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A Duke Energy Company

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July 19, 2001

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

SUBJECT: Duke Energy Corporation
Catawba Nuclear Station Unit 2
Docket No. 50-414
Licensee Event Report 414/00-002 Revision 1

Attached please find Licensee Event Report 414/00-002 Revision 1, entitled "Inoperable Ignitors on Both Trains of the Hydrogen Ignition System Due to a Common Cause Failure Mode on Non-Safety Related Equipment Resulting in a Technical Specification Violation."

This Licensee Event Report does not contain any regulatory commitments. Questions regarding this Licensee Event Report should be directed to R. D. Hart at (803) 831-3622.

Sincerely,

G. R. Peterson

Attachment

IE22

xc:

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NRC FORM 366 (1-2001) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001
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.

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TITLE (4)
Inoperable Ignitors on Both Trains of the Hydrogen Ignition System Due to a Common Cause Failure Mode on Non-Safety Related Equipment Resulting in a Technical Specification Violation

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME: None	DOCKET NUMBER
04	29	2000	2000	– 002	– 01	07	19	2001	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	100

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

	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)	X	50.73(a)(2)(v)(D)	
	20.2203(a)(2)(v)	X	50.73(a)(2)(i)(B)	X	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)	

LICENSEE CONTACT FOR THIS LER (12)

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

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
X	BB	RNR	AC Delco	Yes					

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	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 22 of 35 ignitors of Train B of the Hydrogen Ignition System (HIS) had failed and were inoperable. 34 ignitors were replaced on Train B (one ignitor was inaccessible 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 this event was lack of a process to ensure that new production lots of ignitors were tested to ensure that the design basis for their applicability could be met. Catawba retroactively determined that multiple ignitors on each HIS train were inoperable due to a common cause failure mode. An emergency Technical Specification (TS) amendment was subsequently requested and approved to exclude the ignitors beneath the missile shield from the HIS TS requirements on a temporary basis. A new procedure has been developed to perform proper testing of ignitors after receipt to ensure they can perform their design function. For this event, the overall hydrogen mitigation function was maintained as a result of the remaining ignitors and other hydrogen mitigation equipment. Therefore the health and safety of the public was unaffected.

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

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 and 10CFR50.36(c)(2)(i), limiting condition for operation of a nuclear reactor not met. This event is also being reported pursuant to 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. In addition, this event is being reported pursuant to 10 CFR 50.73(a)(2)(v), any event or condition that could have prevented the fulfillment of the safety function of structure or systems that are needed to mitigate the consequences of an accident.

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 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:

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1) Surveillance Requirement (SR) 3.6.9.1, which requires that each HIS train power supply breaker be energized and that ≥ 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 ≥ 1700°F.

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 7 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 times are approximate)

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. While attempting to locate the failed ignitors in containment (by circuit energization and visual inspections), 10 additional ignitors (for a total of 22 of 35 on train B) were identified as having failed. 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 tested 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 tested 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.

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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 the lack of a process at Catawba to ensure that new production lots of glow plugs are tested in such a way as to ensure that the design basis requirements for the glow plugs are being satisfied. The re-design of the glow plugs by sub-contractor B was the major contributor to the failure of the Unit 2 glow plugs.

Although the behavior of the glow plug on the test stand was observed to be different, this observation was not correlated to glow plug performance or reliability concern, at the time, based upon years of satisfactory service with this type glow plug. The successful performance of the burn-in process and the surveillance tests (current and temperature measurement) using the sub-contractor B glow plugs instilled a false confidence in the personnel that the glow plugs would satisfy their design function.

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. 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

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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).

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 tested 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.

5. The glow plugs removed from containment, which had not experienced any failure, were subjected to an endurance test to determine their ability to operate for the time period required by the safety analysis.

6. In order to preclude future undetectable glow plug design chances from impacting the reliability of the HIS, Catawba has developed a procedure (IP/0/B/3170/004) to implement a program for subjecting representative samples (i.e., samples from

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different production lots) of new glow plugs to the extended endurance testing.

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.

SAFETY ANALYSIS

During this event, 22 ignitors were found to be inoperable on Train B and 2 ignitors were found to be inoperable on Train A. The other ignitors (13 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 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

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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.

In May 2001, an endurance test was performed on the ignitors that had been removed from containment in April 2000. There were 56 ignitors available for testing. Engineering provided test instructions to assist maintenance in performing the testing and document the results. Prior to testing any of the ignitors, a resistance continuity check was performed to identify any failed ignitors prior to testing. Of the ignitors checked, 16 of 56 did not pass the resistance continuity check and were not tested. From the time that the ignitors were removed from containment (April 2000) until the endurance testing (May 2001), the ignitors were handled frequently and stored in less than ideal conditions for these ignitors. This was done because plant personnel understood that these ignitors were not to be used again. The ignitors were tested at the voltage they would be subject to after an accident and were kept at that voltage for 48 hours. The 48 hours was based on engineering judgement as to the time frame the ignitors would be

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required to operate after an accident to be able to perform their design function. The results of the test are as follows:

1. 14 ignitors lasted for the entire 48 hours (7 from 'A' train and 7 from 'B' train)
2. 4 ignitors lasted for 41, 39, 34, & 25 hours respectively
3. 10 ignitors lasted for 17 hours before experiencing rapid failure because of a test equipment anomaly.
4. 4 ignitors lasted between 12-14 hours
5. 8 ignitors lasted for less than 12 hours

These results were compared to the documented analysis for hydrogen combustion. When the EHM System is initiated, the ignitor elements are energized and heat up to a surface temperature ≥ 1700 °F. At this temperature, they ignite the hydrogen gas that is present in the airspace in the vicinity of the ignitor. The EHM System depends on the dispersed location of the ignitors so that local pockets of hydrogen at increased concentrations would burn before reaching a hydrogen concentration significantly higher than the lower flammability limit. Hydrogen ignition in the vicinity of the ignitors is assumed to occur when the local hydrogen concentration reaches 8.5 percent by volume and results in 100% of the hydrogen present being consumed. This ensures that the HIS will maintain the hydrogen concentration in all containment compartments to less than 10%. Lower containment is where hydrogen ignition most likely would occur for most of the analyses for hydrogen combustion. One of the sequences analyzed involves ignition in the upper containment. Even in this sequence, a number of lower compartment burns were also initiated. The overall containment response would not conform to the analysis in the absence of lower containment ignitors.

The 14 ignitors that passed the endurance test were distributed in the upper containment dome, fan room, ice condenser upper plenum, the upper containment, and the pipe chase near the reactor coolant drain tank. Four additional ignitors that survived for at least 24 hours were also in the same general locations. None of the ignitors that survived greater than 24 hours were located in lower containment in the vicinity of the reactor coolant system.

Six (6) of the ten (10) ignitors that failed after 17 hours due to a test equipment anomaly were located in lower containment. These ignitors operated for at least 17 hours and would have been

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available in the early phases of an accident. The 4 ignitors that lasted for 12-14 hours were also located in lower containment and would have been able to reduce hydrogen concentration in their area. This would help reduce the possibility of a challenge to containment integrity as a result of hydrogen combustion.

Therefore, based on engineering judgement it would be expected that the quantity of ignitors that were functional would have protected the containment from uncontrolled combustion of hydrogen in the event of a severe accident. The ignitors that passed the endurance test were evenly split between the A and B trains so that upon a loss of power to either train would still result in ignitors available to perform their function. It cannot be concluded that all of the design requirements of the HIS would be satisfied under all conditions, however, this does not mean that a significant containment challenge would have resulted.

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 function of the hydrogen recombiners is to provide for the capability of controlling the bulk hydrogen concentration in containment to less than the lower flammability limit following a design basis accident. This control would prevent a containment wide hydrogen burn; thus ensuring the pressure and temperature assumed in the analyses are not exceeded. The recombiners combine hydrogen and oxygen to form water vapor. To meet the requirements for redundancy and independence, two recombiners are provided. A single recombiner is capable of maintaining the hydrogen concentration in containment below the flammability limit.

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

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ADDITIONAL INFORMATION

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

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.

There were no releases of radioactive materials, radiation exposures or personnel injuries associated with this event.

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [ ].

Although the safety impact of this event was minimal, this condition met the reporting criteria of 10 CFR 50.73(a)(2)(v) and therefore will be recorded under the NRC Performance Indicators for Unit 2 as a Safety System Functional Failure.