the hydrogen analyzer with the highest reading will automatically read hydrogen analyzer AT-1B; recombiner system operation will continue normally.

Failure Mode (2) - Hydrogen analyzer AT-1A fails in a manner causing it to read hydrogen concentration higher than is actually present in the offgas header.

Failure Effect (2) - A stochiometric mixture of hydrogen and oxygen saturated with water vapor will contain less than 55% hydrogen by volume. If the hydrogen analyzer indicates 55% hydrogen concentration an alarm will sound; if the hydrogen analyzer indicates 60% hydrogen concentration or higher the recombiner train associated with that analyzer will automatically shut down. The alternate recombiner train will be started, if available.

VI. BYPASS VALVE PCV-18 (This valve bypasses steam jet air ejector offgas flows which are in excess of recombiner train capacity back to the main condenser.)

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Normally closed bypass valve PCV-18 fails to the open position.

Failure Effect (1) - Offgas will be drawn back into the main condenser through the bypass valve; pressure in the offgas header upstream of the dilution eductors will be decreased to near main condenser vacuum; dilution eductors will be unable to pump offgas against the vacuum, resulting in a low temperature alarm at the recombiner outlet and a low flow alarm at the recombiner; main condenser vacuum will decrease at a rate similar to that experienced with loss of the air ejectors, and may cause a reactor scram before corrective action can be taken. This condition can be alleviated by closing of the manual valve downstream of PCV-18, which has a reachrod extending into the normally accessible pump room located outside the shield envelope.

B. Prefailure Condition - Reactor plant operating with steam jet air ejector offgas flows in excess of recombiner train capacity.

Failure Mode - Bypass valve PCV-18 fails to open upon receipt of high pressure signal.

Failure Effect - Redundant valve PCV-19 opens and relieves pressure back to main condenser.

VII. INLET OFFGAS FLOW VALVE FCV-12

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Loss of control air to valve or false close signal to valve.

Failure Effect (1) - Valve FCV-12 will close, resulting in low temperature alarm at recombiner outlet and low flow alarm at recombiner condenser outlet. The only adverse effect of this action would be a loss of main condenser vacuum due to termination of offgas flow. The standby recombiner train would be started to prevent reactor scram due to loss of main condenser vacuum and to permit access to the faulty valve.

Failure Mode (2) - Valve FCV-12 sticks in the open position.

Failure Effect (2) - There would be no effect of non-operability of FCV-12 during normal full power operation because there is sufficient dilution steam to handle hydrogen flows of approximately 150% design values. Under transient power conditions, higher offgas flows would cause FT-12 to alarm, followed by train shutdown if hydrogen inlet to the recombiner reached 21 lbs/hr (very improbable). The standby recombiner train would be started.

VIII. STEAM DILUTION EDUCTOR J-1201A

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Recombiner dilution steam flow drops to less than 6100 lb/hr.

Failure Effect (1) - Redundant steam flow transmitters FT-1A and FT-1B will alarm at steam flow rates of approximately 6200 lb/hr and will cause automatic train shutdown at 6100 lb/hr. This will preclude hydrogen concentrations in excess of 4% from entering the recombiner; therefore, there will be no adverse effects. The standby recombiner train would be started.

Failure Mode (2) - Recombiner steam flow rate exceeds 6750 lb/hr.

Failure Effect (2) - Excessive dilution steam flows will result in higher pressure at the outlet to the dilution eductor and in higher cooling water discharge temperature at the recombiner condenser. Both of these abnormal conditions are alarmed. If corrective action is not taken, and steam flow continues to increase the train will be automatically shut down by pressure transmitter PT-1 or pressure switch PSH-44. There will be no other detrimental effects. The standby recombiner train would be started.

IX. RECOMBINER PREHEATER E-603A

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Loss of heating steam to the shell side of the preheater.

Failure Effect (1) - Redundant temperature elements TE-3 or TE-23 will sense reduction in preheat temperature and will alarm if the temperature drops to below 277°F. If corrective action is not taken and the temperature drops to below 257°F, which is 50° superheat during normal operation 35° superheat during startup operation, the recombiner inlet valve TCV-3B will automatically shut and the recombiner bypass valve TCV-3C will automatically open. This represents a safe condition for the recombiner train. The standby recombiner train would be started.

Failure Mode (2) - Leakage of steam from the shell side into the offgas (tube) side of the preheater.

Failure Effect (2) - Minor leakage of steam into the tube side of the preheater will augment the dilution steam and cause no significant problem in the system. Steam leakage rates of several hundred pounds per hour would result in overload of the recombiner condenser. Temperature element TE-18, located on the recombiner condenser cooling water outlet header, would alarm on high temperature. If corrective action were not taken, and the recombiner condenser capacity were exceeded due to excess steam flow, pressure transmitter PT-3

and temperature element TE-14 would alarm high pressure and temperature conditions in the offgas outlet header from the recombiner condenser. If corrective action again were not taken, the temperature sensor TE-14 would cause flow control valve FCV-16 in the recombiner condenser offgas header to close when the temperature reached approximately 212°F. This would immediately result in high pressure detected by pressure transmitter PT-1 or pressure switch PSH-44 at the dilution eductor outlet and subsequent safe shutdown of the recombiner train. The standby recombiner train would be started.

Failure Mode (3) - Preheater shell side liquid level control valve LCV-11 fails in the wide open position.

Failure Effect (3) - Preheater operation would not be directly effected, however, steam flow to condensate flash tank V-808 would exceed condensate flash tank handling capacity. This would result in abnormally high pressure in condensate flash tank V-808. Condensate flash tank pressure transmitter PT-38 would sense the abnormally high pressure and alarm. If corrective action were not taken, the higher pressure in the flash tank would prevent proper drainage of liquid from recombiner condenser E-601A after several minutes. This would interfere with proper condensing action in the condenser and result in the same series of alarms leading to train shutdown as were described in Failure Effect (2) above. The standby recombiner train would be started.

Failure Mode (4) - Preheater shell side liquid level control valve LCV-11 fails in the closed condition.

Failure Effect (4) - The preheater would slowly be filled with condensate. The failure effect leading to resulting safe shutdown would be similar to that described in Failure Effect (1) above wherein steam flow to the preheater were lost. The standby recombiner train would be started.

X. RECOMBINER INLET VALVE TCV-3B

A. Prefailure Condition - Reactor plant operating normally at any power condition or during startup.

Failure Mode (1) - Normally open valve TCV-3B fails to the closed position.

Failure Effect (1) - Closure of this valve without simultaneous shutoff of dilution steam will result in rapid pressurization of the offgas header downstream of the steam dilution eductor. Pressure transmitter PT-1 or pressure switch PSH-44 would alarm the abnormally high pressure and would cause the train to shut down normally when the pressure reached 20 psia. The standby recombiner train would be started.

Failure Mode (2) - Valve TCV-3B fails to close upon receipt of low preheat temperature signal.

Failure Effect (2) - A low preheat temperature alarm would have sounded prior to the shutdown signal to valve TCV-3B. Upon receipt of this alarm the operator would normally shut down that train. Failure of the operator to respond to this alarm could result in a slow deterioration of recombiner efficiency. This would result in an additional alarm from the redundant hydrogen analyzers on the recombiner condenser outlet offgas header when the hydrogen concentration reached 1% by volume. This would be followed by automatic shutdown of the recombiner train by hydrogen analyzer AT-2A or AT-2B when the outlet hydrogen concentration reached 2% by volume. The standby recombiner train would be started.

Failure Mode (3) - Valve TCV-3B fails to respond to a close signal from either the automatic train shutdown or the train selector switch.

Failure Effect (3) - Valve FCV-12, the offgas inlet to the recombiner system would close along with the dilution steam inlet valve FCV-22 and the train outlet valve FCV-16, resulting in normal train shutdown. The standby recombiner train would be started.

XI. RECOMBINER BYPASS VALVE TCV-3C

A. Prefailure Condition - Reactor plant operating normally at any power level or in startup condition.

Failure Mode (1) - Normally closed valve TCV-3C fails to the open position.

Failure Effect (1) - Part of the diluted offgas flow intended for the recombiner would be bypassed through this valve back to the main condenser. This abnormal condition would be

sensed by temperature switch TS-37 in the return header to the main condenser and would be alarmed. The condition would also be efident as low pressure (PT-1) at the dilution eductor outlet. The result would be an increased load on the plant steam jet air ejectors to recycle this offgas back to the recombiner system, but this would not constitute a hazardous condition and probably would not cause a loss of main condenser vacuum. The standby train would be started to permit repair of the defective valve.

Failure Mode (2) - Valve TCV-3C fails to respond to the open signal when the recombiner train selector switch is placed in the warmup position.

Failure Effect (2) - The back pressure at the dilution eductor outlet would be increased immediately as there would be no return path for the warmup steam flow. This condition woul be sensed by pressure transmitter PT-1 or pressure switch PSH-44 and the train would be automatically reverted from the warmup to the shutdown position.

XII. RECOMBINER CATALYST

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Recombiner catalyst becomes suddenly and catastrophically depleted and immediately fails to catalyze the recombination of hydrogen and oxygen.

Failure Effect (1) - Redundant hydrogen analyzers AT-2A and AT-2B on the recombiner condenser offgas outlet header will sense hydrogen concentration in excess of 2% by volume after about 30 seconds and will initiate a normal train shutdown. Prior to the automatic shutdown, the operator should receive a low temperature alarm at the recombiner outlet, a high flow alarm at the recombiner condenser outlet, and a high hydrogen concentration alarm. As much as 75 cubic feet of unrecombined gas containing as much as 30 cubic feet of hydrogen would pass the hydrogen analyzer due to its 30 second response time. This unrecombined gas would be sufficiently diluted in the 5000 cubic buried pipe to preclude any possibility of an explosion mixture reaching the compressors. Corrective

action in this case would include reference to the sequence of events monitor to determine the probable cause of recombiner catalyst failure. The standby recombiner train would be started unless there was sufficient reason to believe that a similar failure of recombiner catalyst would result.

Failure Mode (2) - Depletion of recombiner catalyst taking place over a period of several minutes.

Failure Effect (2) - The redundant hydrogen analyzers on the condenser offgas outlet header, AT-2A or AT-2B, would alarm when the hydrogen concentration reached approximately 1%. The operator would then refer to the thermocouples buried at various levels in the recombiner catalyst bed and observe whether catalyst depletion was occuring at an abnormally high rate. The normal operating procedure would then be to initiate a train shutdown. If the operator fails to take action, the train would be automatically shut down by the outlet hydrogen analyzers when the hydrogen concentration reached 2% by volume. Corrective action would be the same as outlined in Failure Effect (1) above.

Failure Mode (3) - Diluted offgas is channeled through only a portion of the recombiner catalyst.

Failure Effect (3) - Normally, channeling of flow through the recombiner catalyst would result only in a slow deterioration of recombination efficiency which would be similar to Failure Effect (2) described above. The channeling would be detected by the differential pressure cell across the recombiner vessel, DPT-20, and would be alarmed. If no operator action were taken, the system would continue to operate in a safe manner until hydrogen concentration on the outlet reached sufficient levels to cause an alarm or to cause an automatic shutdown of that train. Unless there was reason to believe that there was some impurity in the offgas or in the dilution steam that caused the recombiner catalyst channeling, the standby recombiner train would be started.

XIII. POST-RECOMBINATION CONDENSER P-601A

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Loss of cooling water to the recombiner condenser.

Failure Effect (1) - Presence of uncondensed steam in the recombiner condenser offgas outlet would result in a high flow alarm and a high temperature alarm. If corrective action were not taken, valve FCV-16 would be closed automatically by the high temperature signal; the increased back pressure would be sensed at the dilution eductor outlet by pressure transmitter PT-1 or pressure switch PSH-44 and would result in an automatic train shutdown. Since the recombiner condensers of both trains are connected in series, loss of cooling water to one would probably result also in loss of cooling water to the other train condenser and necessitate a plant shutdown. Such a failure, however, is regarded as being highly improbable because of the redundancy of the cooling water supply pumps and because the source of water is the reactor plant condensate system.

Failure Mode (2) - Failure of the recombiner condenser condensate level control valve LCV-10 in the closed position.

Failure Effect (2) - The recombiner condenser would be filled with condensate and condensate would overflow into the offgas outlet header. This would also result in increased back pressure at the dilution eductor outlet and would be sensed by pressure transmitter PT-1 or pressure switch PSH-44. This condition would be alarmed and if operator action were not taken immediately the train would be automatically shut down by this high pressure signal. The standby recombiner train would be started.

Failure Mode (3) - Failure of condensate level control valve LCV-10 in the open position.

Failure Effect (3) - The loss of the water seal in the recombiner condenser would result in steam being drawn into the drain line and into condensate flash tank V-808-A. This steam would exceed the capacity of the steam outlet valve and

piping on the condensate flash tank and result in high pressure buildup in the flash tank. This high pressure would be sensed and alarmed by pressure transmitter PT-38. If corrective action were not taken, the continued increase in back pressure would result in an inability to properly drain the recombiner condenser of condensate. The resulting conditions would be similar to those described in Failure Effect (2) above and would eventually result in automatic train shutdown. There would be no unsafe conditions created and the standby recombiner train would be started.

Failure Mode (4) - Leakage of high pressure condensate cooling water into the shell side of the recombiner condenser.

Failure Effect (4) - Minor leakage would not create a problem, as the reactor condensate is of the same quality and of the same ultimate destination as the condensate from the recombiner condenser. If the leakage exceeded the capacity of the condensate return system, the recombiner condenser would slowly be filled with condensate as described in Failure Effect (2) above and automatic train shutdown would result. There would be no unsafe conditions and the standby recombiner train would be started.

XIV. HYDROGEN ANALYZER AT-2A ON THE OFFGAS OUTLET LINE FROM THE RECOMBINER TRAIN

A. Prefailure Condition - Reactor plant operating normally at full power.

Failure Mode (1) - Hydrogen Analyzer AT-2A fails in a manner causing it to indicate less hydrogen than is actually present in the offgas.

Failure Effect (1) - The electronic auctioneer circuitry designed to select a signal from the hydrogen analyzer with the highest reading will automatically select hydrogen analyzer AT-2A; plant operation will continue normally.

Failure Mode (2) - Hydrogen Analyzer AT-2A fails in a manner causing it to read hydrogen concentration higher than is actually present in the offgas header.

Failure Effect (2) - If the erroneously high reading is between 1 and 2% hydrogen volume, an alarm will be sounded. If the erroneously high reading is 2% or above by volume, the train will be automatically shut down. The standby recombiner train would be started.

XV. RECOMBINER TRAIN OUTLET ISOLATION VALVE FCV-16

A. Prefailure Condition - Reactor plant operating normally at any power level or at startup.

Failure Mode (1) - Normally open valve FCV-16 fails to the closed position.

Failure Effect (1) - A low flow alarm would be immediately sounded by flow transmitter FT-24. If corrective action were not taken, an increase in back pressure would be sensed at the outlet to the dilution eductor by pressure transmitter PT-1 or pressure switch PSH-44. These pressure signals would sound an alarm and, if corrective action were still not taken, would result in an automatic train shutdown. The standby recombiner train would be started.

Failure Mode (2) - Valve FCV-16 fails to respond to a close signal for an automatic train shutdown or for a manual shutdown via the train selector switch.

Failure Effect (2) - Offgas inlet flow and dilution steam inlet flow would be terminated in the normal manner. The recombiner and recombiner condenser would not be isolated from the alternate train or from the buried delay pipe. This would not create unsafe conditions, however, and the failure of the valve to close would be indicated by the valve position indicator. Corrective action would be to isolate the system by closure of the manual valve downstream of FCV-16.

XVI. CONDENSATE FLASH TANK V-808

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Condensate flash tank level control valve LCV-8 fails in the open position.

Failure Effect (1) - The condensate flash tank would be drained of liquid level, allowing steam to pass into the drain cooler and into the liquid drain line. Two phase flow in this line would result in flow restriction for liquid level drainage from the condensate flash tank. This would result in the flash tank becoming filled with condensate such that condensate would pass out the steam vent line in the top of the tank. This would restrict steam flow and result in an increased pressure in the condensate flash tank. Both a high level alarm from the condensate flash tank level control LC-8 and from the condensate flash tank pressure transmitter PT-38 would sound. If corrective action were not taken, the increased back pressure would result in inadequate drainage of the recombiner condenser eventually leading to a train shutdown as described in XIII, Failure Effect (2), above.

Failure Mode (2) - Condensate flash tank level control valve LCV-8 fails in the closed position.

Failure Effect (2) - Condensate flash tank condensate level would increase and eventually result in train automatic shutdown as described in Failure Mode (1) above.

XVII. DRAIN COOLER E-607A

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Loss of cooling water to the drain cooler.

Failure Effect (1) - Inadequate cooling of the condensate from the flash tank would result in flashing of the condensate immediately downstream of level control valve LCV-8. This would produce two phase flow in the drain line and result in pressure buildup and backup of condensate as described in XVI, Failure Effect (1), above.

Failure Mode (2) - Leakage of reactor condensate (cooling water) into the drain cooler.

Failure Effect (2) - Minor leakage of reactor condensate into the drain cooler would not create a problem as the reactor condensate cooling water is of the same quality as the drains being processed by the cooler. If the leakage, however, exceeded the capacity of the drain return system, the liquid level in the condensate flash tank would rise above normal and train shutdown would result as discussed in Failure Effect (1) above.

XVIII. CONDENSATE COOLING SUPPLY PUMP P-902A

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Cooling water flow decreases to less than 900 gallons per minute.

Failure Effect (1) - Flow transmitter FT-5 will sense the decreased flow and will alarm the low flow at approximately 1000 gpm. If corrective action is not taken and flow continues to decrease to 900 gpm, the standby pump P-902B will be automatically started.

XIX. DRAIN COLLECTING TANK V-810 ON THE PREVIOUSLY INSTALLED 5000 CUBIC FOOT BURIED DELAY PIPE

A. Prefailure Condition - Reactor plant operating normally at any power level or during startup.

Failure Mode (1) - Tank level switch LIS-2 fails so as to allow the tank to overflow.

Failure Effect (1) - High level alarm LAH-2 will sound. If corrective action is not taken, water will back up into the offgas header pipe leading to the buried 5000 cu.ft. pipe and will cause flow restriction in that line. Flow restriction will result in increased back pressure on the recombiner after-condensers which will be sensed and alarmed by pressure transmitters PT-3 and PT-4. If corrective action is still not taken, increased back pressure on the dilution eductors will result in pressure alarms by pressure transmitter PT-1 or PT-2 and their associated redundant pressure switches. When the pressure at these points reaches 20 psia, automatic train shutdown will be initiated. There will be several hours between the initial alarm and automatic recombiner shutdown. The tank can be drained during this time by over-riding the signals to the drain valve and pump which are located in the mechanical vacuum pump area and which are accessible during power operations.

Failure Mode (2) - Level switch LIS-2 fails so as to cause complete drainage of collecting tank.

Failure Effect (2) - Since the drain collecting tank is normally under vacuum, and drain pump P-900 is unable to pump gas, there should be no loss of gas to the closed radwaste system. The pump will continue operating, however, maintaining the tank empty until continuous operation of the pump is noted by the plant operator.

XX. DRAIN COLLECTING TANK V-813 SERVING THE 60 SECOND BURIED DELAY PIPE BETWEEN THE AIR EJECTORS AND THE RECOMBINER SYSTEMS (The failure modes and effects for this tank are similar to those described for tank V-810 above, except that the main condenser air ejectors would be choked, resulting in slow deterioation of main condenser vacuum)

XXI. STORAGE SYSTEM BYPASS VALVE, HCV-1

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Normally closed storage system bypass HCV-1 opens partially (this is an electric motor-operated valve, and the key switch is locked in the closed position to prevent unauthorized opening of the valve).

Failure Effect (1) - The limit switch for the closed position of the valve would cause an alarm to be sounded in the control room. Due to the subatmospheric pressure in the buried pipe, air would be drawn from the stack past the

partially opened valve and into the buried pipe and compressors suction. If the inleakage rate exceeded compressor capacity, the compressor high suction pressure alarm would be sounded by PSH-25A or PSH-25B. There would be no leakage of offgas to the stack through this valve becau. under all normal operating conditions compressor capacity is greater than the off-gas flow rate.

B. Prefailure Condition - Reactor plant operating in startup mode.

Failure Mode (1) - Valve HCV-1 fails to open.

Failure Effect (1) - The limit switch on HCV-1 will indicate that the valve is still closed and offgas flow will be automatically limited to compressor capacity. If the valve is slightly open, and if the offgas flow rate is in excess of available capacity (the control of offgas flow to within compressor capacity is over-riden when the limit switch is in open position), the compressor suction high pressure alarm PSH-25A and PSH-25B will be actuated. If corrective action is not taken, back pressure will be increased so that the pressure transmitters at the outlet to the dilution eductors in the recombiner system will sense pressures in excess of normal operating conditions. These pressure transmitters, PT-1 and PT-2, with backup pressure switches PSH-44 and PSH-45, will alarm the high pressure. If corrective action is still not taken, these transmitters will result in automatic recombiner train shutdown when the pressure reaches 20 psia.

XXII. HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTER IN THE COMPRESSOR SUCTION HEADER

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - The HEPA filter becomes clogged such that flow through the filter is abnormally impaired.

Failure Effect (1) - The high differential pressure switch DPIS-34 across the filter will cause an alarm to be sounded. Corrective action is to switch to the alternate filter. If corrective action is not taken, back pressure on the recombiner train will increase to abnormally high levels and will

result in high pressure alarms and eventual shutdown of the recombiner trains by pressure transmitters PT-1 or PT-2 and their associated pressure switches, PSH-44 and PSH-45, when the pressure at the dilution eductor outlet reaches 20 psia. Pressure buildup above the alarm point will normally be very slow, providing several hours or days for switchover to the standby filter.

Failure Mode (2) - Offgas leakage from the filter assembly.

Failure Effect (2) - Due to subatmospheric pressure, any leakage around the filters would be into the system. This would be detected if the tank fill time were found to be proportionately less than the expected, based on the offgas flow rate at the recombiner train outlet. Corrective action would be to switch to the alternate filter. The filters are individually shielded so that repairs can be made on one filter while the other filter is in operation.

XXIII. COMPRESSOR INLET ISOLATION VALVE, SV-6

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Valve SV-6 fails to the closed position while the compressor is operating.

Failure Effect (1) - The compressor would be automatically unloaded or shut down by the low pressure switch (depending upon the selected mode). If the alternate compressor were in the standby mode, it would automatically be started when the pressure in the suction header increased slightly. If the alternate compressor were not in the standby mode, the increase in pressure would be sensed and alarmed by the pressure transmitters at the recombiner condenser outlets, PT-3 and PT-4. If corrective action were not taken, the recombiner systems would be shut down by the pressure transmitters at the dilution eductor outlets.

Failure Mode (2) - Valve SV-6 fails to close when the compressor is shut down.

Failure Effect (2) - This failure would cause a problem only if compressor maintenance were necessary. In this case it would be necessary to close the valve at the HEPA filter outlet long enough to repair the defective valve or to blank the flange to the compressor suction.

XXIV. OFFGAS COMPRESSOR, C-1001A

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Loss of compressor cooling water.

Failure Effect (1) - High second-stage discharge temperature will be alarmed by temperature switch TSH-10A and the compressor will be automatically shut down. The standby compressor will automatically assume the load.

Failure Mode (2) - Loss of compressor sealing air.

Failure Effect (2) - This condition will be alarmed by pressure switch PS-33 and both compressors will be automatically shut down. (There are two service air compressors supplying this header and simultaneous failure of both is improbable.)

Failure Mode (3) - Loss of compressor lubricating oil pressure.

Failure Effect (3) - This condition will be alarmed by pressure switch PSL-24 and the compressor will be automatically shut down. The standby compressor will automatically assume the load.

Failure Mode (4) - Excessive offgas leakage from the compressor.

Failure Effect (4) - Offgas leakage rates sufficient to cause airborne concentration levels in excess of the limits for 40 hours per week occupancy will be sensed and alarmed by the ventilation air discharge monitor. Corrective action is to isolate the compressor or portion of piping involved and switch to the alternate compressor.

Failure Mode (5) - Failure of the compressor to automatically unload when the outlet pressure reaches 300 psia.

Failure Effect (5) - The high pressure alarm on the tank being filled will have sounded to signify the tank is filled. If the compressor discharge is not switched to another tank and if the unloader valve fails to function, relief valve PSV-5A will lift and relieve the excessive pressure back to the compressor suction.

XXV. COMPRESSOR OUTLET VALVE, SV-7

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Normally open SV-7 fails in the closed position.

Failure Effect (1) - The compressor will automatically unload or shut down. The standby compressor will assume the load.

Failure Mode (2) - Valve SV-7 fails to close when the compressor is shut down.

Failure Effect (2) - The check valve upstream of SV-7 will normally prevent any offgas flow back into the compressor. However, if compressor maintenance is required, standard procedure will be to close the manual valve downstream of SV-7 and open the leak-off valve back to the compressor suction. This will relieve the pressure on the high pressure section of the compressor.

XXVI. OFFGAS STORAGE TANK, NUMBER 1, INLET VALVE SV-31

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Valve SV-31 fails to close after the tank has been filled and the tank selector switch has been placed in the "hold" position.

Failure Effect (1) - The valve position indicator for Valve SV-31 will show that the valve has not closed. If the operator fails to note that the valve has not closed and proceeds to open the fill valve for a second tank, the first tank will then blow down through the fill header into the second tank until the pressure between the two tanks has equalized. This will

result in loss of the "tank filled" signal for the first tank. Again, if this is not noted by the operator, the two tanks will be filled simultaneously, and when they are filled the operator will receive fill signals for both tanks. This should again serve to alert the operator of the abnormality. However, if corrective action is not taken, there will be a repeat blowdown of tank number 1 to the next tank selected for fill in the same manner. This will continue until the abnormality is noted and corrected. In each case, tank number 1 will receive a fresh partial charge of offgas from the compressors; therefore, it will not decay sufficiently to be released. Corrective action for this failure is to close the manual valves upstream and downstream of valve SV-31 and to effect repair or replacement of the valve as necessary.

Failure Mode (2) - Valve SV-31 fails to open when the selector switch is placed in the "tank fill" position.

Failure Effect (2) - Normally there will not be an alternate tank available for filling and therefore it will be necessary to fill tank number 1 using an alternate fill route through the sample piping. This alternate fill route is established by selecting any of the other tanks other than the one currently being released and closing the manual tank isolation valve in the tank fill-discharge header. Assuming tank number 2 is selected for this purpose, the tank selector switch will then be placed in the fill position causing valve SV-32 to open. The sample valves SV-15A and SV-15B would also be opened. This, in effect, connects the compressor discharge header to the sample header. Next the sample valve SV-14A and SV-14B on tank number 1 are opened. This connects tank number 1 to the sample header also and establishes an alternate charging route. Once tank number 1 fill has been completed, the defective valve, SV-31, will be isolated by closure of the manual valves upstream and downstream of the valve, and the sampling system valves will be closed, reverting the system back to normal operation. Valve SV-31 will be repaired or replaced as necessary.

Failure Mode (3) - Valve SV-31 leaks slightly after the tank has been filled and the valve is in the closed position.

Failure Effect (3) - Leakage by valve SV-31 will be into the fill header and thus into the next tank being filled. Loss of pressure in tank number 1 will result in loss of the "tank filled"

signal. This loss of pressure will also be noted in the periodic recordings of the storage tank pressure. Corrective action is to isolate valve SV -31 by closure of the manual valve upstream and downstream and to effect repair or replacement of the valve as necessary.

XXVII. TANK NUMBER 1 DISCHARGE VALVE, SV-21

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Valve SV-21 fails to close after the tank has been emptied and the selector switch has been changed to the "fill" position.

Failure Effect (1) - The valve position indicator switch for valve SV-21 will indicate that the valve has not closed. The interlock of the valve position indicator switch will prevent valve SV-31 from being opened so that offgas cannot be channeled directly from the compressor outlet to the offgas discharge header. It will normally be necessary, however, to fill this tank as there will be no other tank empty. To accomplish this, it will be necessary to close the manual valve downstream of SV-21. Filling of the tank can the accomplished either by overriding the interlock to valve SV-31, or by electing to fill the tank using an alternate fill route through the sample system as described in XXVI, Failure Effect (2). Once the tank has been filled the defective valve can be isolated by closure of the manual valves upstream and downstream and repair or replacement effected as necessary.

Failure Mode (2) - Valve SV-21 fails to open when the tank has been decayed and selected for discharge.

Failure Effect (2) - The valve position indicator for valve SV-21 will indicate that the valve has not opened. Also the flow transmitter FT-9 in the discharge header will indicate that the valve has not opened. Normally another tank will be selected for discharge and the valve isolated and repaired or replaced as necessary. It is possible however to discharge this tank using an alternate discharge route through the sample header. This is accomplished by aligning the tank in a manner similar to that described in XXVI, Failure Effect (2) above.

Failure Mode (3) - Valve SV-21 leaks slightly when the tank is pressurized.

Failure Effect (3) - If leakage occurs at a significant rate from a tank which has not been decayed, the stack radiation monitor will indicate higher levels than normal. Such leakage also will be evidenced by a decay of the tank pressure whenever the tank is in the isolated position and loss of the "tank filled" annunciation. The combined leakage rate of all tanks can be measured if all discharge valves are closed by using flow transmitter FT-9. The operating procedure will call for the plant operator to note this leakage rate each time a tank is selected for discharge. If the leakage rate is sufficient to be detected by the flow transmitter, the procedure will call for identification of the leaking valve by selectively closing the manual valves downstream of each solenoid discharge valve. The leaking valve will then be isolated by closure of the manual valves on either side and repair or replacement of the valve effected as necessary.

XXVIII. OFFGAS STORAGE TANK NUMBER 1

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Tank leakage.

Failure Effect (1) - Significant leakage of offgas from a storage tank will be detected by the air sampler in the ventilation discharge duct. The faulty tank can be identified by correlating the high radiation readings with the tank pressures. A leaking tank will then be isolated in the empty condition until such time as repairs can be effected.

XXIX. OFFGAS STORAGE TANK NUMBER 1, RADIATION MONITOR

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Tank radiation monitor RM-1 reads erroneously high radiation levels.

Failure Effect (1) - The tank will not fit the normal discharge sequence because it will not be the lowest reading tank after the other four have been filled. If the radiation detector at the air ejector discharge did not indicate abnormally high radiation levels during the time that this tank was being filled, a bottled

sample will then be taken from the tank and analyzed in the laboratory. If the radioactivity level of the sample does not correspond with the radiation monitor reading, the radiation monitor will be removed for calibration and repair as necessary. Meanwhile, tank discharge procedures will be based on the bottled sample results.

Failure Mode (2) - Radiation monitor RM-1 reads erroneously low radiation levels.

Failure Effect (2) - Again this tank will not correspond to the normal discharge sequence. Action will be taken as described in Failure Effect (1) above. Protection is provided against premature release due to incorrect radiation monitor reading by the 12-hour interlock on the valve discharge selector switch. The 12-hour decay provides for at least 90% of the decay that would be achieved if the radiation monitor were reading correctly. Corrective action is to remove the radiation monitor for calibration and repair or replacement as necessary.

XXX. OFFGAS DISCHARGE FLOW CONTROL VALVE, FCV-9

A. Prefailure Condition - Reactor plant operating normally at any power level.

Failure Mode (1) - Valve FCV-9 fails to the fully open position.

Failure Effect (1) - Flow limiting nozzle FO-15 will limit the maximum flow to approximately 150 scfm maximum. This is approximately 30 times the most concentrated output rate of 5 scfm from the recombiner system. Since the 50-hour retention times gives a dose reduction of approximately 100 over the 30-minute retention time system, the plant boundary dose should be well below Technical Specification limits. In the event that the stack release rate should exceed Technical Specification limits, the stack monitors would provide a signal for automatic closure of valve SV-5 downstream of the failed FCV-9 and also closure of the stack isolation valves. In any event, the radiation level at the stack monitors would be higher than normally experienced and under most cases would result in a higher radiation alarm in the control room. Upon receipt of this alarm or observation that the radiation release rate is above normal, corrective action would be to manually close the valve SV-5. The defective valve can then be isolated

by closing manual valves both upstream and downstream of the valve, permitting the valve to be repaired or replaced as necessary. During the time that the valve is out of service for repair or replacement, offgas discharge can be made through a manual throttle valve located in a bypass line around the flow controlled valve station. When this manual bypass valve is not being used it is padlocked in the closed position.

Failure Mode (2) - Valve FCV-9 fails in the fully closed position.

Failure Effect (2) - Flow transmitter FT-9 would register zero offgas discharge flow rate. Corrective action would be to isolate the defective valve and to use the flow control station bypass valve as described in Failure Effect (1) above.