Exelon Nuclear

OYSTER CREEK STATION - UNIT 1

OPERATIONAL RECORDS REVIEW FOR LICENSE RENEWAL

Sargent & Lundy

December 21, 2004
Project No. 11324-016
Safety Related

Prepared by: Thomas Ryszka Date: 12-21-2004
T. Ryszka – Sargent & Lundy

Reviewed by: Kenneth R Rach Date: 12-21-04
K. R. Rach – Sargent & Lundy

Approved by: Kenneth R Rach Date: 12-21-04
K. R. Rach – Sargent & Lundy

Project Closeout Report
S&L Project # 11324-016,
Operational Records Review Regarding Fatigue Cycle Analysis for the License Renewal Application

Project Purpose

Oyster Creek Station is in the process of preparing their license renewal application for an extension of twenty years to its operating license. There are many activities that must take place to meet all the requirements for approval of the application. One of these activities is the fatigue analysis for many of the primary system components at the plant. In order to ensure that accurate information is transmitted to the NRC, an actual count of specific component cycles needs to be conducted to determine the baseline cycle counts for various components. This information will also provide the input into the FatiguePro® program for Oyster Creek.

One of the first steps in this process requires identifying when all reactor heatup and cooldowns occurred over the life of the plant. Numerous information sources have been used to identify when these events occurred. Identifying the heatup and cooldowns provided the framework to improve the efficiency of the information analysis. Data has been gathered by Exelon to identify the operating history of Oyster Creek.

Project Scope

Exelon determined the date of all reactor heatup and cooldowns and this information was captured in their thermal cycle analysis procedure. To support the review of Oyster Creek's License Renewal Application by the NRC, some additional transient information needed to be retrieved from various plant records.

The Oyster Creek thermal cycle counting program, while identifying many of the components that needed to be reviewed, did not cover all the components that are included in the license renewal process. Therefore, a review of various plant records (e.g. LERs, surveillance tests) was performed to identify the cycles on the components that were not part of the Oyster Creek thermal cycle counting program.

Sargent & Lundy determined the number of actuations for the following equipment based on our approach for each system identified in the subsequent section of this document:

- Shutdown Cooling transients
- EMRV actuations for each EMRV
- Isolation Condenser initiations
    - into an idle/isolated loop
    - into an operating loop
- Vessel Pressurization due to nuclear fission

- Hydrostatic pressure test to 1250 psig
- Hydrostatic pressure test to 1375 psig
- Reactor Pressure Vessel Boltup
- Reactor Pressure Vessel Unbolt
- Idle Reactor Recirculation pump starts
- Core Spray Injection into a hot reactor vessel
- Turbine Roll Up to 100% (listed as turbine roll w/ FW injection)
- Emergency cooldown (300° F/hr)

The scope of the work identified when the components were cycled and tabulated those results by performing a review of LERs for EMRVs cycles, Isolation Condenser actuations, and Core Spray system actuations. Additionally, the appropriate surveillances performed at Oyster Creek for EMRV cycles were also reviewed.

Approach to Work

There were a number of possible methods to conduct this review. One method to verify that the fatigue cycles for the various components are counted correctly is to count each component cycle since the first plant heatup that was caused by nuclear fission. This approach although producing accurate results would be a time consuming and expensive process. Therefore, a more efficient method was proposed utilizing past research studies as a baseline. This method utilized the research already completed by Exelon as a starting point.

Exelon provided documentation that identified the specific dates of each unit heatup and cooldown. These dates are the basis for the cycles throughout the plant operation.

Based on S&L's experience with performing similar work at Dresden and Quad Cities license renewal project it became apparent that there are many occurrences of relief valves being cycled outside normal plant heatup and cooldowns. In order to accurately capture the cycles of relief valves a number of documents were reviewed. Those documents include License Event Reports (LERs), Technical Specification review, both past and present, of relief valve cycling requirements, and plant operating surveillances.

Sargent & Lundy determined the number of actuations for the following equipment using the methods identified below.

<u>Electromatic Relief Valves (EMRVs) Actuations</u>

Specific EMRV actuation by valve number was tabulated by reviewing the following references.

1. LER's
2. Surveillance Test Procedure 602.4.003
3. Annual Operating Reports

4. A sample of Control Room Log books containing 1,145 pages. This reference source provided limited information for specific EMRV cycles.

Additionally, during the project the cycle counting methodology was adjusted based on the following information. The EMRVs will automatically cycle open in response to an increase in reactor pressure. As of February 21, 1995 issuance of Amendment No. 177 to Facility Operation License No. DPR-16, the 'A' and 'D' EMRVs lift at 1085 psig, and the 'B', 'C', and 'E' EMRVs lift at 1105 psig. Prior to this time, the Tech Spec Limit for the 'A' and 'D' EMRVs was set to lift at or prior to 1070 psig and the 'B', 'C', and 'E' EMRVs was set to lift at or prior to 1090 psig.

At various times in the history of the plant operations the EMRVs have not properly reseated after opening. If the EMRVs did not reseat properly then the valves had to be cycled again in an attempt to reseat the valves. Because of this historical problem many cycles have occurred. Using this information the following methodologies were developed for cycling of the EMRVs during plant transients and surveillance testing.

A number of different plant transients can cause an increase in reactor pressure such that an EMRV will lift. Two of the more common transients are a trip of the Main Turbine and an isolation of the Main Steam Isolation Valves (MSIV). For the period prior to 1995, assuming the plant was operating at full power each time a Main Turbine trip occurred we identified a total of 2 cycles for the 'A' and 'D' EMRVs. One cycle was counted for both valves on the initial pressure pulse and one additional cycle on the repressurization of the reactor vessel. Additionally, for this same period, when the MSIVs isolated a larger amount of energy needed to be removed from the reactor vessel. Therefore, for each isolation of the MSIVs all five EMRVs were given one cycle count to handle the initial pressure pulse and the 'A' and 'D' EMRVs were given two additional cycles on the normal repressurization of the reactor vessel. For the post-1995 plant-operating period, i.e., with the higher EMRV Tech Spec limit settings, the Oyster Creek simulator ran these same two scenarios with the following results.

- Main Turbine Trip at rated power resulted in an actuation of both 'A' and 'D' EMRVs with subsequent reactor pressure control being maintained by the Turbine Bypass valves.
- Isolation of all MSIVs from rated power resulted in an actuation of the 'A' and 'D' EMRVs and subsequent start-up of both Isolation Condensers to control reactor pressure.

Therefore, after 1995, a cycle count each for the 'A' and 'D' EMRV was counted for the Turbine Trip and MSIV isolation scenarios. The overall method for EMRV cycle counts described above was discussed with the Oyster Creek System Manager on December 20, 2004, and was identified to be a conservative method in capturing EMRV cycles.

EMRV cycles also occur during the running of procedure 602.4.003, "Electromatic Relief Valve Operability Test." This test has been run on a decreasing frequency during the life of the plant as changes to the Technical Specification requirements have changed over time to match the length of the operating cycles. This procedure was first run every 12 months, and then changed to every 18 months, then every 24 months. This procedure was also used for post maintenance testing on the EMRVs. This procedure requires cycling all five of the EMRVs. Since many of the EMRVs, especially in the early years of operation did not reseat properly two cycles were counted only for the surveillances when S&L did not have copies of procedure 602.4.003 for that timeframe.

<u>Isolation Condenser Actuations</u>

Two Isolation Condensers automatically initiate on a reactor pressure of 1060 psig for 1.5 seconds, and on low-low reactor water level of +86 inches above the top of active fuel. Our review indicated that the reason for most of the automatic initiations is high reactor pressure.

A review of some of the operator logs from plant did not always specify the number of times the Isolation Condensers were placed in and removed from service. What was determined is since the Isolation Condensers cannot throttle their flow they are cycled numerous times when placed in service. During the 1980's numerous studies were performed at Oyster Creek regarding the Isolation Condensers. One of those documents, EM-85-1433, dated May 23, 1985, indicated the following information.

> "The number of thermal cycles already experienced prior to the last maintenance outage by the Iso Condenser is 255 per N. Shah and J. D. Abramovici of Tech Functions. This includes 5 scrams/year for 15 years and 36 full cycles as a decay heat device in which during each cycle the system was turned off and on approximately 5 times due to temperature limits on the system."

A review of the available Oyster Creek memos from the 1980's also indicated that up until 1985 the Isolation Condensers were used numerous times which added to the system cycle counts.

A number of information sources were used to accurately capture the number of cycles for this system. One of the sources was a sample of control room logs. Those operator logs identified some specific Isolation Condenser system actuations. When operator logs were not available for review a standard 5 thermal cycles was counted for each reactor cooldown prior to ~1982 when the Isolation Condensers were used as one of the primary methods to cooldown the reactor. Additionally, simulator scenarios were performed to determine the plant response when the Main Steam Isolation Valves (MSIVs) were closed after a scram. These scenarios indicated that the Isolation Condensers could be place on and off between 26 to 30 times until Shutdown Cooling was place in service. Therefore, if it could be determined that the MSIVs were closed then 13 thermal cycles were counted for each Isolation Condenser.

The information that was reviewed to determine the cycles on the Isolation Condensers included:

1. LER's

2. Numerous plant memos and documents. The details are listed in the reference list.

A review of plant documentation indicated that there is no regularly scheduled surveillance that will initiate the Isolations Condensers. There is a surveillance to cycle valves on the system but the valve's positioning does not allow an operational cycle to occur.

The initial system actuations were counted if the reactor vessel temperature were at rated conditions (520 F, 1000 psig) through Cold Shutdown (212 F, at zero psig). If the system was initiated in that temperature range then it was assumed to have run until Shutdown Cooling was placed in service.

Shutdown Cooling (SDC)

The SDC system consists of three loops which take a common suction from the "E" Reactor Recirculation loop, upstream from the suction valve, and discharge back into the "E" Recirc loop downstream of the discharge valve. The limited number of control room operator logs (containing 1,145 pages) reviewed did indicate specific instances of SDC system operation. The review of the logs indicated that the operational trend during the 1970s was cycling the system on and off more than once during each shutdown. This cycling included evolutions from just swapping pumps in the system to shutting down and restarting the system. Therefore, for the time period up to and including 1979, unless otherwise indicated by another document for each unit shutdown when SDC would have been run, two SDC system cycles were counted.

A review of the system operational response data from 2002 to 2004 indicated that typically two SDC pumps are run to achieve the desired flow. The review also indicated that the SDC system has two temperature peaks > 200° F during a typical unit shutdown. Although there are two temperature peaks > 200° F the differential temperature between the Reactor Recirculation suction temperature and the SDC heat exchanger outlet temperature is a better indicator of potential fatigue. An analysis of the differential temperature indicates only one peak when the SDC system is first started. Therefore, after 1980, unless otherwise indicated by another document for each unit shutdown when SDC would have been run one SDC system cycles was identified.

We utilized the operating chronological history for refueling outages (RFO) and forced outages (FO) to determine total number of times that the Shutdown Cooling system was placed into operation.

Starts of 'Cold' Reactor Recirculation Pump(s)

Cold Recirc Pump starts are prohibited by procedure and Oyster Creek Technical Specifications. During discussions with Structural Integrity and Exelon it was identified that pump starts with less than a 50° F differential from the Recirc loop to reactor coolant temperature do not pose a challenge to any components.

Reactor Vessel Head Boltups/ Detensionings

The reactor vessel head is typically only detensioned and bolted up once per refuel outage. Based on previous discussions between S&L, Structural Integrity, and Exelon this number was determined to be the number of refuel outages plus an agreed upon number to ensure that the number identified was conservative. This number will be a bounding number for reactor vessel head boltups and detensionings.

Pressurizations

Based on previous discussions with S&L, Structural Integrity, and Exelon this number was anticipated to be very low and was determined to be the number of refuel outages plus an agreed upon number to ensure that the number identified was conservative.

1. Typically Operational Leak Tests occur once per refuel outage (this should encompass Hydro tests to 1250 psig in the early years, plus operational leak tests to 1050 psig in subsequent years)
2. Overpressure events to 1375 psig - none are anticipated
3. Overpressure events to 1250 psig – none are anticipated
4. Overpressure hydrostatic testing to 1563 psig – one event is anticipated and was performed in the manufacturers shop; none are anticipated to have occurred at the site.

Core Spray Injections (into hot RPV)

1. LER's
2. Numerous plant memos and documents which are listed in the reference list at the end of this report.

The Core Spray system is an Engineered Safeguards System that makes up part of the Emergency Core Cooling System. The system provides low pressure spray to remove decay heat and prevent fuel clad melting following a LOCA. The Core Spray nozzles were identified as being the component most affected by fatigue.

Turbine Rolls (Generator Synchronization)

The electronic data log of the operating history was used to determine the number of times the plant returned to power. This information is identified in the heatup column of the electronic data log.

Based on the available operating history S&L determined that the generator was typically synchronized for each plant startup. S&L used the following information sources:

- OCNGS Topical Report 026
- OCNGS Procedure, "Estimated Critical Position", no. 1001.2
- Oyster Creek Transient / Cycle Summary for the Fatigue Monitoring Program

Oyster Creek performs a transient / cycle summary fatigue monitoring program (reference #22). Based on the review of available information S&L will perform an independent count of plant heatups and choose the more conservative number for the total counts.

Emergency Cooldowns (300°F/hr)
It was anticipated that few if any events of this type occurred since there are procedural and technical specification requirements to limit all plant cooldowns to less than 100°F/hr A review of LER's and all available operational documentation indicated that zero emergency reactor cooldowns occurred (300°F/hr).

Project Results

The detailed results and operational timeline are contained in the electronic data log which is in a Microsoft Excel file.

The summary details for each system are as follows.

EMRV Actuations

Year	A	B	C	D	E	non-specific	Yearly Totals
1969	6	2	2	6	2	0	18
1970	9	3	3	9	3	0	27
1971	4	4	2	2	2	0	14
1972	10	6	6	9	6	0	37
1973	5	4	3	5	3	0	20
1974	4	2	2	4	2	0	14
1975	8	2	2	8	2	0	22
1976	2	2	2	2	2	0	10
1977	5	1	1	5	2	0	14
1978	4	3	3	4	3	0	17
1979	0	0	0	0	2	0	2
1980	2	2	2	1	2	0	9
1981	4	0	3	4	2	0	13
1982	4	1	2	3	1	0	11
1983	0	0	0	0	0	0	0
1984	7	2	5	8	5	0	27
1985	10	6	12	16	4	0	48
1986	3	2	9	8	2	2	26
1987	3	1	1	3	1	0	9
1988	0	0	0	0	0	0	0

Year	A	B	C	D	E	non-specific	Yearly Totals
1989	9	2	1	4	3	0	19
1990	0	0	0	0	0	0	0
1991	1	1	2	1	2	0	7
1992	2	1	1	1	0	0	5
1993	1	1	1	1	1	0	5
1994	2	2	1	3	2	0	10
1995	2	0	0	2	0	0	4
1996	3	6	3	3	2	0	17
1997	2	1	1	3	1	0	8
1998	1	5	4	7	1	0	18
1999	0	0	0	0	0	0	0
2000	5	4	3	2	5	0	19
2001	0	0	0	0	0	0	0
2002	1	1	1	1	4	0	8
2003	2	0	0	2	0	0	4
2004	0	0	2	0	1	0	3
Totals	121	67	80	127	68	2	465

Isolation Condenser Actuations

	IsoCond A(1)	IsoCond B(2)	IsoCond n/sp	Yearly Totals
1969	35	37	3	75
1970	26	11	4	41
1971	10	11	0	21
1972	31	34	1	66
1973	34	36	0	70
1974	13	14	0	27
1975	26	26	0	52
1976	5	7	0	12
1977	17	38	0	55
1978	9	8	0	17
1979	9	25	0	34
1980	0	0	0	0
1981	10	10	0	20
1982	3	3	0	6
1983	0	0	0	0
1984	0	0	0	0
1985	30	30	0	60
1986	5	2	0	7
1987	1	1	0	2
1988	0	1	0	1
1989	7	7	0	14
1990	0	0	0	0
1991	3	3	0	6
1992	26	26	0	52
1993	0	0	0	0
1994	3	3	0	6
1995	3	3	0	6
1996	0	0	0	0
1997	13	13	0	26
1998	13	13	0	26
1999	0	0	0	0
2000	14	14	0	28
2001	0	0	0	0
2002	0	0	0	0
2003	4	4	0	8
2004	0	0	0	0
Totals	350	380	8	738

The information contained in the above table identifies all the actuations of the Isolation Condensers at Oyster Creek. The Isolation Condensers condensate return path is the Reactor Recirculation system. The main fatigue concerns with the operation of the Isolation Condensers are the stresses that are induced when the system is first initiated. This is due to the large differential temperature between the relatively cold condensate that is returned into a hot Reactor Recirculation system. Therefore, S&L was requested to identify the number of initial actuations of the Isolation Condensers.

The number of initial actuations for the Isolation Condensers are listed below and in the electronic data log.

Initial Isolation Condenser System Actuations	Total Number
Isolation Condenser A(1)	68
Isolation Condenser B(2)	73
Isolation Condenser non-specific	4

Shutdown Cooling System Actuations

	SDC A	SDC B	SDC C	SDC n/sp	Yearly Totals
1969	0	0	0	14	14
1970	5	3	7	2	17
1971	5	4	7	0	16
1972	9	9	9	1	28
1973	0	1	4	1	6
1974	0	0	0	8	8
1975	0	0	0	18	18
1976	0	0	0	3	3
1977	0	3	1	2	6
1978	0	0	0	8	8
1979	0	0	0	4	4
1980	0	0	0	5	5
1981	0	0	0	7	7
1982	0	0	0	5	5
1983	0	0	0	1	1
1984	0	0	0	4	4
1985	0	0	0	9	9
1986	0	0	0	3	3
1987	0	0	0	6	6
1988	0	0	0	3	3
1989	0	0	0	7	7
1990	0	0	0	5	5
1991	1	1	0	3	5
1992	0	0	0	6	6
1993	0	0	0	1	1
1994	0	0	0	4	4
1995	0	0	0	1	1
1996	0	0	0	6	6
1997	0	0	0	2	2
1998	0	0	0	2	2
1999	0	0	0	0	0
2000	0	0	0	6	6
2001	0	0	0	2	2
2002	0	0	0	1	1
2003	0	0	0	3	3
2004	0	0	0	3	3
Totals	20	21	28	156	225

Starts of a "cold" Reactor Recirculation Pump

Cold Recirc Pump starts are prohibited by procedure and Oyster Creek Technical Specifications. During discussions with Structural Integrity and Exelon it was identified that pump starts with less than a 50° F differential from the Recirc loop to reactor coolant temperature do not pose a challenge to any components. Since S&L's review did not identify any cold Recirc pump starts, and the pump starts are limited procedurally no cycles of this type of transient have been identified

Reactor Vessel Head Boltups/ Detensionings
The reactor vessel head is typically only detensioned and bolted up once per refuel outage. Based on previous discussions with S&L, Structural Integrity, and Exelon this number is determined to be the number of refuel outages plus three additional evolutions. The three additional reactor vessel head boltups and detensionings provide a conservative estimate for this evolution. The number of reactor vessel head boltups and detensionings are 20 (refuel outages) plus 3 equals 23 evolutions.

Pressurizations
Based on previous discussions with S&L, Structural Integrity, and Exelon this number was anticipated to be very low.

1. Typically Operational Leak Tests occur once per refuel outage (this encompasses Hydro tests to 1250 psig in the early years, plus operational leak tests to 1050 psig in subsequent years). Three additional leak tests provide a conservative estimate for this evolution. An additional hydrostatic test was identified on August 15, 1982. The number of pressurizations are 20 (refuel outages) plus 3 plus 1 (August 15, 1982 event) equals 24 evolutions
2. Overpressure events to 1375 psig - none were identified
3. Overpressure events to 1250 psig – none were identified
4. Overpressure hydrostatic testing to 1563 psig – one event is anticipated and was performed in the manufacturers shop; none were identified to have occurred at the site.

Core Spray Injections (into hot RPV)
Review LER's for any events. No events were anticipated to have occurred for this transient; however, S&L's review indicated that two Core Spray injections occurred. These events occurred on June 30, 1973 and October 29, 1984.

- The June 30, 1973 event is identified in Control Room Log Book 101, page 10017. The log indicated that 'Core Spray System One" initiation occurred during the transient after a reactor scram. The log did identify that EMRVs opened and Isolation Condensers initiated during this transient but did not specify if the Core Spray system injected after it initiated. This event was counted as an initiation to capture this event and ensure that the cycle counts were conservative.
- The October 29, 1884 event was identified in LER-84-025. LER 84-025-00, inadvertent initiation of Core Spray system during reactor low-low sensor calibration. Reactor was shutdown for refueling and the temperature was approx. 195 deg F. Core Spray I was inadvertently initiated and injected Torus water into

the vessel for approx. 20 seconds during calibration of reactor water level instrumentation. Reactor water level was increased by approx. 22 inches and vessel temp was reduced by only 3° F.

Turbine Rolls (Generator Synchronization)
The number of turbine rolls is based on the information made available to S&L and is the number of heatups that were identified in the electronic log. The S&L count of plant heatups is based on the available information and is 184. The Oyster Creek Transient / Cycle Summary for the Fatigue Monitoring Program (reference #22) identified that there were 213 plant heatups as of January 1, 2004. Adding in three more heatups for the two force outages and the one refueling outage in 2004 brings the count to 216. Therefore, in order to provide a conservative count 216 is identified as the number of plant heatup cycles and Main Turbine Rolls. The S&L information is tabulated by year.

Year	# of Heatup Cycles
1969	9
1970	9
1971	6
1972	7
1973	7
1974	7
1975	10
1976	3
1977	6
1978	7
1979	8
1980	6
1981	7
1982	6
1983	1
1984	4
1985	13
1986	5
1987	6
1988	3
1989	9
1990	5
1991	4
1992	6
1993	1
1994	4
1995	1
1996	6
1997	2
1998	2
1999	0
2000	6
2001	2

Year	# of Heatup Cycles
2002	1
2003	2
2004	3
Total	184

Emergency Cooldowns (300°F/hr)

S&L's review of LER's and all available operational documentation indicated that zero emergency reactor cooldowns, of 300 °F/hr occurred. There were two reactor cooldowns identified that exceeded 100 °F/hr. These events occurred on 12/29/72 and 11/15/2000.

Reference	Document Title
1*	Memo - Isolation Condensers, December 21, 1972
2*	Memo - Oyster Creek Emergency Condenser Leakage Investigation, April 17, 1984
3	Memo - OC Isolation Condenser Operating Temperatures, October 12, 1984
4	Memo - Oyster Creek GORB Action Item 420, October 31, 1984
5	Memo - Emergency Condenser Operation TFWR A01106, April 19, 1985
6	Memo - Morpholine Release from ISO-Condenser 'B', May 16, 1985
7	Memo - V-14-35 Isolation Condenser Condensate Return Valve Tech Spec Surveillance, June 6, 1985
8	TDR No. 580 rev. 2 - Isolation Condenser System Piping Cracked Welds - Repair and Failure Analysis, 11-5-85
9	TFWR No. A01258 - Iso Condenser Steam Vent Piping, 7-11-85
10	TR No. AT4469 - Condensate Return Valve Control, 11-3-86
11	Memo - OC-Leak Rate and Iso-Condenser Penetration Evaluation, September 4, 1987
12	Memo - Oyster Creek Isolation Condensers Heatup by Cycling Vent Valves, November 23, 1988
13	Memo - Number of Thermal Cycles for Isolation Condenser Piping, December 20, 1988
14	SE No. 000211-010 - Closure of Iso-Condenser Vent Valves, 12-1-90
15	Student Handout 2621-828.0.0023 Attachment 2 - OCNGS Systems / Isolation Condenser System, rev. 0, 6-12-02
16	Nuclear Plant Operator Initial Course No. 2611-PGD-2621 - Core Spray System, Code 828.0.0010, rev.5, 3-12-02
17	Nuclear Plant Operator Initial Course No. 2611-PGD-2621 - Automatic Depressurization System, Code 828.0.0005, rev.4, 5-2-02
18*	OCNGS Topical Report 026 revision 6 Table 4-3
19*	OCNGS Topical Report 026 revision 6 Table 5-1
20*	OCNGS Procedure, "Electromatic Relief Valve Operability Test", no. 602.4.003
21*	OCNGS Procedure, "Estimated Critical Position", no. 1001.2
22	Oyster Creek Transient / Cycle Summary for the Fatigue Monitoring Program

* Data extracted from reference and entered on "counts" spreadsheet

Note: The reference numbers in this table are also used in the electronic data log for this project.