NINE MILE POINT UNIT 2

ANALYSES AND DESIGN CONCEPTS FOR PLANT MODIFICATIONS TO SUPPORT FINAL CLOSURE OF THE SECONDARY CONTAINMENT DRAWDOWN ISSUE

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INTRODUCTION

1.0 This report presents the analyses and design concepts for required plant modifications to support the final resolution of the secondary containment drawdown issue for Nine Mile Point Unit 2.

The drawdown issue developed as a result of NMPC discovering that the original drawdown analysis for NMP2 did not use the most limiting design parameters. The original analysis did not appropriately reflect the effect of the differential temperature between secondary containment atmosphere and service water on drawdown time. In addition, the original analysis, consistent with the Standard Review Plan, utilized the assumption of a LOCA concurrent with a loss-of-off site power (LOOP) and a single active failure of the component to produce the most severe design condition. The original analysis assumed a single active failure of one emergency diesel generator. However, a subsequent evaluation of a number of accident scenarios determined that the LOCA without a LOOP and a loss of the Division II 600 volt bus produces the greatest heat load and consequently the longest drawdown time. As NMPC's review of this matter continued, additional parameters affecting the drawdown time were discovered, requiring additional changes to the drawdown analysis.

As an interim measure, NMPC has imposed certain compensatory measures to ensure that the radiological consequences of a design basis Loss-of-Coolant Accident (LOCA) remain within 10CFR100 guideline values and GDC 19 criteria. These measures include both modifications and the imposition of administrative controls to ensure that an adequate differential temperature is maintained between the air in the reactor building and the service water pump discharge. Deliberate heating of the reactor building is required in the summer months during periods of high service water temperature in order to maintain an adequate differential temperature. NMPC has determined that the original Standby Gas Treatment System (SGTS) capacity needs to be increased by approximately 100% to allow removal of these administrative controls. These above aspects of the final drawdown analysis and the SGTS modifications are discussed in greater detail in this report.

This report also discusses the final secondary containment drawdown analysis including a discussion of significant parameters and changes. These changes were made, in part, as a result of the decision to replace the existing SGTS subsystems with higher capacity subsystems. Other changes were made to reflect unit cooler performance and possible future power uprate conditions.

The remainder of the report is divided into three sections:

- Secondary Containment Drawdown Analysis
- Proposed Permanent Plant Modifications
- Evaluation

The information provided in this report is preliminary in nature since the design review process is presently on-going within NMPC. However, the major aspects of the design are firmly established and NMPC does not anticipate any major changes to the information presented in this report. Major equipment has already been ordered to support installation of the SGTS. As the design process continues, the plant modifications and USAR changes will be evaluated and approved in accordance with NMPC procedures.

As a result of the revised drawdown analysis and the installation of the new SGTS design, Technical Specification changes will be needed. The SGTS modification is scheduled for implementation during the third refueling outage, starting September 1993. NMPC will submit a license amendment containing these technical specification changes no later than December 31, 1992. NMPC is requesting that the staff complete its review of these changes no later than June 30, 1993.

2.0 SECONDARY CONTAINMENT DRAWDOWN ANALYSIS

This section of this report discusses various aspects of the Secondary Containment Drawdown Analysis:

(1) Definition of secondary containment drawdown time

(2) Parameters which affect secondary containment drawdown time

(3) Significant assumptions applied to the drawdown analysis and a discussion of the drawdown analysis

2.1 Definition of Secondary Containment Drawdown Time

The secondary containment, consisting of the reactor building and auxiliary bay structures, completely surrounds the primary containment. During normal operation, the secondary containment is maintained at a minimum negative pressure of 0.25 inch water gauge with respect to the surrounding outside atmosphere by use of a non-safety grade forced air ventilation system which discharges unfiltered air to the outside environment. Following a postulated Loss of Coolant Accident (LOCA), the non-safety grade forced air ventilation system is automatically secured and a safety grade ventilation system, SGTS, which filters out radioactive particles, is automatically initiated. The SGTS re-establishes and maintains secondary containment at a negative 0.25 inch water gauge with respect to the surrounding atmosphere in order to prevent the uncontrolled and unfiltered release of secondary containment atmosphere. The accident scenario results in a change in the heat gain and heat removal capabilities in the secondary containment which, together with the startup delay times of the SGTS and the Category I unit coolers, causes an initial increase in secondary containment pressure. When the secondary containment pressure increases, the 0.25 inch water gauge criterion is no longer met. The SGTS must then work in conjunction with the unit coolers to re-establish an acceptable pressure differential. The interval between the time the accident scenario begins and the time at which a negative differential pressure of 0.25 inch water gauge is reestablished is defined as the "drawdown time".

2.2 Parameters which Affect Secondary Containment Drawdown Time.

The secondary containment drawdown time is primarily dependent upon the following:

(1) Secondary containment environmental conditions (pressure, temperature, relative humidity) prior to LOCA.

(2) Secondary containment inleakage.

(3) SGTS exhaust capacity and startup delay.

(4) Building unit cooler and central cooling system capacity and startup delay.

(5) Service water temperature.

(6) Outside environmental conditions (temperature, relative humidity).

(7) Heat generation (sensible and latent).

(8) Building volume.

Heat is generated in the secondary containment as a result of the LOCA. In addition, operation of safety related and non-safety related equipment and spent fuel decay also contribute heat to secondary containment. This heat is removed by the operation of unit coolers within secondary containment. These coolers utilize cooling water from Lake Ontario via the service water system. Without the operation of these unit coolers, secondary containment temperature would increase due to the effect of the above heat loads. Since the fans which force air across the unit coolers' heat exchanger tubes operate automatically to maintain a preset temperature or in response to a LOCA, the startup delay associated with the energization of the fans' motors subsequent to a LOCA will impact the drawdown time.

An evaluation of drawdown analysis calculations indicates that when secondary containment atmospheric temperature is considered in relation to service water temperature, drawdown time is strongly influenced by the differential temperature between these two media. As the differential temperature between the service water and the secondary containment atmosphere decreases, the heat removal capability of the unit cooler also decreases. Therefore, the drawdown time increases.

A portion of the unit cooler heat removal capacity is used in the removal of the latent heat of condensation associated with moisture in the secondary containment air. In addition, since the unit coolers operate by forcing air across the unit cooler tubes, the reduction in the heat transfer rate due to the condensation of water on the tubes reduces the ability of the unit coolers to remove heat. Therefore, as relative humidity increases, the drawdown time also increases.

Temperature differences between secondary containment and outside air can affect the inleakage into secondary containment. Whenever the outside air temperature is lower than the temperature in the secondary containment, the vertical pressure decrease at a higher elevation outside the secondary containment is greater than the pressure decrease inside the secondary containment because of the higher density of the colder air. Since secondary containment pressure is measured and controlled at the top of the building, the differential pressure at the lower elevations can be significantly greater than 0.25 inch water gauge. Thus, the secondary containment inleakage rate increases as the outside temperature decreases. In addition, as the colder outside air is drawn into secondary containment, it is heated and expands. This also contributes to an increase in the inleakage rate.

The SGTS system is provided in order to offset the building inleakage as well as to provide a filtered release to the environment. Since SGTS must offset secondary containment inleakage, the exhaust capacity of SGTS will affect the drawdown time. The difference between secondary containment inleakage and SGTS exhaust flow is the net SGTS exhaust rate or differential flow. The drawdown time is strongly

influenced by the differential flow. Also, since SGTS is not normally running, the startup delay associated with bringing SGTS into operation subsequent to a LOCA will affect the drawdown time.

2.3 Significant Assumptions Applied to the Final Drawdown Analysis

USAR section 6.2.3.3.1.3 discusses the assumptions applied to an interim version of the drawdown analysis. The following two items correspond to items 5 and 11 in USAR Section 6.2.3.3.1.3. The assumptions are revised in the final drawdown analysis as follows:

(1) Spent fuel heat loads are 14.4×10^6 BTU/hr as defined in section 9.1.3.3 of the USAR. This value also envelops a possible future power uprate condition.

(2) Five unit coolers in Division I plus one unit cooler in Division III or five unit coolers in Division II plus one unit cooler in Division III are available. The drawdown related unit coolers are assumed to operate at 90% of design capacity.

Additional significant assumptions applied to the final drawdown analysis not discussed in section 6.2.3.3.1.3 of the USAR are:

(1) Service water temperature is at 82°F. The technical specifications permit power operation of NMP2 up to and including a maximum service water temperature of 81°F. One degree is added to the 81°F limit to account for service water heatup due to the service water pump.

(2) Each SGTS train exhausts 7500 cfm from secondary containment (only one fan operates).

(3) The current inleakage value of 3190 cfm has been revised to approximately 2850 cfm. This revision is due to a change in the calculated free air secondary containment volume from 4,600,000 to 4,100,000 ft^3. Secondary containment inleakage at -20°F outside air temperature is approximately 2850 cfm (one secondary containment air change per day). As previously described in section 2.3 of this report, as outside temperature increases the effective inleakage decreases.

The drawdown time estimation is done using the THREED computer code. The secondary containment is divided into multiple subvolumes based on localized heat loads and cooling rates. The heat load estimation, which addresses a possible future power uprate condition, considers the operation of equipment prior to LOCA, initiation of equipment following LOCA, and residual heat of equipment which trips following LOCA. The heat removal of the cooling systems is based on the differential temperature between the building and the cooling water. The analysis also considers the worst case single failure of 600 V Division II bus failure without loss of offsite power and appropriate system startup delays.

Because of the many parameters that impact drawdown capability, it is clear that various accident scenarios need to be evaluated to determine the most limiting

combination of heat loads and heat removal capabilities within the secondary containment. Based upon such an evaluation, it is concluded that the postulation of a LOCA without a LOOP and a loss of the Division II 600 volt bus produces the most limiting design condition. The loss of the Division II 600 volt bus renders one division of the unit coolers and one division of the SGTS inoperable, while leaving all divisional emergency core cooling equipment operable as a source of heat. The loss of the Division II 600 volt bus produces a higher ratio of heat load to heat removal capacity than the loss of its equivalent Division I bus. Also, by postulating that offsite power is available, a number of non-essential components remain operable and capable of generating heat.

3.0 PROPOSED PERMANENT PLANT MODIFICATIONS

This section of this report discusses the major aspects of the permanent plant modifications which are required to support final resolution of the NMP2 secondary containment drawdown issue.

The major aspects of the plant modifications are summarized as follows:

(1) Existing SGTS Filter Trains and Fans are to be replaced with larger capacity subsystems. The capacity of each filter train will be increased from 4000 cfm to 8000 cfm. An 8000 cfm capacity centrifugal fan is provided downstream of each SGTS filter train. This fan is a direct-drive type with a two-speed motor powered from a Class 1E bus. With one filter train operating the SGTS draws approximately 7500 cfm from the discharge duct of the emergency recirculation unit cooler to either maintain or restore a subatmospheric pressure within the reactor building.

(2) In the current design, the exhaust flow through an SGTS filter train is modulated by a recirculation line around the filter train and a variable position valve. The new design eliminates the recirculation line and utilizes a modulating inlet flow control vanes. Each fan will have a modulating inlet flow control vanes capable of producing an overlapping family of fan curves for low and high speeds for a smooth transition from one-speed to another.

(3) Both fans are started automatically at fast speed when there is a LOCA or a reactor building refueling area exhaust vent duct low air flow or high radiation signal. Each fan is provided with a keylock selector switch for Lead or Lag operation logic. In addition, each fan is provided with a selector switch for fast speed or slow speed, to be used for manual operation.

One filter train is designated Lead, the other Lag, by a selector switch located in the control room. Upon receipt of a start signal, both the Lead and Lag fans start simultaneously at fast speed, with respective inlet vanes fully open. After achieving negative pressure (differential pressure > -0.25"WG), the Lead fan will continue to operate at fast speed and the lag fan will trip. The Lead fan will continue to operate at high speed with the inlet flow control vanes modulating to achieve the required negative pressure until the flowrate is reduced to approximately 3700 cfm, at which time the fan will switch to slow speed. If for any reason the negative pressure decreases to a value of < -0.25"W.G., simultaneously, the Lead fan will switch back to fast speed and the Lag fan will start again at fast speed. The vanes will modulate as required. In the event of HI/HI temperature, or No Flow conditions in the lead filter train, the Lag fan will become Lead, provided a GTS start signal is also present. The filter trains can also be started manually.

The GTS system can be started manually in either fast speed or slow speed. The selector switch for automatic/manual has a spring return to automatic. If

the GTS system is operating in a manual mode at slow speed (1800RPM), and a LOCA signal is received, the system will operate as follows:

(a) Continue operating at slow speed, provided the secondary containment differential pressure is maintained, (greater than -0.25"WG), or

(b) if the secondary containment differential pressure is reduced below the proper value, the fan motor will automatically shift to fast speed (3600RPM). When flow requirements allow, the fan motor will return to the slow speed setting.

(4) The NMPC licensed position for charcoal loading, 10 mg-iodine/gram of charcoal, remains unchanged.

(5) NMP2 was licensed with an emergency primary containment venting provision as discussed in the staff's Supplemental Safety Evaluation Report (SSER5), section 13.5.2.3.1. Specifically, the NMP2 current design utilizes a 14 inch bypass line around each of the SGTS filtration units to prevent any damage to the SGTS components during emergency primary containment venting. To bypass an SGTS filtration unit, personnel presently would manually insert blind flanges in the 20-in. lines outboard of the flexible bellows (which are located upstream and downstream of the SGTS fan and filtration unit) when it becomes apparent that the use of the 14-in. bypass line will be required.

In conjunction with the SGTS modification, the NMP2 design for emergency venting is being revised to eliminate the need to insert blind flanges. The new design will utilize a remotely operated valve within a single line that bypasses both SGTS filter trains in place of the existing individual bypass lines.

(6) Impregnated activated carbon is tested before installation in accordance with ASME Code AG-1 with test methods per ASTM ND3803.

4.0 EVALUATION

This section of the report evaluates the proposed permanent plant modifications and the final drawdown analysis against the licensing basis for the original design.

The USAR, Section 6.5.1, identifies various regulatory and industry documents which the current SGTS design meets. The new proposed SGTS design complies with all the regulatory and industry documents identified in USAR Section 6.5.1 to the same degree as the original design with the exception of RDT Standard M16-IT. This standard provides guidance regarding test methods for impregnated activated carbon. NMPC will utilize ASME Code A6-1 with test methods per ASTM ND3803 since the original criteria are obsolete.

The Standard Review Plan (SRP), NUREG-0800 establishes additional criteria for atmosphere cleanup systems, such as:

(1) GDC 19, "Control Room"

(2) GDC 41, "Containment Atmosphere Cleanup",

(3) GDC 42, "Inspection of Containment Atmosphere Cleanup System ",

(4) GDC 43, "Testing of Containment Atmosphere Cleanup System:, and

(5) GDC 64, "Monitoring Radioactivity Releases"

The new proposed design complies with the above GDC's.

The SGTS modification will increase the load on Division I and II emergency diesel generators. The scenarios and the corresponding existing load and the new load are presented as follows:

	Existing Load (KW)		New Load (KW)	
Scenarios	Div. I	Div. II	Div. I	Div. II
Simult. Loop & LOCA	4274	3884	4317	3962
Loop & Delayed LOCA	4274	3884	4317	3962
LOCA & Delayed Loop	4274	3884	4317	3962
Loop & Unit Trip	3205	3016	3283	3094

Continuous Rating = 4400 Kw

2000 hr. Rating = 4750 Kw

Based upon this tabulation, it can be concluded that the increased new total load remains below the continuous rating of each diesel generator under all USAR analyzed accident scenarios.

The calculated drawdown time for the new SGTS flow rate and the assumptions discussed previously is approximatley 4 minutes. For conservatism, the resulting radiological doses have been calculated assuming a 6 minute drawdown time. The new radiologial results for the design basis LOCA, provided below, are within the guidelines of 10CFR100 and the requirements of General Design Criterion 19.

Location	Whole-Body Dose (rem)	Thyroid Dose (rem)	Beta Dose (rem)
Exclusion area (2 hr.)	6.4	233	4.3
Low population zone (30-day)	2.8	57.9	2.1
Control room (30-day)	1.7	15.6	23.8

The above radiological effects are based upon: (1) an assumed 6 minute drawdown time, (2) utilization of the assumptions described in USAR Section 6.2.3.3.1.3, as revised by Section 2.3 of this report, and (3) operation of the new SGTS design. These results represent a slight increase over the results of the current radiological analysis, shown below and in USAR Table 15.6-16b. The increase is primarily attributed to the increased exhaust capacity of the SGTS which is assumed to occur for the entire 30-day duration.

Location	Whole-Body Dose (rem)	Thyroid Dose (rem)	Beta Dose (rem)
Exclusion area (2 hr.)	6.3	232	4.2
Low population zone (30-day)	2.6	56.1	1.9
Control room (30-day)	1.6	15.5	22.9

The proposed SGTS design changes meet the existing design criteria identified in the USAR. The USAR design criteria include seismic qualification, environmental qualification, separation requirements, fire protection, Appendix R, human factors, single failure criterion, manual start from the control room, instrument setpoint criteria and quality assurance.

The change to the emergency venting provisions is designed such that neither SGTS train is destroyed or damaged by the use of the emergency venting provision. The new line is designed to ASME Code, Section III, code class 2 requirements. The new single line replaces the existing individual bypass lines around each SGTS filter train. The remotely operated valve in the new line is non safety grade and non divisionally powered. However, the valve and operator meet seismic and environmental

qualification criteria for a design basis LOCA. Since the valve operator is powered from a non Class 1E source, the control power for the valve will be normally de-energized to prevent spurious operation of the valve. The new line meets seismic criteria. This design is acceptable as emergency venting is beyond the licensing basis criteria and the single failure criterion need not apply to the emergency venting design.

The net effective activated charcoal provided in each new filter train is 2,225 lbs. As a result of a design basis accident, the load of the charcoal bed is:

(1) 2.12 mg. of iodine/gm of charcoal at 30-days post LOCA

(2) 4.6 mg. of iodine/gm of charcoal at 100 days post LOCA

Both the 30 and 100 days post LOCA loadings of the charcoal beds are below the limit of 10 mg. of iodine/gram of charcoal specified in the discussion on compliance to Regulatory Guide 1.52, Rev. 1, contained in USAR section 1.8.