UNIVERSITY *of* MISSOURI

RESEARCH REACTOR CENTER

July 27, 2015

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

REFERENCE: Docket No. 50-186
University of Missouri-Columbia Research Reactor
Amended Facility License R-103

SUBJECT: Written communication as required by University of Missouri Research Reactor Technical Specification 6.1.h(2) regarding a deviation from Technical Specifications 3.2.a

The attached document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on June 29, 2015, that resulted in a deviation from MURR Technical Specification 3.2.a.

If you have any questions regarding this report, please contact John L. Fruits, the facility Reactor Manager, at (573) 882-5319.

Sincerely,

for Ralph Butler

Ralph A. Butler, P.E.
Director

Signed before me 7/27/15
Margee P. Stout

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI
MARGEE P. STOUT
My Commission Expires
March 24, 2016
Montgomery County
Commission #12511436

RAB:jlb

Enclosure

IE22
NRR

1513 Research Park Drive Columbia, MO 65211 Phone: 573-882-4211 Fax: 573-882-6360 Web: www.murr.missouri.edu

Licensee Event Report No. 15-02 – June 29, 2015
University of Missouri Research Reactor

Introduction

On June 29, 2015, with the reactor operating at 10 MW in the automatic control mode, the control room operator initiated a manual rod run-in to shut down the reactor as part of performing compliance procedure CP-10, "Rod Drop Times." Immediately after the rod run-in was initiated, the control room operator noted that shim control blade 'A' was not driving in the inward direction. The reactor was immediately shut down by placing Master Control Switch 1S1 in the "Test" position in accordance with reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod." Operation of Master Control Switch 1S1 removes the holding current from the four control rod drive mechanism (CRDM) electromagnets, thus allowing all of the control blades to drop to their fully inserted positions without inward movement of the CRDMs. All immediate actions of REP-8 were completed. Failure of the CRDM to move control blade 'A' in the inward direction resulted in a deviation from Technical Specification (TS) 3.2.a, which states, *"All control blades, including the regulating blade, shall be operable during reactor operation."*

Description of the Rod Control System

The reactivity of the reactor is controlled by five neutron absorbing control blades. Each control blade is attached to a CRDM by means of a support and guide extension (offset mechanism). Four of the control blades, referred to as the shim blades, are used for coarse adjustments to the neutron density of the reactor core. The fifth control blade is a regulating blade. The low reactivity worth of this blade allows for very fine adjustments in the neutron density in order to maintain the reactor at the desired power level. The nominal speed of the shim blades is one inch per minute in the outward direction and two inches per minute in the inward direction. Nominal speed of the regulating blade is 40 inches per minute in both the inward and outward directions. The speed of the control blades cannot be adjusted without physically altering the system. The four shim blades are actuated by electro mechanical CRDMs that position, hold, and scram each shim blade. Each CRDM consists of a 0.02-HP, 115-volt, one-amp, single-phase, 60-cycle motor connected to a lead screw assembly through a reduction gearbox and overload clutch. The reactivity worth and speed of travel for the control blades are sufficient to allow complete control of the reactor system from a shutdown condition to full power operation. The insertion rate of the control blades is adequate to ensure prompt shutdown of the reactor in the event a scram signal is received.

Control blade movements, interlocks and bypasses, and control modes are managed by the Rod Control System. The Rod Control System is a relay and switch logic system used to prohibit accidental or incorrect operation which could result in an unsafe condition. During normal operation, Master Control Switch 1S1 allows the shim blades to be withdrawn or inserted manually by a three-position ("In-Normal-Out") switch (1S4) located on the reactor control console. The switch is spring return to the mid-position ("Normal") when released. A five-position ("A-B-C-D-Gang") selector switch (1S3) enables the reactor operator to select the shim blades individually or as a group. 115 VAC power is supplied to the CRDM motor windings through motor relays (see Attachment 1); K1 for shim control blade insertion and K2 for shim control blade withdrawal.

Detailed Event Description

On June 29, 2015, at 02:00 with the reactor operating at 10 MW in the automatic control mode, the control room operator initiated a manual rod run-in as part of performing compliance procedure CP-10, "Rod Drop Times." Immediately after the rod run-in was initiated, the control room operator noted that shim control blade 'A' was not driving in the inward direction. The reactor was immediately shut down by placing Master Control Switch 1S1 in the 'Test' position in accordance with reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod." Operation of Master Control Switch 1S1 removed the holding current from the four CRDM electromagnets, thus allowing all of the control blades to drop to their fully inserted positions without inward movement of the CRDMs. All control blades were verified to be fully inserted. All immediate actions of REP-8 were completed. Failure of the CRDM to move shim control blade 'A' in the inward direction resulted in a deviation from TS 3.2.a, which states, *"All control blades, including the regulating blade, shall be operable during reactor operation."*

After the reactor was secured, the CRDM was removed for inspection. Troubleshooting efforts revealed an intermitted failure of CRDM 'A' motor relay K1. Relay contacts 6 and 10 would intermittently not make sufficient contact to allow current flow with the relay coil energized; thus preventing the motor inward direction windings from being energized.

Safety Analysis

The basis for TS 3.2.a is to ensure that the normal method of reactivity control is used during reactor operation. When operating the reactor at 10 MW in the automatic control mode, the control blades are routinely shimmed in the outward direction as a result of poison buildup and fuel depletion. Shimming of a control blade in the in-ward direction after initial reactor startup is not a routine occurrence and therefore it is difficult to postulate at what time the failure occurred and how long the reactor may have been in operation with the failed relay. A review of the

Nuclear Instrumentation (NI) power level strip-chart recorders indicated conditions consistent with steady-state operation for the entire week. While the ability of inward movement of control blade 'A' may have been unavailable sometime during this period, at no time was the ability to scram the reactor, either through automatic initiation or manually by the control room operator, affected by this failure. CRDM motor relays K1 and K2 are not a part of the Reactor Safety System.

Corrective Actions

When the control room operator discovered that CRDM 'A' would not move the shim control blade in the inward direction, he immediately initiated a reactor scram by placing Master Control Switch 1S1 in the "Test" position and completed the immediate actions of reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod," to ensure the reactor was in a safe shutdown condition. All four shim control blades were verified to be fully inserted.

Troubleshooting efforts identified the failure of CRDM motor inward relay K1. The relay was bench tested to identify the single component intermittent failure of contacts 6 and 10. A visual inspection of the relay internals also revealed some discoloration on contacts 8 and 12, which can be associated with a high resistance connection (Attachment 1). This type of relay, Magnecraft 782HXDXH21-120A, has been used at MURR for many years and has proven very reliable in the past. However, a similar event occurred on April 23, 2014 (see LER 14-02, letter dated May 16, 2014). As a result of that event, all Magnecraft relays of that lot number were removed from service and a new lot of relays were installed. At that time the relay manufacturer (Schneider Electric) was contacted and MURR was assured that the failure was an isolated instance and not an identified deficiency. Because this June 29th occurrence is a similar repeat failure, the Magnecraft relay has been replaced with an equivalent relay from a different manufacturer (Allen Bradley) (Attachment 2). In addition to replacing the failed relay, all Magnecraft relays have been removed from the remaining CRDMs and replaced with Allen Bradley relays.

MURR electronic maintenance procedure EMP-12, "Drive Mechanism," was completed on CRDM 'A.' Additional post maintenance testing included bench testing to ensure correct operation of the CRDM relay contacts, monitoring CRDM run current and speed over the full length of travel, and performing multiple cycles of the CRDM motor relay to ensure proper operation.

Additionally, this event was entered into the MURR Corrective Action Program as CAP entry No. 15-0057 and any additional information or corrective actions will be considered and documented.

If there are any questions regarding this Licensee Event Report, please contact me at (573) 882-5319. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

John L. Fruits
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

for Ralph Butler

Ralph A. Butler, P.E.
Director

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. Garnett S. Stokes, Provost
Dr. Henry C Foley, Senior Vice Chancellor for Research
Mr. Geoffrey Wertz., U.S. NRC
Mr. Johnny Eads, U.S. NRC

Attachments:

1. Control Rod Drive Mechanism Motor Relay K1
2. 700-HC Miniature Ice Cube Relay

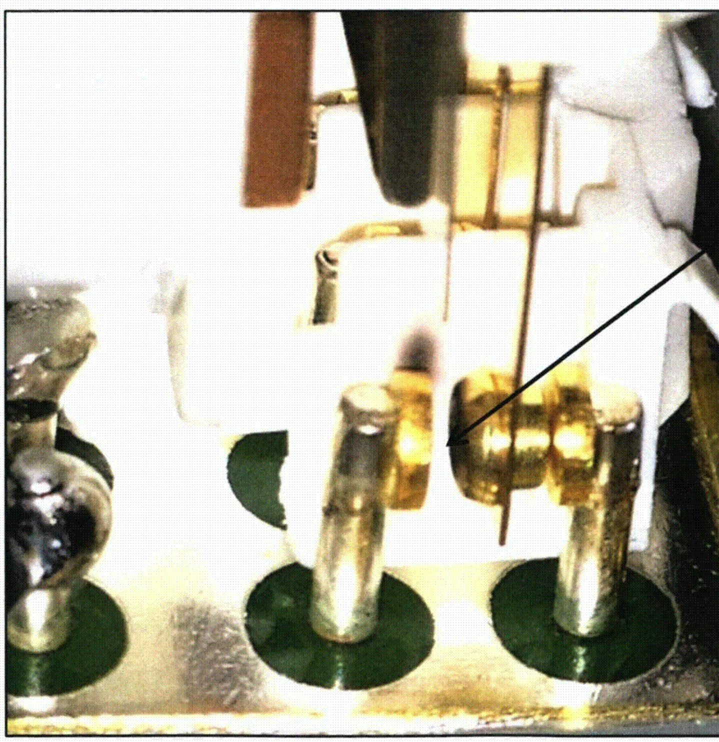
Signed before me 7/27/15

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

MARGEE P. STOUT
My Commission Expires
March 24, 2016
Montgomery County
Commission #12511436

ATTACHMENT 1

Magnecraft 782H Hermetic Ice Cube Relay



Relay Contacts 6-10

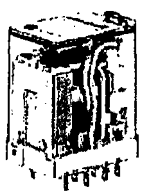
Control Rod Drive Mechanism Motor Relay K1

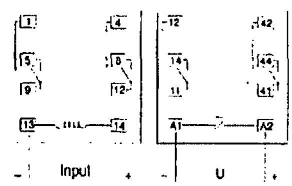
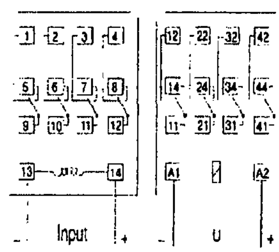
ATTACHMENT 2

Bulletin 700-HC Miniature Ice Cube Relay

Product Selection

Bulletin 700-HC Miniature Square Base with Blade Terminals



Description	Contact Rating	Wiring Diagrams U.S./Canada	Wiring Diagrams International	Coil Voltage	Cat. No. * ‡
2PDT 2-Pole 2 Form C Contacts: 10 A = AgNi Contacts	10 A C300 R300 Low energy rating; (10V, 10 mA) 100 mW			12V DC	700-HC22Z12
				24V DC	700-HC22Z24
				24V AC	700-HC22A24
				120V AC	700-HC22A1
		700-HN128	700-HN103 700-HN104	240V AC	700-HC22A2
4PDT 4-Pole 4 Form C Contacts: 7A = AgNiAu Gold Plated Contacts	7 A Low energy rating; (5V, 10 mA or 25V, 2 mA) 50 mW			6V AC	700-HC14A06
				12V AC	700-HC14A12
				24V AC	700-HC14A24
				120V AC	700-HC14A1
				240V AC	700-HC14A2
				6V DC	700-HC14Z06
				12V DC	700-HC14Z12
				24V DC	700-HC14Z24
				48V DC	700-HC14Z48
				110V DC	700-HC14Z1
4PDT 4-Pole 4 Form C Contacts: 7A = AgNi Silver Contacts	7 A C300 R300 Low energy rating; (10V, 10 mA) 100 mW			6V AC	700-HC24A06
				12V AC	700-HC24A12
				24V AC	700-HC24A24
				120V AC	700-HC24A1
				240V AC	700-HC24A2
				6V DC	700-HC24Z06
				12V DC	700-HC24Z12
				24V DC	700-HC24Z24
			700-HN103	48V DC	700-HC24Z48
		700-HN128	700-HN104	110V DC	700-HC24Z1

* LED Option: Add suffix (-4) to the selected Bulletin 700-HC Relay Cat. No. except for the 240V AC units, add (-4L).

‡ Push-to-Test and LED Option: Add suffix (-3-4) to the selected Bulletin 700-HC Relay Cat. No., except for the 240V AC units, add (-3-4L).

Cat. No. 700-HC...

ATTACHMENT 2

Electrical Ratings

Pilot Duty Rating ‡		NEMA C300, R300					
Rated Thermal Current (I_{th})		7 A and 10 A					
Rated Insulation Voltage (U_i)		250V IEC - 300V UL/CSA					
Contacts	Inductive	700-HC_4		Hp	700-HC22		Hp
		►)(◄	◄)(►		►)(◄	◄)(►	
	120V AC	15 A	1.5 A	1/8	15 A	1.5 A	1/3
	240V AC	7.5 A	0.75 A	1/3	7.5 A	0.75 A	3/4
	General Purpose	7 A, 277V AC			10 A, 277V AC		
	Resistive	7 A, 30V DC			10 A, 24V DC		
Min. Low Energy Permissible Load		100 mW (10V, 10 mA) - Silver Contacts 50 mW (5V, 10 mA or 25V, 2 mA) - Gold Contacts					
Permissible Coil Voltage Variation		Pickup:	80...110% of Nominal Voltage at 50 Hz		Must Dropout Voltage:	20% of Nominal Voltage at AC	
			80...110% of Nominal Voltage at 60 Hz			10% of Nominal Voltage at DC	
			80...110% of Nominal Voltage at DC				
		50 Hz			60 Hz		
Coil Consumption ±10% — AC Coils	Inrush	2.2 VA			1.6 VA		
	Sealed	1.3 VA			1.1 VA		
DC Coils		1.0 W					
Max. Allowable Leakage		20% of VA (AC)					
		10% of W (DC)					

Design Specification/Test Requirements

Electrical

Dielectric Withstand Voltage	Pole-to-Pole	2000V
	Contact to Coil	4000V
Electrical Life (Cycles)		100 000 minimum

Mechanical

Degree of Protection (Open Type) IEC 529		IP 20 (Guarded Terminal Sockets)
Mechanical Life Cycles		20×10^{6} (AC) 50×10^{6} (DC)
Switching Frequency Operations		1800/HR
Coil Voltages		See Product Selection
Operating Time (ms)	Max. Pickup	10
	Max. Dropout	3
Maximum Operating Rate		8 cycles/s

Environmental

Temperature	Operating	-30...+55 °C
		(-22...+131 °F)
	Storage	-55...+85 °C
		(-67...+185 °F)
Altitude		2000 m (6560 ft)
Insulating Material		Molded High Dielectric Material
Enclosure		Transparent Dust Cover
Contact Material		AgNi (700-HC2) AgNi + 5 µm Au (700-HC1)
Terminal Markings on Socket		In accordance with EN50 0005
Sockets		700-HN103, -HN128, -HN104
Certifications		cURus Recognized (File No. E14843, Guide NRNT2/NRNT8), cULus Listed when used with Bulletin 700-HN103, -HN104, and -HN128 sockets (File No. E14843, Guide NRNT/NRNT7), CE Marked, LR Certified
Standards		UL 508, CSA 22.2 No. 14, EN 61810-1

• See Performance Data.

‡ NEMA Rating Chart is in publication 700-SG003*