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A Duke Energy Company

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May 30, 2000

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: Catawba Nuclear Station, Unit 2
Docket No. 50-414
Licensee Event Report 414/00-002

Attached is Licensee Event Report 414/00-002 titled "Inoperable Ignitors on Both Trains of the Hydrogen Ignition System Due to a Common Cause Failure Mode of Non-Safety Related Equipment Resulting in a Technical Specification Violation."

The planned corrective actions stated in this report represent a regulatory commitment.

This event is considered to be of no significance with respect to the health and safety of the public. If there are any questions on this report, please contact L.J. Rudy at (803) 831-3084.

Sincerely,

for

Gary R. Peterson

Attachment

IE22

RGN-001

xc (with attachment):

Mr. Luis A. Reyes
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NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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TITLE (4)

Inoperable Ignitors on Both Trains of the Hydrogen Ignition System Due to a Common Cause Failure Mode of Non-Safety Related Equipment Resulting in a Technical Specification Violation

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
04	29	2000	2000	002	00	05	30	2000	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9): 1

POWER LEVEL (10): 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		
	20.2203(a)(2)(iv)	X	50.36(c)(2)	X	50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
L.J. Rudy, Regulatory Compliance	(803) 831-3084

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE
	BB	RNR	AC Delco	Yes					

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

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

On April 26, 2000, during Mode 1 operation, it was discovered that 12 of 35 ignitors of Train B of the Hydrogen Ignition System (HIS) failed their Technical Specification (TS) Surveillance Requirement and were inoperable. 34 ignitors were replaced on Train B (one ignitor was inaccessible in Mode 1 due to its location beneath the reactor vessel missile shield). Following replacement of the Train B ignitors, Train A of the HIS was tested on April 29, 2000, and 2 of 35 ignitors failed. 34 Train A ignitors were replaced (the inaccessible ignitor beneath the missile shield was not replaced). The cause of the ignitor failures was determined to be the fact that, unknown to Catawba, the internal design of the component was changed by a new vendor sub-contractor. This rendered the ignitors unsuitable for the intended use in the HIS. Catawba retroactively determined that multiple ignitors on each HIS train were inoperable due to a common cause failure mode. An emergency TS amendment was subsequently requested and approved to exclude the ignitors beneath the missile shield from the HIS TS requirements on a temporary basis. For this event, the overall hydrogen mitigation function was maintained as a result of the remaining ignitors and other hydrogen mitigation equipment.

Background

Catawba Nuclear Station Unit 2 is a Westinghouse Pressurized Water Reactor [EIIS: RCT]. Unit 2 was operating in Mode 1, "Power Operation" at 100% power immediately prior to this event. The event is being reported pursuant to 10CFR50.73(a)(2)(i)(B), (any operation or condition prohibited by the plant's Technical Specifications), 10CFR50.73(a)(2)(vii)(D), (any event where a single cause or condition caused at least one independent train or channel to become inoperable in multiple systems or two independent trains or channels to become inoperable in a single system designed to mitigate the consequences of an accident), and 10CFR50.36(c)(2)(i) (limiting condition for operation of a nuclear reactor not met).

The function of the Hydrogen Ignition System (HIS) [EIIS: BB] is to employ a method of controlled ignition, using thermal ignitors, to reduce the hydrogen concentration in an ice condenser containment following a degraded core accident. The HIS was installed to mitigate beyond design basis accidents as a post-TMI requirement according to 10CFR50.44. Per emergency procedures, the HIS is utilized in conjunction with the Hydrogen Recombiners [EIIS: RCB] and the Containment Air Return and Hydrogen Skimmer System [EIIS: BB] to maintain hydrogen concentrations in containment below explosive limits. At Catawba, a total of 70 ignitors (35 per train) are distributed throughout the various regions of containment in which hydrogen could be released or to which it could flow in significant quantities. Each containment region has two ignitors, one per train, controlled and powered redundantly so that ignition would occur in each region even if one train failed to energize. Catawba utilizes diesel glow plugs as the hydrogen ignitors. The ignitors are non-safety related and there is no equipment qualification or commercial dedication process required concerning glow plug use in the HIS.

Technical Specification (TS) 3.6.9 governs the HIS and is applicable in Modes 1 and 2. TS 3.6.9 requires that two HIS trains be operable in Modes 1 and 2. Operability of the HIS is demonstrated by:

1) Surveillance Requirement (SR) 3.6.9.1, which requires that each HIS train power supply breaker be energized and that $\geq$ 34 ignitors be verified to be energized in each train,
2) SR 3.6.9.2, which requires that at least one hydrogen ignitor be verified operable in each containment region, and
3) SR 3.6.9.3, which requires that each hydrogen ignitor be energized and its temperature verified to be $\geq$ 1700°F.

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

With one HIS train inoperable per Condition A, Required Action A.1 requires that the HIS train be restored to operable status within 7 days, or alternatively, per Required Action A.2, SR 3.6.9.1 may be performed on the operable train once per 7 days. With one containment region with no operable hydrogen ignitor per Condition B, Required Action B.1 requires that one hydrogen ignitor in the affected containment region be restored to operable status within 7 days. With any Required Action and associated Completion Time not met, Required Action C.1 requires that the unit be in Mode 3 within 6 hours. With more than one containment region with no operable hydrogen ignitor, TS 3.0.3 would apply and the unit would have to be in Mode 3 within 6 hours.

No structures, systems, or components were out of service at the time of this event that contributed to the event.

Event Description (dates and approximate times)

March-April 2000
During the Unit 2 end-of-cycle 10 refueling outage, all ignitors were replaced with ones of a different vendor sub-contractor (sub-contractor B). Prior to installation, they were burned in for 6 hours and tested. After installation, they were subjected to TS surveillance testing and all passed. Following the replacement and testing, all ignitors were verified to be operable before Unit 2 entered Mode 2.

April 26, 2000
Testing was performed on the Train B ignitors per TS 3.6.9 SRs. During the performance of the test, a total of 12 ignitors failed.

April 26-28, 2000
Catawba replaced 34 of the Train B ignitors which were accessible with the unit in Mode 1. A power reduction to 18% power was necessary to replace some of these ignitors in order to minimize radiation exposure. The 34 ignitors were replaced with ones from the same vendor sub-contractor (sub-contractor A) that had previously been utilized prior to the end-of-cycle 10 refueling outage, as these were proven to be reliable. There was one remaining Train B ignitor located beneath the reactor vessel missile shield, which is inaccessible during power operation due to radiological and personnel safety concerns. Hence, this one ignitor was not replaced on Train B.

April 29, 2000/0045 hours
Following replacement of the 34 Train B ignitors, Train B of the HIS was retested and was declared operable. Train A of the HIS was then tested and 2 ignitors failed. All of the other Train A ignitors passed. Based on the Train B experience, 34 of the ignitors were replaced with ones from the same vendor sub-contractor (sub-contractor A) that had previously been utilized. Again, the one Train A ignitor beneath the reactor vessel missile shield was not replaced due to it being inaccessible in Mode 1.

April 30, 2000/0322 hours
Following replacement of the 34 Train A ignitors, Train A of the HIS was retested and was declared operable.

The ignitors beneath the reactor vessel missile shield were logged inoperable effective April 29, 2000, at 0600 hours, despite the fact that they passed their SRs. The decision to consider these ignitors inoperable was based on the fact that there was a low confidence that they would function for the required duration in the event that the HIS was required.

May 3, 2000
Catawba submitted an emergency TS change request for Unit 2 to exclude the inoperable ignitors located beneath the reactor vessel missile shield from TS 3.6.9 requirements for the remainder of cycle 11 or until the unit enters Mode 5 which would allow affected ignitor replacement.

May 5, 2000
The NRC approved the emergency TS change request for Unit 2.

Causal Factors

The root cause of this event was determined to be a component failure. As part of Catawba's investigation into the failed ignitors, it was learned that the new vendor sub-contractor (sub-contractor B) changed the internal design of the glow plug without making any change to the part number or to the functionality in the intended end-use application (automotive diesel engines). Following the observed ignitor failures, Duke Energy performed testing on representative glow plugs. This testing identified that the heater coil in the tip of the glow plug sheath had melted, resulting in an open circuit and causing the glow plug to fail. Despite the fact that glow plugs are designed for application in automotive diesel engines, Catawba had always utilized them as ignitors in the HIS. Ignitor performance and reliability using glow plugs from the old vendor sub-contractor (sub-contractor A) was acceptable; therefore, Catawba had no indication of any change in performance and reliability as a result of the change in vendor sub-contractors.

TS 3.6.9 allows one ignitor per train to be inoperable without impacting the operability of that train. Based upon the cause of the ignitor failures, both trains of the HIS were considered to be inoperable simultaneously. Therefore, Unit 2 was determined retroactively to have been in TS 3.0.3, beginning from the date and time that Mode 2 was entered following completion of the end-of-cycle 10 refueling outage (Mode 2 was entered on April 8, 2000, at 0229 hours).

No events within the last two years have occurred involving the HIS at Catawba. Also, no events within the last two years have occurred involving undetectable changes in vendor parts. Therefore, this event was determined to be non-recurring in nature.

Corrective Actions

Immediate

1. Troubleshooting and replacement of the affected ignitors was initiated and continued as described in the Event Description section of this LER.

Subsequent

1. The affected ignitors were replaced and retested for both HIS trains (with the exception of the ignitors located beneath the reactor vessel missile shield).

2. An emergency TS change was requested and approved by the NRC concerning the ignitors located beneath the reactor vessel missile shield that could not be replaced.

3. Catawba performed extended endurance testing on a sample of the glow plugs supplied by the old vendor sub-contractor (sub-contractor A) to ensure that the ignitors that are now installed will perform their design function. This testing consisted of subjecting the sample to an extended burn time, which bounds the design required burn time.

4. All glow plugs supplied by the new vendor sub-contractor (sub-contractor B) were purged from stock.

Planned

1. Per the emergency TS change, the ignitors located beneath the reactor vessel missile shield will be replaced at the end of cycle 11 or during the next Unit 2 entry into Mode 5, whichever occurs first.

2. In order to preclude future undetectable glow plug design changes from impacting the reliability of the HIS, Catawba will develop and implement a program for subjecting representative samples (i.e., samples from different production lots) of new glow plugs to the extended endurance testing.

Safety Analysis

During this event, 12 ignitors were found to be inoperable on Train B and 2 ignitors were found to be inoperable on Train A. The other ignitors (23 on Train B and 33 on Train A) had previously passed their TS SRs. However, given the failure data that was subsequently obtained concerning the ignitors, the engineering evaluation concluded that there was low confidence that they would perform as intended.

It has been demonstrated through analysis that direct ignition of the hydrogen within a containment region is not required in order to burn the hydrogen at low concentrations, which is the fundamental objective of the HIS. Burns ignited in one compartment can readily propagate into adjacent compartments when the hydrogen concentration in the adjacent compartment exceeds the propagation limit. Propagation limits are lower than the ignition limits.

The effectiveness of the propagation of burns can be seen in the analysis submitted by Duke Energy in 1993, Revision 15 to "An Analysis of Hydrogen Control Measures at McGuire Nuclear Station," to close out various open items related to the operating license for Catawba. This analysis clearly shows that propagation of burns between compartments is effective for initiating burns within compartments that have not yet reached the ignition limit. For the three LOCA sequences analyzed, the only compartment in which ignition occurred was the lower containment compartment. Combustion in all of the other compartments, dead-ended volumes, ice condenser, and upper

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containment resulted from the propagation of the burn from the lower compartment into those areas. In the fourth sequence analyzed, a high pressure sequence initiated by a loss of all feedwater, some burns were ignited in the dome area of the containment in addition to the lower containment. Combustion in all of the other compartments resulted from propagation. Propagation is also described in NUREG/CR-4993, "A Standard Problem for HECTR-MAAP Comparison: Incomplete Burning."

The significance of the propagation is that complete containment coverage with ignition sources is not a requirement for effective hydrogen control. The containment air return fans and the hydrogen skimmer fans provide for a well-mixed environment inside the containment. Ignition in any compartment is likely to result in combustion in every compartment that has accumulated hydrogen at the propagation limit. With lower containment as the region most likely to see the hydrogen source term, ignition occurs frequently in this compartment and spreads readily to the dead-ended compartments and up into and through the ice condenser into upper containment.

As a result of the operation of the containment air return fans and the hydrogen skimmer system, the ice condenser containment is well mixed with flow assured through virtually every compartment in the containment. Among the dead-ended compartments, only the letdown heat exchanger room does not have a hydrogen skimmer system connection. Propagation of hydrogen deflagration flame fronts both within a compartment and between compartments assures that control of the hydrogen concentration in the containment would be effective with multiple ignitors unavailable.

Throughout the period that the ignitors were inoperable, at least one train of the Unit 2 Containment Air Return and Hydrogen Skimmer System was always operable. Train B of the system was inoperable on April 26, 2000, from 0820 hours to 1255 hours to support performance testing of the containment air return fans and hydrogen skimmer fans. During this time, Train A was operable and Train B could have been returned to operable status within a short time period, had its use been required. In addition, throughout the period that the ignitors were inoperable, both trains of the Hydrogen Recombiners were operable. The recombiners combine hydrogen and oxygen to form water vapor. A single recombiner is capable of maintaining the hydrogen concentration in containment below the flammability limit.

No glow plugs from sub-contractor B have been employed on Unit 1. Therefore, the subject failure mechanism is limited to Unit 2 only.

The health and safety of the public were unaffected by this event.