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RA-20-0152

10 CFR 50.73

May 13, 2020

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

Subject: Duke Energy Carolinas, LLC
Catawba Nuclear Station, Unit 1
Docket No. 50-413
Licensee Event Report (LER) 413/2020-001-01

Pursuant to 10 CFR 50.73(a)(1) and (d), attached is LER 413/2020-001-01, entitled "Valid Actuation of the Unit 1 Reactor Protection System and Auxiliary Feedwater System." This is a revision to LER 413/2020-001-00 submitted on April 13, 2020. Revisions to the LER are designated by revision bars in the margin.

This report is being submitted in accordance with 10 CFR 50.73(a)(2)(iv)(A).

There are no regulatory commitments contained in this letter or its attachment.

This event is considered to be of no significance with respect to the health and safety of the public.

If questions arise regarding this LER, please contact Sherry E. Andrews of Regulatory Affairs at (803) 701-3424.

Sincerely,

Tom Simril
Vice President, Catawba Nuclear Station

Attachment

xc (with attachment):

L. Dudes
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U.S. Nuclear Regulatory Commission - Region II
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J. Austin (without enclosure)
NRC Senior Resident Inspector

NRC FORM 366 (04-2020) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Catawba Nuclear Station, Unit 1	05000413	1 OF 5

4. TITLE

Valid Actuation of the Unit 1 Reactor Protection System and Auxiliary Feedwater System

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
02	12	2020	2020	- 001	- 01	05	13	2020	FACILITY NAME	DOCKET NUMBER
										05000

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
1	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
100	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(D)	☐ 73.77(a)(2)(i)
	☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(ii)
		☐ 50.73(a)(2)(i)(C)	☐ OTHER Specify in Abstract below or in NRC Form 366A	

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER *(Include Area Code)*
Sherry E. Andrews	(803) 701-3424

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
D	TL	EXC	G080	Yes					

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

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

16. ABSTRACT

At 1800 [EST] hours on February 12, 2020, with Unit 1 in Mode 1 at approximately 100 percent power, Catawba Unit 1 experienced an automatic reactor trip that was triggered by a self-revealing generator lockout signal. Degraded brushes in the generator exciter failed to establish adequate excitation to keep the generator online. The trip was not complex, with all systems responding normally post-trip. Because of the reactor trip, the Auxiliary Feedwater system actuated as expected due to an Anticipated Transient Without Scram Mitigation System Actuation Circuitry signal.

The cause of the reactor trip is that the station did not establish and maintain an effective single point vulnerability preventative maintenance mitigation strategy for the turbine exciter.
There was no impact to the health and safety of the public.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Catawba Nuclear Station, Unit 1	05000-413	2020	- 001	- 01

NARRATIVE

BACKGROUND

The following information is provided to assist readers in understanding the event described in this LER. Applicable Energy Industry Identification [EIIS] system and component codes are enclosed within brackets. Catawba Nuclear Station unique system and component identifiers are contained within parentheses.

This event is being reported under the following criterion:

10 CFR 50.73(a)(2)(iv)(A), "Any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B)." The applicable 10 CFR 50.73(a)(2)(iv)(B) systems include the Reactor Protection System and the Auxiliary Feedwater System.

Reactor Protection System [JC] (IPE):

The Reactor Trip System (RPS) automatically limits reactor operation to within a safe region by shutting down the reactor whenever the limits of the region are approached. Whenever a direct process or calculated variable exceeds a setpoint the reactor will be shutdown in order to protect against either gross damage to fuel cladding or loss of system integrity which could lead to release of radioactive fission products into the containment. The various reactor trip circuits automatically open the reactor trip breakers whenever a condition monitored by the Reactor Trip System reaches a preset level. The reactor will trip on an anticipatory Turbine Trip. The anticipatory reactor trip on turbine trip is actuated by a low pressure signal from two-out of- four stop valve electro-hydraulic fluid pressure switches, or by valve closed signals from four-out-of-four turbine steam stop valve limit switches.

Engineering Safety Feature Actuation System [JE] (ISE):

The Engineered Safety Features Actuation System is a functionally defined system. The equipment which provides the actuation functions is listed below
1. Process Instrumentation and Control System
2. Solid State Logic Protection System
3. Engineered Safety Features Test Cabinet
4. Manual Actuation Circuits

Auxiliary Feedwater System [BA] (CA):

The Auxiliary Feedwater System (CA) assures sufficient feedwater supply to the steam generators (S/G), in the event of loss of the Condensate/Feedwater System, to remove energy stored in the core and primary coolant. The CA System may also be required in some other circumstances such as evacuation of the main control room or cooldown after a loss-of-coolant accident for a small break, including maintaining a water level in the steam generators following such a break.

BACKGROUND (continued)

The CA System is designed to start automatically in the event of loss of offsite electrical power, trip of both main feedwater pumps, safety injection signal, or low-low S/G water level; any of which may result in, coincide with, or be caused by a reactor trip. The CA System will supply sufficient feedwater to maintain the reactor at hot standby for two hours followed by cooldown of the Reactor Coolant System to the temperature at which the Residual Heat Removal System may be operated.

The motor driven pumps will automatically start and provide the minimum required feedwater flow within one minute following any of these conditions:

1. Two out of four low-low level alarms in any one of the four steam generators.
2. Loss of both main feedwater pumps
3. Initiation of the safety injection signal
4. Loss of station normal auxiliary electric power
5. AMSAC signal

An Anticipated Transient Without Scram (ATWS) is an anticipated occurrence which is accompanied by a failure of the Reactor Trip System to shut down the reactor. ATWS Mitigation System Actuation Circuitry (AMSAC) actuation will occur when either both main feedwater pumps trip or when main feedwater flow to the steam generators is blocked due to valves closing in the line. When an actuation occurs, the AMSAC circuitry will perform the following:

1. Trip the main turbine
2. Start both motor driven auxiliary feedwater pumps
3. Close the steam generator blowdown and sampling valves

The AMSAC design for Catawba is based on conditions that indicate a loss of main feedwater event, which if accompanied by a failure of the RPS to scram leads to over-pressurization of the Reactor Coolant System. The system monitors the position of all Main Feedwater Control Valves, Feedwater Bypass Control Valves, and Feedwater Isolation Valves (Unit 1 only) and the operating status of both main feedwater pumps.

Turbine-Generator

The turbine-generator converts the thermal energy of steam produced in the steam generators into mechanical shaft power and then into electrical energy. The Generator requires direct current to energize its magnetic field. The DC current is obtained from the exciter driven by the main turbine. The output of the exciter is three phase AC and is rectified to DC by water cooled rectifiers. This type of excitation system uses collector rings and brushes to apply the DC power to the field winding on the main generator Rotor. To control the excitation current to the main generator the field current of the exciter is controlled by voltage regulator. By varying the output of the exciter, the field current on the main generator is changed and the output voltage of the main generator is changed.

The exciter is a small AC generator, similar to the main generator, driven by the turbine/generator shaft, that supplies the main generator field. The exciter field is supplied by the ABB Unitrol 5000 Automatic Voltage Regulator (AVR) System. The output of the exciter is supplied to the main generator field windings through a set of five water cooled rectifiers, each 25% capacity. The field power is put on the generator rotor through collector rings and brushes.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Catawba Nuclear Station, Unit 1	05000-413	2020	- 001	- 01

NARRATIVE

EVENT DESCRIPTION

Timeline of Events:

1/20/20: Inspection of both Unit 1 and Unit 2 exciter and generator brushes was performed.

2/3/20: Inspection of both Unit 1 and Unit 2 exciter and generator brushes was performed. Unit 1 work order completion comments state: “Performed monthly inspection of brushes, sight glasses, panels, and shaft using strobe. All items SAT.”

2/12/20 1800: Catawba Unit 1 turbine tripped as a result of loss of excitation to the main generator field. A Zone ‘G’ Lockout occurred which tripped the Generator Protection Circuit Breakers ‘A’ and ‘B’ and the exciter. The turbine trip caused an automatic reactor trip. Because of the reactor trip, the CA System actuated as expected due to an AMSAC signal. The CA pumps started as designed when the valid system actuation was received.

2/16/20 0410: Catawba Unit 1 back on-line. The degraded brushes, brush holders, and housings were replaced. The collector ring was machined to clean off any residual damage.

2/17/20 0137: Catawba Unit 1 reached 100% power.

The generator Zone ‘G’ Lockout signal was a result of degraded Alterex brushes that were no longer able to supply excitation to the main generator field. The brushes had either been worn down too far to make proper contact with the collector plate, even with a spring force driving the brush toward the collector plate, or carbon buildup caused binding that prevented movement of the brush. Without proper contact, the current flow through the degraded brushes would have decreased, and as a result, the remaining brushes with good contact would have seen an increase in current. The brushes that were still conducting became overheated and were damaged. This caused damage to the collector ring. At some point, sustained electrical arcing developed between the degraded exciter brushes and the collector plate resulting in a flashover event. Damage was sustained by the brushes, brush holders, housing, and collector ring from the flashover.

Because of this damage, there was a decrease in current flow to the exciter, which resulted in a decreasing Generator Field. The Generator Terminal Voltage started to rapidly decrease. The AVR attempted to make up for the Voltage drop by increasing the AVR current output. This increased the heating on the brushes and they started to fail. As a result, the Generator Terminal Voltage dropped to 18.5kV and initiated a trip of the Loss of Field Relay (40) Relay. This led to the Turbine / Generator Trip and ultimately the Reactor Trip.

CAUSAL FACTORS

A root cause analysis was completed for the Unit 1 reactor trip event. The cause is that the station did not establish and maintain an effective single point vulnerability preventative maintenance mitigation strategy for the turbine exciter.

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Catawba Nuclear Station, Unit 1	05000-413	2020	- 001	- 01

NARRATIVE

CORRECTIVE ACTIONS

Immediate Actions:

1. Degraded brushes, brush holders, and housings within the Catawba Unit 1 generator exciter were replaced. The associated collector ring was machined to remove residual damage. (Complete)
2. Inspect the exciter and generator brushes in Units 1 and 2. (Complete)

Interim and Subsequent Actions:

1. Combine maintenance activities for brush inspection and brush replacement into one work order package to permit immediate, timely field replacement if an issue is identified. (Complete)

Planned Actions:

1. Add new qualitative and quantitative acceptance criteria to a brush inspection procedure. Ensure Catawba procedure is aligned with industry and vendor recommendations for Alterex brush inspection criteria.
2. Correct the single point vulnerability preventative maintenance strategy for the exciter system.

SAFETY ANALYSIS:

At 1800 [EST] hours on February 12, 2020, with Unit 1 in Mode 1 at approximately 100 percent power, the reactor tripped following a main turbine trip. The Catawba Unit 1 scram did not impact the health and safety of the public and there is no safety consequence to this event. The generator lockout signal was caused by a failure in a non-safety related component and did not impact the ability of the reactor to safety shutdown and maintain a safe shutdown condition. The trip was uncomplicated with all systems responding normally post-trip. The crew performed appropriately for the condition. The unit was safely shutdown on February 12 and was restarted on February 16. Unit 2 was not affected.

ADDITIONAL INFORMATION

A review of Catawba License Event Reports from the past 3 years based on the preliminary cause did not identify any similar occurrences. This is not considered a recurring event.