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A Duke Energy Company

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December 8, 2003

U. S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Duke Energy Corporation
Catawba Nuclear Station Unit 1
Docket Nos. 50-413
Licensee Event Report 413/03-006 Revision 0
1B Containment Spray System Inoperable for Longer than Technical Specifications Allow Due to Heat Exchanger Baffle Plate Degradation

Attached please find Licensee Event Report 413/03-006 Revision 0, entitled "1B Containment Spray System Inoperable for Longer than Technical Specifications Allow Due to Heat Exchanger Baffle Plate Degradation."

This Licensee Event Report does not contain any regulatory commitments. This event is considered to be of no significance with respect to the health and safety of the public. Questions regarding this Licensee Event Report should be directed to R. D. Hart at (803) 831-3622.

Sincerely,

D. M. Jamil

Attachment

IE22

xc:

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NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)	Estimated burden per response to comply with this mandatory information collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE
1B Containment Spray System Inoperable for Longer than Technical Specifications Allow Due to Heat Exchanger Baffle Plate Degradation

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME: None	DOCKET NUMBER
10	09	2003	2003	- 006 -	00	12	8	2003	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE	1
10. POWER LEVEL	100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)		50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)	X	50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)	X	50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
R. D. Hart, Regulatory Compliance	803-831-3622

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
X	BE	HX	YUBA	Y					

14. SUPPLEMENTAL REPORT EXPECTED				15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

The 1B containment spray system (CSS) was declared inoperable on October 6, 2003 at 0400 hours to allow the installation of inspection ports to support upcoming Unit 1 refueling activities. Inspections of the 1B CSS heat exchanger revealed degradation of the baffle plates. Engineering review of the 1B CSS heat exchanger determined that the heat exchanger could not be returned to service within the time limits required by Technical Specifications (TS). A notice of enforcement discretion (NOED) was requested from the NRC to allow time to prepare and approve an exigent TS change to support continued operation. The NRC granted the NOED on October 9, 2003 at 2125. Subsequent evaluations by engineering with support from a vendor determined that the 1B CSS heat exchanger could be determined to be operable with some limitations on shell side flows. This evaluation was reviewed and approved by station management and the 1B CSS heat exchanger was declared operable on October 21, 2003 at 2106. The exigent TS change was determined to not be required and was withdrawn. The 1B CSS heat exchanger is being replaced during the current Unit 1 refueling outage. The health and safety of the public was not affected.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

BACKGROUND

Catawba Nuclear Station Unit 1 is a Westinghouse Pressurized Water Reactor [EIIS: RCT].

The Containment Spray System (CSS) [EIIS: BE] provides containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. Reduction of containment pressure and the iodine removal capability of the spray reduce the release of fission product radioactivity from containment to the environment, in the event of a Design Basis Accident (DBA).

The CSS consists of two separate trains of equal capacity, each capable of meeting the system design basis spray coverage. Each train includes a containment spray pump [EIIS: P], one containment spray heat exchanger [EIIS: HX], spray headers, nozzles [EIIS: NZL], valves [EIIS: V], and piping. Each train is powered from a separate Engineered Safety Feature (ESF) bus [EIIS: BU]. The refueling water storage tank (RWST) [EIIS: DA] supplies borated water to the CSS during the injection phase of operation. In the recirculation mode of operation, containment spray pump suction is transferred from the RWST to the containment recirculation sump(s). When the CSS suction is from the containment recirculation sump, its associated heat exchanger receives nuclear service water system (NSWS) flow for cooling. The NSWS is served by two bodies of water, Lake Wylie and the Standby Nuclear Service Water Pond (SNSWP). Lake Wylie serves as the non-safety class, non-seismic, normal source of nuclear service water. The SNSWP is a Category 1 seismically designed structure with sufficient water to bring the station to cold shutdown following a Loss of Coolant Accident on one unit and a normal cooldown on the other unit.

The CSS heat exchangers are vertical shell and U-tube design. Borated water from the RWST or containment recirculation sump circulates through the tubes, while NSWS circulates through the shell. During normal operation, the NSWS side of the CSS heat exchangers is maintained in wet lay-up condition with the NSWS side isolated and treated NSWS water recirculated through the heat exchanger. Historically, the wet lay-up systems for the CSS heat exchangers are in service approximately 50% of the time. The basic materials of construction for the CSS heat exchangers are carbon steel; including the shell, divider plate, tie-rods, and baffle plates. The tubes and impingement plate are stainless steel. The tube sheet is stainless steel clad carbon steel. The purpose of the baffle plates is to create turbulent flow of the shell side fluid (NSWS). The baffle plates create a tortuous path through the shell side, increasing the velocity of the fluid. An increase in the velocity of the fluid results in an increase in heat transfer of the heat exchanger.

Technical Specification (TS) 3.6.6 requires in part that two CSS trains be operable. Condition A for TS 3.6.6 states that with one CSS train inoperable, the CSS train must be restored to operable status within 72 hours. Condition B states that with the Required Action and associated Completion Time of Condition A not met, the unit must be in Mode 3 within 6 hours and in Mode 5 within 84 hours.

This event is being reported under 10 CFR 50.73(a)(2)(i)(B) (any operation or condition prohibited by the plant's Technical Specifications (TS)), and 10CFR50.36(c)(2)(i) (Limiting Condition for Operation (LCO) not met). No structures, systems, or components were out of service at the time of this event that contributed to the event. At the time these conditions were identified, Unit 1 was operating in Mode 1, Power Operation.

EVENT DESCRIPTION
(Dates and times are approximate)

Date/Time	Event Description
10/06/03~0400	Operations removed the 1B CSS heat exchanger from service to allow maintenance to install inspection ports to support upcoming Unit 1 refueling activities.
10/06/03~1900	Inspections of the 1B CSS heat exchanger revealed degradation of the baffle plates. The most significant finding was the loss of tube baffle plate ligament material on the outer and inner bundle periphery tube rows, which adversely affects the unsupported tube length. A video probe inspection within the bundle outer periphery rows at six baffle plate locations verified the presence of baffle plate

NARRATIVE (*If more space is required, use additional copies of NRC Form 366A*) (17)

	ligament support at three to five rows deep on the shell outlet and at two rows deep on the shell inlet.
10/06/03~2200	A team was formed to evaluate the results and determine the next course of action. Maintenance was requested to install some additional inspection ports.
10/07/03	Some of the additional inspection ports were installed as requested on the 1B CSS heat exchanger. Inspection of the heat exchanger revealed similar degradation of the baffle plates. Engineering continued its review of the inspection data to determine the extent of condition and its effect on the 1B CSS heat exchanger.
10/08/03~0428	Maintenance completed installing the additional inspection ports requested by Engineering. Engineering began additional inspection of the heat exchanger and collecting additional data.
10/08/03	The Plant Operations Review Committee (PORC) reviewed and approved the NOED request.
10/08/03~1630	A telephone conference was held between the NRC and Catawba to request the NOED for the 1B CSS heat exchanger.
10/08/03 2125	The NRC verbally granted the NOED request. The NOED request was for 336 hours from time of approval to allow the development, submittal and NRC approval of an exigent TS amendment to support continued operation of Unit 1 until the fall 2003 refueling outage.
10/09/03	Catawba submitted the NOED request in writing to the NRC.
10/09-11/03	Maintenance activities continued including installation of covers on the inspection ports and hydro testing of the heat exchanger tubes.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

	Engineering continued activities to evaluate the status of the 1B CSS heat exchanger and to determine if an operability evaluation could be supported.
10/13/03	Maintenance activities were complete and the 1B CSS heat exchanger was released to Operations for placing in service and associated testing.
10/13/03	The PORC reviewed and recommended approval of an exigent TS amendment to support continued operation of Unit 1 with the 1B CSS heat exchanger inoperable but inservice until the upcoming fall 2003 refueling outage.
10/14/03	The Nuclear Safety Review Board reviewed and recommended approval of the exigent TS amendment.
10/14/03	Testing of the 1B CSS for heat capacity and resistance factor was completed. The acceptance criteria were met for both procedures.
10/15/03	The exigent TS amendment was signed and sent to the NRC.
10/16/03	A draft operability evaluation for 1B CSS heat exchanger was distributed for site review based upon a structural evaluation of seismic loading performed by a contract equipment supplier.
10/20/03	The PORC approved the operability evaluation.
10/21/03 2106	Operations approved the operability evaluation for the 1B CSS heat exchanger and the NOED was exited.
10/22/03	Catawba sent a letter to the NRC withdrawing the exigent TS amendment.

CAUSAL FACTORS

The degraded condition of the 1B CSS heat exchanger was caused by contact of raw water on the carbon steel components and the lack of an adequate program to inhibit the corrosion mechanisms. Additional factors such as excessive flow may have contributed to the accelerated rate of corrosion. The fact that some level of corrosion was present in the heat exchangers was well known, and several opportunities were available to better understand the extent of the degradation and the impact this condition could have on heat exchanger operability. These opportunities included installation of an inspection port and subsequent inspection on the 1B CSS heat exchanger in 1991. In the subsequent years eddy current testing was completed on both Units CSS heat exchangers and the results indicated baffle plate wear. In 2002, tubes were pulled from the 1B and 2B CSS heat exchangers which showed baffle plate wear as "non-typical with irregular circumferential tube scaring marks affecting small areas of circumference.

Based on the known condition of corrosion and the associated missed opportunities, the root cause for this event was failure to recognize the impact of a known degrading condition on the operability of a safety-related component. A contributing cause was also identified as inadequate monitoring and oversight of a degrading component with known design vulnerabilities.

CORRECTIVE ACTIONS

Immediate:

1. A team was formed to investigate the cause of the fouling of the 1B CSS heat exchanger. The team investigated several potential root causes and corrective actions.

Subsequent:

1. The inspection ports installed on the 1B CSS heat exchanger were covered; the heat exchanger was tested and returned to service.

2. Engineering completed an operability evaluation with administrative flow limits which allowed the 1B CSS heat exchanger to be declared operable. The administrative flow

limits were put in place and the 1B CSS heat exchanger was declared operable.

Planned:

1. The 1B CSS heat exchanger is being replaced in the current Unit 1 refueling outage, 1EOC14. The new heat exchanger is redesigned to have the NSWS flow going through the tubes. This will facilitate routine cleanings and enhance the ability of the plant to maintain the heat exchanger.

2. The shell sides of the 2A and 2B CSS heat exchangers will be inspected. The results will be used to identify any additional actions and document those actions in the corrective action program.

3. The information from this event will be evaluated to enhance the CSS heat exchanger monitoring program as described in LER 413-03-004.

4. For safety related heat exchangers, ensure a method is in place for monitoring the condition of subcomponents that are in contact with raw water and are capable of affecting the operability of the heat exchanger.

The planned corrective actions as well as any future corrective actions will be addressed via the Catawba Corrective Action Program. There are no NRC commitments contained in this LER.

SAFETY ANALYSIS

During the time period that the 1B CSS heat exchanger was inoperable, the 1A CSS train was operable and no equipment was taken out of service that would have rendered this train inoperable.

Duke Energy evaluated the effect of remaining at power for an additional 336 hours (actual time was approximately 305 hours) with the 1B CSS heat exchanger out of service using an Internal and External Events probabilistic risk assessment with average unavailabilities. The CSS has no impact on the calculated core damage frequency (CDF). The CSS is not included in the Level One PRA model. The CSS also has no significant impact on the

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calculated large early release frequency (LERF). At Catawba, LERF is dominated by sequences involving inter-system loss-of-coolant-accidents (ISLOCAs) or pressure spikes due to hydrogen burns. It is unlikely that the CSS could mitigate the pressure spikes due to a hydrogen burn.

The CSS system may have some impact on Large Late Releases. However, the impact of one CSS train unavailable is small. Generally, accidents that lead to core damage involve loss of support systems and the independent failures are not large contributors. These systems support both the core damage mitigation systems as well as CSS. The increase in the Large Late Release Frequency can be approximated by multiplying the frequency of the Intact Containment release categories with sprays available by the failure probability of CSS with only one train (2.3E-02). Note that this approximation is conservative since it assumes that a CSS train failure will move a sequence from the Intact Containment category to the Late Containment Failure category. The increase in the Large Late Release Frequency is approximately 2.2E-08 for a 14 day CSS extension. This increase is approximately 0.08 percent of the total late containment failure probability for a year. A qualitative assessment of the risks that were not considered in the quantitative analysis resulted in the development of several compensatory measures. These were implemented during the period of non-compliance with the Technical Specifications.

At Catawba, the residual heat removal (RHR) system has been designed to include a provision for diversion of a portion of the RHR pump flow from the low head injection path to auxiliary spray headers in the upper containment volume. For this mode, the RHR pumps continue to supply recirculation flow from the containment sump to the core via the safety injection and centrifugal charging pumps. The diversion of the RHR flow from the low head injection path to the auxiliary spray headers occurs only after the switchover to the recirculation mode and no earlier than 50 minutes after initiation of the LOCA.

The inspection of the 1B CSS heat exchanger identified that the divider plate between the 2 passes appeared to be intact. Since the segmental baffles function both to support the heat exchanger tubes and to promote heat transfer by diverting flow back and forth across the tube bundle, tube integrity, heat transfer effectiveness and overall structural integrity were evaluated. Existing

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calculations for containment heat removal have been reviewed to assess any adverse impact due to the loss of segmental baffle plates. The reanalysis showed that the 1B CSS heat exchanger continued to provide required heat transfer capability as measured by the product of U (overall heat transfer coefficient) and A (heat transfer surface area) consistent with assumptions used in the Catawba containment peak pressure analysis, as long as the 1B CSS heat exchanger operating parameters are maintained. The integrity of the CSS HX 1B tubes has been verified by hydrostatic testing performed October 9-11, 2003. The testing was performed by pressurizing and holding 1800 psig of pressure on 100% of the non-plugged tubes to demonstrate integrity. The 1800 psig test pressure far exceeds the pressure differential across the tubes under accident conditions, which would be limited by the CSS Pump shutoff head to less than 250 psig. Existing calculations for containment fission product removal were reviewed to identify and assess any adverse impact caused by the loss of segmental baffle plates. A review of methodology and assumptions used to calculate iodine removal rate constants used in offsite and control room dose calculations confirmed that removal rate constant results are not sensitive to containment temperature and pressure assumptions. In addition it has been confirmed that the calculated UA results for the 1B CSS heat exchanger assuming partial loss of the segmental baffle plates do not result in the need to revise the peak containment pressure and temperature analysis. Therefore, fission product removal remains unaffected.

Degraded tube bundle structural response to a simulated Safe Shutdown Earthquake (SSE) for the CNS site has been evaluated. The analysis was performed using a bounding dynamic model of a tube supported at the bottom by the tube sheet. The tube is unsupported along its length with contact elements modeled at the top-end to simulate tube-to-baffle impacts, and at the mid-span to simulate tube-to-shell and tube-to-tube impacts. Gaps were considered at the mid-span and top support locations to represent baffle degradation. The total damage expenditure from the combined effect of the SSE earthquake and 30 days of 3000 gpm operation was determined to be well below the ASME code required limit of 1.0 for fatigue usage. The analysis considered tube-to-tube and tube-to-long baffle impact loadings, as well as bending stress at the tube sheet attachment location. The conclusion of this evaluation is that the tube bundle can withstand the combined effects of a design basis seismic event and up to 30 days of operation at < 3000 gpm

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NSWS System flow without sustaining tube failure. In lieu of performing an Operating Basis Earthquake (OBE) seismic evaluation, seismic conditions (i.e., minimum detectable seismic events of 0.01 g) were monitored and a computer alarm response procedure directed the operators to declare the 1B CSS System inoperable and to isolate the 1B CSS heat exchanger had an OBE occurred.

In addition, a review of plant history over the past three years did not discover any time where a seismic event occurred that met the criteria of an OBE or SSE. Therefore, the seismic capability of the 1B CSS heat exchanger had not been challenged.

In May 2003, post cleaning visual inspection of the 1A CSS heat exchanger indicated no significant degradation of the shell side baffle plates and indicated that the carbon steel surfaces were in fact very hard (not soft or flaking). Considering data from the inspections of the 1A CSS heat exchanger, engineering determined that the 1A CSS heat exchanger bundle remains structurally sound. There is no evidence of the severe baffle plate damage as was found in the 1B CSS heat exchanger.

Engineering reviewed previous eddy-current testing results for the Unit 2 CSS heat exchangers against the Unit 1 CSS heat exchangers and the visual inspections recently completed. Similar but less severe baffle plate hole degradation has been observed in the Unit 2 CSS heat exchangers. The shell side flow restrictions implemented for the operability evaluation for the 1B CSS heat exchanger have also been implemented for both the 2A and 2B CSS heat exchangers. This adds additional margin for structural integrity of the Unit 2 CSS heat exchangers.

In conclusion, the overall safety significance of this event was determined to be minimal and there was no actual impact on the health and safety of the public.

ADDITIONAL INFORMATION

A review of LERs from the last three (3) years found one LER written for components serviced by the NSWS being inoperable for longer than required by TS due to fouling. LER 413-03-004 was written for the 1A CSS heat exchanger being inoperable for greater than TS allowed due to NSWS system fouling and corrosion. The corrective actions from LER 413-03-004 would not have prevented the issue in this LER since the corrosion found in the 1B CSS heat exchanger most probably existed for some period of time. Therefore, the corrective actions from LER 413-03-004 and this LER should prevent future occurrences.

A review was performed of operating experience for similar events associated with heat exchanger material degradation and events associated with the failure to detect degraded material conditions associated with heat exchangers that have occurred at Duke nuclear plants or within the nuclear industry during the period of 01/01/1991 and 10/09/2003. The Duke operating experience review was performed utilizing the corrective action programs at the Duke nuclear plants. The industry operating experience review was performed utilizing the Duke Power Operating Experience Database (OEDB) and INPO Nuclear Network. The primary objective of the review was to identify operating experience with similarities to the Catawba Nuclear Spray System heat exchanger 1B degradation and determine if there were previously identified lessons learned (missed opportunities) that could have been more effectively internalized to prevent the Catawba event. The primary focus of the operating experience review was on the identification of:

- Degraded heat exchanger materials/components
- Inadequate or ineffective performance/condition monitoring methods/programs
- use of ECT data related to material condition other than tube condition

Searches of the corrective action databases and of the OEDB were performed to ensure comprehensive identification of related operating experience. Review of industry operating experience determined there is an abundance of industry and internal operating experience associated with heat exchanger issues and established a longstanding history within the industry associated with raw water related heat exchanger problems. However, there was no specific internal or industry operating experience identifying missed opportunities that would have prevented the 1B CSS heat exchanger baffle plate degradation event. However, in the aggregate, the information contained in pertinent Catawba operating experience and the root cause associated with LER 413-03-004 indicates that Catawba may have missed opportunities to rigorously evaluate heat exchanger material conditions and to pursue more effective corrective actions that may have assisted in detecting the 1B CSS heat exchanger condition sooner.

Energy Industry Identification System (EIIS) codes are identified in the text as [EIIS: XX]. This event did involve an equipment failure and is reportable to the Equipment Performance and Information Exchange (EPIX) program. This event did not include a Safety System Functional Failure. There were no releases of radioactive materials, radiation exposures or personnel injuries associated with this event.