University of Missouri

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May 10, 2019

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

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

SUBJECT: Written communication as required by University of Missouri Research Reactor Technical Specification 6.6.c(3) regarding a deviation from Technical Specifications 3.2.a and 3.2.f

The enclosed document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on April 28, 2019, that resulted in a deviation from MURR Technical Specifications 3.2.a and 3.2.f.

If you have any questions regarding this report, please contact Bruce A. Meffert, the facility Reactor Manager, at (573) 882-5118.

Sincerely,

J. David Robertson, PhD
Reactor Facility Director

JDR:jlm

Enclosure

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. Mark McIntosh, Vice Chancellor for Research, Graduate Studies and Economic Development
Mr. Geoffrey Wertz, U.S. Nuclear Regulatory Commission
Mr. William Schuster, U.S. Nuclear Regulatory Commission

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Enclosure
U.S. Nuclear Regulatory Commission
May 10, 2019

Licensee Event Report No. 19-03 – April 28, 2019
University of Missouri Research Reactor

Introduction

On April 28, 2019, with the reactor operating at 10 MW in the automatic control mode, the Lead Senior Reactor Operator (LSRO) was conducting surveillance Technical Specification (TS) 4.2.a, which states, "*All control blades, including the regulating blade, shall be verified operable within a shift.*" During this shiftly verification of control blade operability, shim control blades 'A,' 'B,' 'C,' and the regulating blade were verified operable. However, shim control blade 'D' would not move in the inward direction. The LSRO then immediately shut down the reactor by initiating a manual scram by placing Master Control Switch 1S1 to the "TEST" position. The LSRO completed all immediate and applicable subsequent actions of reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod," and verified all shim control blades were fully inserted.

Not being able to move shim control blade 'D' 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.*" Additionally, TS 1.15 states, "*Operable means a component or system is capable of performing its intended function.*" The basis for TS 3.2.a is to ensure that the normal method of reactivity control is used during reactor operation. It was later discovered that the cause of this malfunction also would have prevented shim control blade 'D' from inserting if the rod run-in system would have initiated, thus resulting in a deviation from TS 3.2.f, which states, "*The reactor shall not be operated unless the following rod run-in functions are operable. Each of the rod run-in functions shall have 1/N logic where N is the number of instrument channels required for the corresponding mode of operation.*" However, shim control blades 'A,' 'B,' and 'C' continued to operate normally and would have inserted if an instrument channel had exceeded its trip set point and required a rod run-in activation. All reactor safety system scram functions were unaffected and remained operable during this event including the scram capability of shim control blade 'D.'

Description of the Rod Control System

As described in Section 7.5, Rod Control System, of the MURR Safety Analysis Report (SAR), the reactivity of the reactor is controlled by five (5) neutron absorbing control blades. Each control blade is attached to a control rod drive mechanism (CRDM) by means of a support and guide extension (offset mechanism). Four (4) 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 control blades is one (1) inch per minute in the outward direction and two (2) 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 four (4) shim control blades are actuated by electromechanical CRDMs that position, hold, and scram each shim control 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.

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. A three-position ("OFF-TEST-ON") keylock master control switch and a two-position ("OFF-ON") magnet current switch located on the reactor control console controls power to the rod control system. The master control switch and the magnet current switch, designated as 1S1 and 1S14 respectively, must both be in the "ON" position to provide current to the shim control blade electromagnets. 115 V a-c power is supplied to the CRDM motor windings through the CRDM motor relays and associated wiring (see Attachment 1) – one (1) relay and associated wires for shim control blade insertion and another relay and associated wires for withdrawal.

Also part of the rod control system is the rod run-in system which initiates the automatic insertion of the shim control blades at a controlled rate should a monitored parameter exceed a predetermined value. The insertion of a shim control blade in response to a rod run-in signal is performed by the same insertion motor windings, relay, and wiring as described above.

Detailed Event Description

On April 28, 2019, at 06:33 CDT, with the reactor operating at 10 MW in the automatic control mode, the LSRO was conducting surveillance TS 4.2.a, which states, "*All control blades, including the regulating blade, shall be verified operable within a shift.*" During this shiftly verification of control blade operability, shim control blades 'A,' 'B,' 'C,' and the regulating blade were verified operable. However, shim control blade 'D' would not move in the inward direction. The LSRO then immediately shut down the reactor by initiating a manual scram by placing Master Control Switch 1S1 to the "TEST" position. The LSRO completed all immediate and applicable subsequent actions of reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod," and verified all shim control blades were fully inserted.

Failure of the CRDM to insert shim control blade 'D' is a deviation from TS 3.2.a, which states, "*All control blades, including the regulating blade, shall be operable during reactor operation.*" In addition, shim control blade 'D' would not have inserted during activation of any rod run-in function listed in TS 3.2.f; however, shim control blades 'A,' 'B,' and 'C' would have inserted. All reactor safety system scram functions where unaffected and remained operable during this event including the scram capability of shim control blade 'D.'

After the reactor was secured, the CRDM for shim control blade 'D' was removed and transported to the Instrumentation Support shop for troubleshooting. Investigation revealed a broken wire to the inward direction motor winding of shim control blade 'D' CRDM. The broken wire prevented the inward direction motor winding from energizing and moving the shim control blade. The wire was repaired, and operability of shim control blade 'D' CRDM was tested satisfactorily. Permission from the Reactor Facility Director was obtained prior to reactor startup per TS 6.6.c(4), and the reactor returned to 10 MW operation at 13:19 CDT on April 28, 2019.

Safety Analysis

The basis for TS 3.2.a is to ensure that the normal method of reactivity control is used during reactor operation. Conservatively, it can be assumed that the reactor operated in deviation of TS 3.2.a for the period of time from when the previous TS 4.2.a shiftly verification of control blade operability was conducted until discovery of the failure, which would have been approximately 12 hours. During this period, the reactor remained at a steady-state power level in automatic control. A review of the nuclear instrumentation power level data recorders indicated conditions consistent with steady-state operation. Therefore, the inward movement of shim control blade 'D' was compromised for a period of no greater than approximately 12 hours.

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 windings and wiring are not a part of the reactor safety system.

During this time, this malfunction also would have prevented shim control blade 'D' from inserting if the rod run-in system would have been initiated. However, shim control blades 'A,' 'B,' and 'C' continued to operate normally and would have inserted during a rod run-in activation. There are no MURR accident analyses that assume the negative reactivity insertion from rod run-in initiation is required to terminate the accident.

Corrective Actions

When the LSRO discovered shim control blade 'D' would not move in the inward direction, he immediately shut down the reactor by initiating a manual scram by placing Master Control Switch 1S1 to the "TEST" position. The LSRO completed all immediate and applicable subsequent actions of reactor emergency procedure REP-8, "Control Rod Drive Mechanism Failure or Stuck Rod," and verified all shim control blades were fully inserted.

Troubleshooting revealed a broken wire to the inward direction motor winding of shim control blade 'D' CRDM. The wire was repaired, and operability of shim control blade 'D' CRDM was tested satisfactorily.

In the past, MURR has occasionally discovered a broken wire or a loose relay on the CRDM motor circuit. A broken wire or loose relay could be caused by either age degradation of components or occasional physical contact with the wiring causing cyclic stress to the wire or movement to the relay. MURR started a shim control blade CRDM refurbishment effort under Modification Record 18-02, "Fabrication of a New Control Rod Drive Mechanism," in which a new, spare CRDM was fabricated and installed in shim control blade 'B' position in October 2018. Installation of a new CRDM is allowing MURR to systematically remove and refurbish the remaining four (4) CRDMs.

Refurbishment includes replacement of the CRDM motor relay sockets and wiring. The installation of a relay retainer bracket and providing more strain relief to the wire bundle is part of the CRDM refurbishment process. MURR will be implementing these wiring and relay bracket changes on an accelerated schedule due to this LER (see Attachments 2, 3, and 4).

In response to this LER, MURR has designed a bracket to help protect the CRDM wiring from physical contact that may occur during CRDM removal and reinstallation or sample handling evolutions in the vicinity of the CRDMs. This bracket will be installed on the same accelerated schedule as the wiring refurbishment (see Attachments 2, 3, and 4).

Additionally, this event has been entered into the MURR Corrective Action Program as CAP No. 19-0057, and any additional information or corrective actions will be considered and documented in that CAP entry.

If there are any questions regarding this LER, please contact me at (573) 882-5118. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Bruce A. Meffert

Bruce A. Meffert
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

J. David Robertson, PhD
Reactor Facility Director

Attachments:

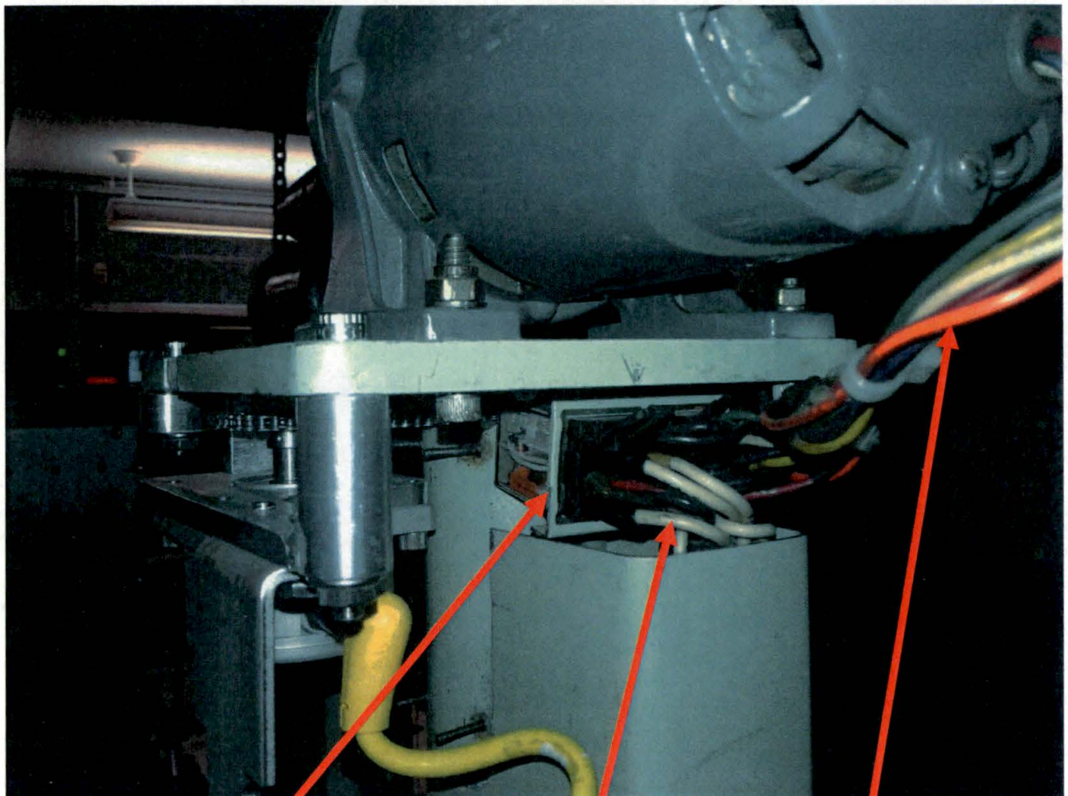
1. Overview of Shim Control Blade Drive Mechanism Motor Circuit Wiring
2. Motor Circuit Prior to Rewiring and Addition of Strain Relief and Wire Protections (Backside View) & Motor Circuit After Rewiring and Addition of Strain Relief and Wire Protections (Backside View)
3. Motor Circuit Prior to Rewiring and Addition of Strain Relief and Wire Protections (Angle View) & Motor Circuit After Rewiring and Addition of Strain Relief and Wire Protections (Angle View)
4. Motor Circuit Prior to Rewiring and Addition of Relay Retainer and Wire Protections (Side View) & Motor Circuit After Rewiring and Addition of Relay Retainer and Wire Protections (Side View)

State of Missouri
County of Boone
Subscribed and sworn to before me this 10 day of May, 2019
Jacqueline L Matyas
JACQUELINE L. MATYAS, Notary Public
My Commission Expires: March 26, 2023

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

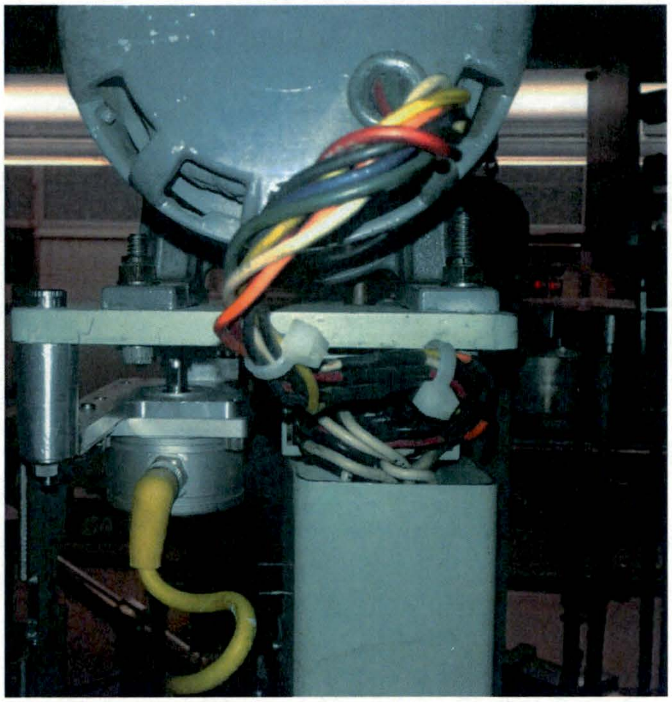
JACQUELINE L. MATYAS
My Commission Expires
March 26, 2023
Howard County
Commission #15634308

ATTACHMENT 1

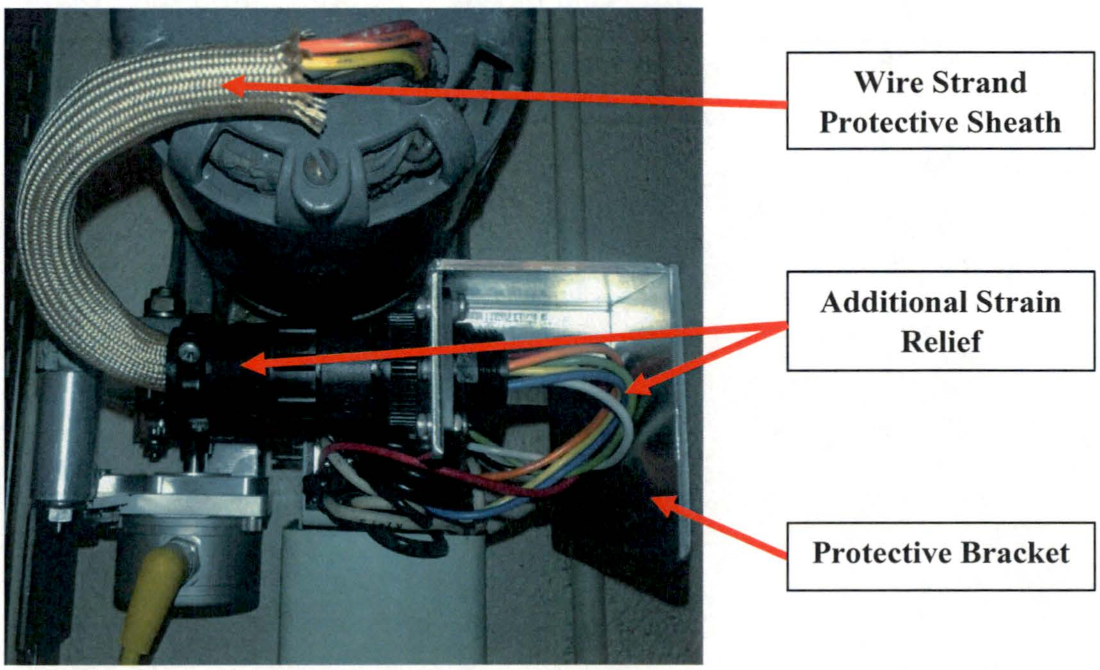


Overview of Shim Control Blade Drive Mechanism Motor Circuit Wiring

ATTACHMENT 2

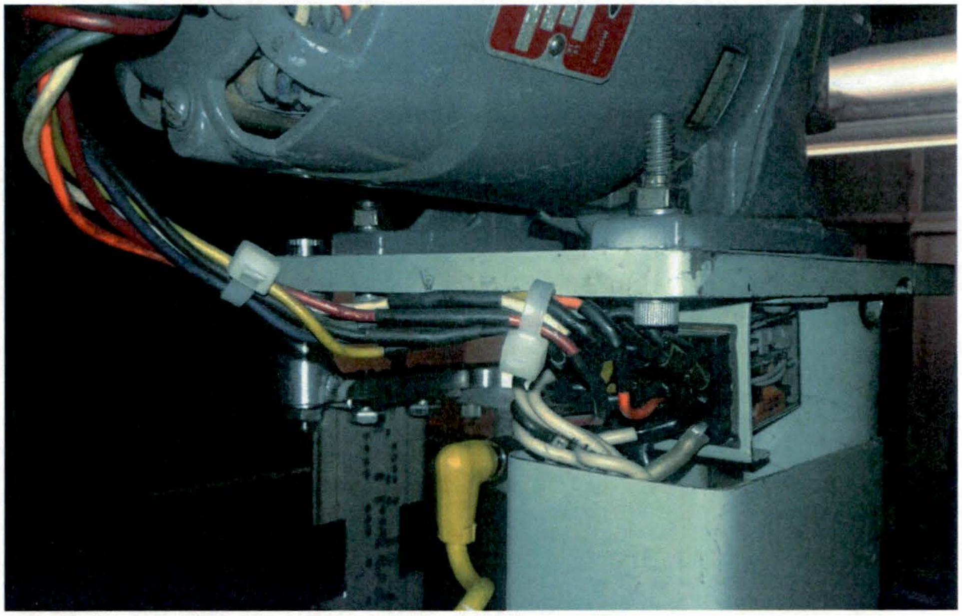


Motor Circuit Prior to Rewiring and Addition of Strain Relief and Wire Protections (Backside View)

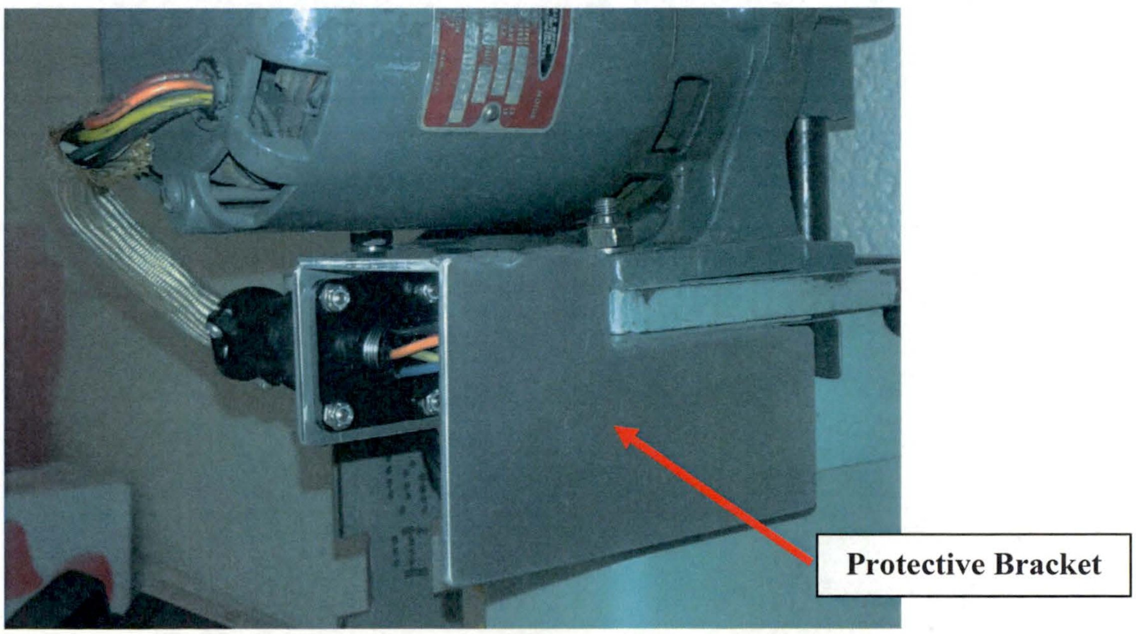


Motor Circuit After Rewiring and Addition of Strain Relief and Wire Protections (Backside View)

ATTACHMENT 3

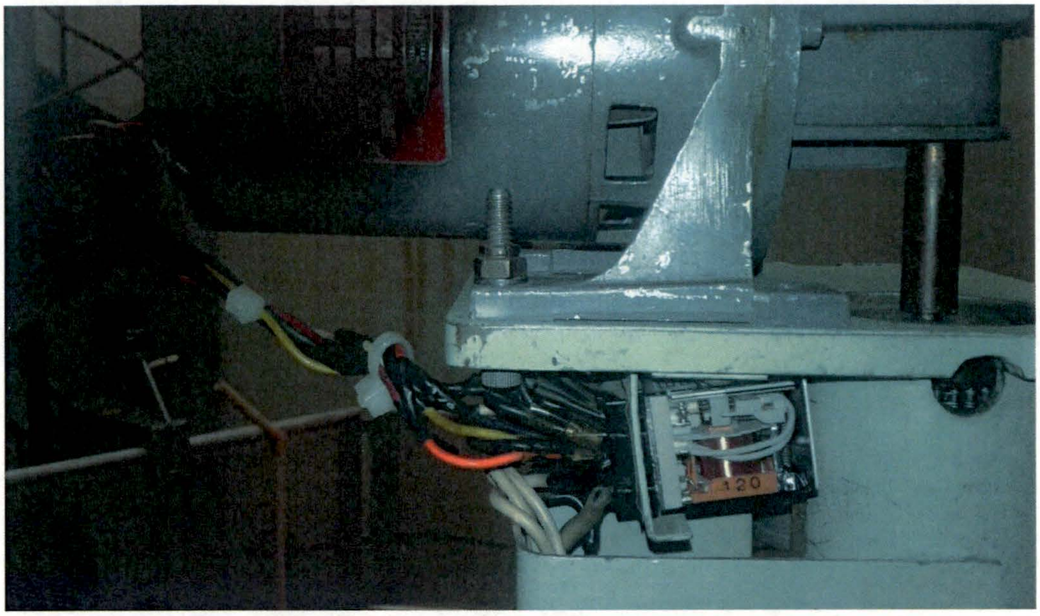


Motor Circuit Prior to Rewiring and Addition of Strain Relief and Wire Protections (Angle View)

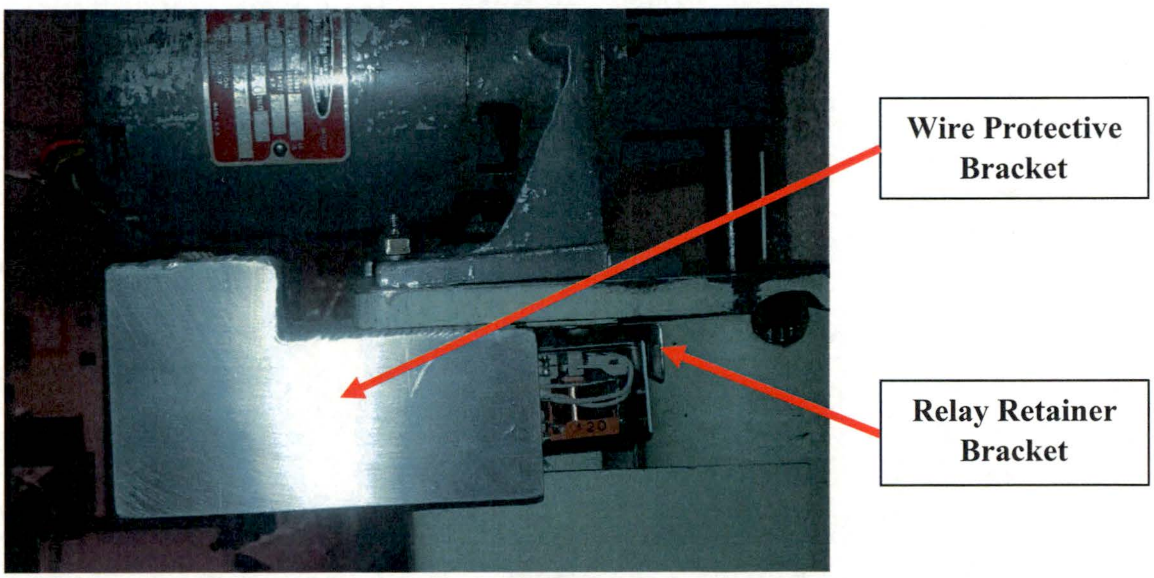


Motor Circuit After Rewiring and Addition of Strain Relief and Wire Protections (Angle View)

ATTACHMENT 4



Motor Circuit Prior to Rewiring and Addition of Relay Retainer and Wire Protections (Side View)



Motor Circuit After Rewiring and Addition of Relay Retainer and Wire Protections (Side View)