Startup Report
for
Virgil C. Summer Nuclear Station Power Uprate

INTRODUCTION

This report describes the testing which was performed to support the increase in licensed power at the Virgil C. Summer Nuclear Station (VCSNS) from 2775 Megawatt thermal (MWt) to 2900 MWt and provides a summary of the results. This report is submitted as required by Sections 6.9.1.1, 6.9.1.2, and 6.9.1.3 of the VCSNS Technical Specifications.

The license amendment requests for approval to operate at 2900 MWt were documented by application on August 18,1995, and supplemented on November 1, 1995, February 14, March 14, and March 25, 1996. These submittals and supplements contained evaluations demonstrating that the Nuclear Steam Supply System and the Balance of Plant (BOP) systems had been evaluated and found acceptable for operation at the uprate conditions. These submittals were subsequently approved by the NRC on April 12,1996 as Amendment No. 133 to the VCSNS Facility Operating License.

The goal of the power uprate was to increase the electrical output of the plant via the increase in rated thermal power and the replacement of the main turbine low pressure turbine rotors.

IMPLEMENTATION OF THE POWER UPRATE

A major portion of the analysis and modifications to support the plant uprate was performed during the eighth refueling outage in the fall of 1994 when the steam generators (SG) were replaced and a majority of the FSAR Chapter 15 accident reanalysis (necessary to support the SG replacement) was performed at plant uprate conditions.

Additional modifications were performed during the ninth refueling outage in the spring of 1996 to several Balance of Plant (BOP) systems to allow the power uprate. These included:

- Rescaling of the main steam flow transmitters,
- Rescaling of the turbine first stage pressure transmitters,
- Reduction of the high steam flow trip setpoints (within Technical Specification limits) to maintain acceptable instrument uncertainty values
- Replacement and modification to several feedwater heater drain valves to increase flow capacity
- Replacement of one of the condensate flow control valves to increase the flow capacity
- Modification of the main condenser to condensate system piping configuration to reduce turbulence and allow uprate power operation
- Modifications to the main generator stator water cooling system to change the mode of operation to a fixed flow rate and increase the capability of the cooling pumps
- Removal of turbine auxiliary system heat loads from the circulating water system to a dedicated closed cooling water modular cooling tower
- Replacement of the main turbine low pressure turbine rotors

An unrelated modification to the power uprate was the change to the steam separation components in the steam generators which was necessitated by excessive steam moisture carryover following the steam generator replacement.

FSAR Chapter 14 testing requirements were evaluated relative to the plant uprate. Testing performed to support the power uprate addresses equipment and components impacted by the uprate. The power sequence was controlled using Reactor Engineering Procedure REP 107.001, "Controlling Procedure for Refueling, Startup, and Power Ascension." This procedure contained the power uprate testing and data collection requirements as well as the normal plant startup physics testing requirements identified in the FSAR.

The data collection for the power uprate was initiated on May 22, 1996, following the completion of zero power physics testing. Plant data was then collected, reviewed, and trended during the power ascension sequence at approximately 10% power intervals. This data was reviewed and compared to previous cycle power ascension data for any adverse conditions due to scaling changes and new temperature program conditions. A power hold was established at the old license power limit of 2775 MWt (approximately 95.7% of the uprate power level). At this point, the following actions were performed:

- plant data was collected and evaluated for acceptable and safe plant conditions
- a plant walkdown was performed to ensure acceptable conditions relative to piping vibration and general operation
- baseline vibration data was collected on balance of plant pumps for evaluation
- baseline radiation surveys, as deemed necessary

After the above data was reviewed and found acceptable, the results were presented to the Plant Safety and Review Committee (PSRC). With the concurrence of the PSRC and the Plant Manager, a slow increase in power was then commenced to the full uprate power level of 2900 MWt. Once power was stabilized, plant data was collected and reviewed relative to the baseline data collected at 2775 MWt. No adverse conditions existed. The plant was then released for unrestricted full power operation.

TESTING

Testing for the power uprate included collection of general plant data, including baseline vibration data on the following components: condensate pumps, main feedwater pumps, feedwater booster pumps and the main turbine. Plant walkdowns were also performed to observe the plant components and piping movement of the main steam, feedwater, condensate, and heater drain piping. The data was trended to ensure that the plant responded in an acceptable manner with respect to predicted values. Radiological surveys were performed for neutron and gamma radiation levels at the previous 100% power level and at the new uprate power level for comparisons.

Data Collection

Plant data was collected via the Integrated Plant Computer System (IPCS) to monitor the plant response during the power ascension and initial 100% power operation. Specific data trends were established to monitor key parameters such as Reactor Coolant System (RCS) temperatures, Main Steam System pressures, and turbine first stage pressure. Key BOP component flow rates were compared to previous operating cycles along with calculated uprate values. Actual operating flow rates at 100% uprate power were bounded by analysis assumptions.

RCS temperatures were trended for hot leg, cold leg and differential temperatures across each of the steam generators. The measured hot and cold leg temperature values were found to agree with the predicted values over the course of the power ascension sequence.

BOP system data was also collected and evaluated over the course of the power ascension sequence. Major parameters such as main steam pressure, circulating water discharge temperatures, and general plant performance were evaluated during the power ascension sequence to ensure that adverse operating conditions were avoided. Main steam pressure was an important consideration in that modifications to the steam generators were made to reduce steam moisture content. Steam pressure was trended during the power ascension and compared to predicted steam pressures at respective steam generator thermal power levels. In general, the steam pressures were higher than predicted. This is attributed in part to the lower than estimated fouling in the secondary side of the steam generators. Moisture content of the steam was measured on June 28, 1996 using a Sodium-24 tracer process. Results of this testing yielded moisture levels averaging approximately 0.04% in the main steam from the steam generators, which is better than warranted performance (< 0.1%) at uprate power conditions. The condensate system was monitored and found to be acceptable for full uprate power operation. Flow noise at the condensate pump suctions had decreased, indicating less turbulent flow.

The condensate flow control valves were also found to have adequate margin to support uprate power operation and any transients which may occur. Feedwater heater drain valves, modified during the ninth refueling outage, provide adequate capacity to support uprate operations.

The main generator performance continues to support uprate power operation and adequate cooling is supplied by the modification to the system. The main turbine operating parameters were monitored over the course of the plant startup following the replacement of the low pressure turbine rotors. Vibration levels were monitored and several periods of higher than normal vibration occurred due to new packing, tighter clearances, and the characteristics of the new solid monoblock rotors. The vibration transients were attributed to expected packing rubs and were responded to in accordance with plant procedures. After initial startup sequences for the turbine were completed, the power ascension went smoothly. Turbine first stage pressure was trended during the power ascension and followed predicted values.

Plant walkdowns were performed at various power levels during the ascension to uprate conditions. A walkdown was performed at the previous 100% power level of approximately 2775 MWt, to observe any abnormal system conditions, piping movement or unusual noise levels in the plant. No adverse or unusual conditions were noted in the plant at this power level. Once the plant achieved 100% uprate power operation, a walkdown was also conducted to look for the same conditions as a result of the new power level. No unusual conditions were identified.

Component vibration measurements were taken on the main feedwater, feedwater booster, and the condensate pumps at both the old 100% power level and the new uprate power level. The old power level readings were to establish a baseline for comparison, since the components were operating at approximately the same flow rates as pre-uprate conditions. Vibration levels at the 100% uprate power level were taken and compared to the pre-uprate data to identify any adverse conditions for these pumps. While the vibration amplitudes did increase slightly, the increases were expected and were well within acceptable levels.

Normal reactor physics testing was performed throughout the power ascension sequence and at 100% uprate power, as identified in the power ascension controlling procedure, and as identified in the VCSNS Technical Specifications. Results of these tests verified that the core parameters were within acceptable limits

CONCLUSION

The testing has shown that the Virgil C. Summer Nuclear Station is operating as expected and is in full compliance with the Technical Specifications for uprated conditions.