

NUCLEAR UTILITY GROUP
ON EQUIPMENT QUALIFICATION

0064539

A-109
50-348/364-CIVP

2/20/92

AP6 Er 109

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May 7, 1986

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F004
EL3586-017

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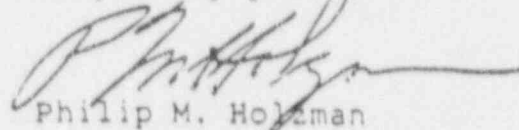
Dear Joe:

Enclosed please find a Nuclear Utility Group on Equipment Qualification (NUGEQ) document on Limatorque actuator environmental qualification. The document has been prepared by the Group based on our discussions with Limatorque and the contents of the referenced Limatorque reports. The Group requests Limatorque's review and comment on this material.

The objective of our efforts has been to clarify various topics which have been raised by Group members related to the actual testing performed by Limatorque. In addition, the Group has an interest in Limatorque's design, testing and manufacturing experience, and any feedback on field experience which would aid utilities in the application of your reports and other qualification data to installed actuators requiring environmental qualification to 10 CFR 50.49.

The Group would appreciate your prompt attention and response. On behalf of the Group, I want to thank you and Limatorque for the time and effort associated with providing this information.

Very truly yours,


Philip M. Holzman

PMH/ak

Enclosure (1)

NUCLEAR REGULATORY COMMISSION

Docket No. 50-348/349 CIV? Original Exh. No. 109
 In the matter of Alabama Power Company
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 Contractor _____ DATE 2/20/92
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NUCLEAR UTILITY GROUP
ON EQUIPMENT QUALIFICATION

0064640

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May 12, 1986

P004
EM3586-030

MEMORANDUM

TO: Nuclear Utility Group on Equipment Qualification

FROM: Philip M. Holzman *PMH*

SUBJECT: Issuance of the NUGEQ Report on Limitorque EQ Clarifications

Attached please find a NUGEQ report titled, "Clarification of Information Related to the Environmental Qualification of Limitorque Motorized Valve Operators," which documents the meeting and discussions held on behalf of the Group during March and April with Limitorque. The clarifications presented in this report address actual test configurations and other analysis and experience which Limitorque uses to support environmental qualification of its actuators. Limitorque and the Group members agreed that case-by-case considerations, other qualification test data, and utility specific analysis are used in combination with the referenced Limitorque reports to support actuator environmental qualification. Therefore, clarifications contained in this document do not fully reflect the final qualification evaluations which apply to installed Limitorque actuators.

If additional information is required, please contact Limitorque or the NUGEQ subcommittee involved in the Limitorque discussions.

PMH/ek

Attachment: Clarification of Information Related to the
Environmental Qualification of Limitorque Motorized
Valve Operators

1/The NUGEQ subcommittee involved in the Limitorque discussions included: Paul Conner - VEPCO; Pedro Salas - CP&L; John Nicosia - NEU; Phil Holzman - EPM; and Bob Phillips - Westinghouse for CP&L.

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Limitorque motorized valve actuators are used extensively throughout the nuclear industry in applications requiring environmental qualification to 10 CFR 50.49. Clarification of the Limitorque's test experience was sought by the Nuclear Utility Group on Equipment Qualification (NUGEQ) in light of recent industry attention to the environmental qualification of Limitorque actuator control wiring, the various actuator configurations which can exist, and the spectrum of generic environmental qualification tests performed by Limitorque.

The attached information was developed by the NUGEQ, based on discussions with Limitorque together with information contained in a series of Limitorque reports. The topics which have been addressed were suggested by NUGEQ members as items for discussion. Their inclusion in this report does not imply that they are issues which are of major importance for the environmental qualification of Limitorque actuators. The objective was rather to provide a set of consistent clarifications for each of these topics.

LIMITORQUE, Introduction

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The attached table identifies the Limitorque qualification test reports which form the basis for the NUGEQ discussions with Limitorque. Relevant data associated with each of these Limitorque reports is provided, where appropriate, in each section of this report. During a review of these sections, please note that Reports B0003 and F-C3271 may be generically referenced as the "out-of-containment" test reports. The NUGEQ recognizes that a number of other Limitorque actuator tests have been performed by others or by Limitorque under proprietary agreements. Information associated with these additional reports has not been incorporated into this document, but should be referenced where appropriate to extend or modify this report's information.

The NUGEQ recognizes that all actuators are essentially equivalent, with differences limited to cover material changes, electrical component differences (including motors, terminal blocks, torque switch and limit switch materials), and the use of motor T-drains and actuator grease-relief valves. It is, therefore, possible for utilities to modify, extend or upgrade an actuator's qualification through the selective combination of applicable reports or through the use of alternate replacement parts.

Finally, the Group notes that Limitorque's test reports and experience provide only one of a variety of input data sources used by licensees to environmentally qualify valve actuators to the requirements of 10 CFR 50.49. A broad spectrum of case-by-case considerations and additional information are used by utilities to formulate their final analysis of environmental qualification. The information contained in this report should not be viewed as restricting the use of these Limitorque reports or limiting the case-by-case considerations which are necessary to adequately address equipment qualification.

TABLE I

- (1) Project 600198 Report F-C2232-01 January 2, 1969
Test of Limitorque Valve Operator To Meet General
Requirements Of An Electric Valve Actuator In Nuclear
Reactor Containment Environment (including Addendum #1,
April 29, 1969)
- (2) Project 600376A Report F-C3441 May 13, 1976
Nuclear Power Station Qualification Type Test Report
Limitorque Actuators For BWR Service
- (3) Project 600456 Report 600456 December 9, 1975
Nuclear Power Station Qualification Type Test Report
Limitorque Actuators For PWR Service
- (4) Project 600426 Report B0009 April 30, 1976
Qualification Type Test Report Limitorque D.C. Valve
Actuators For Nuclear Power Station Service Conditions

1/These reports are also provided as appendices to Limitorque
Report B0058, Limitorque Valve Actuator Qualification For
Nuclear Power Station Service, January 11, 1980.

LIMITORQUE, Introduction

0064647

- (5) Project 600461 Report B0003 June 2, 1976
Qualification Type Test Report Limitorque Valve Actuators
For Class 1E Service Outside Primary Containment In Nuclear
Power Station Service
- (6) Project 360160 Report F-C3271 February 1972
Qualification Test Of A Limitorque Valve Actuator In A Steam
Environment
- (7) Project 600508 Report B0027 August 31, 1978
Limitorque Valve Actuator Temperature Related To High
Superheat Ambient Temperatures
- (8) Project Report B0212 April 10, 1985
Nuclear Power Station Qualification Type Test Report
Limitorque Valve Actuators With Type LR Motor for
Westinghouse PWR
- (9) Project 681041 Report B0119 Rev. 1 November 10, 1982
Qualification Type Test Report of Multi-Point Terminal
Strips For Use In Limitorque Valve Actuators For PWR Service

1/These reports are also provided as appendices to Limitorque
Report B0058, Limitorque Valve Actuator Qualification For
Nuclear Power Station Service, January 11, 1980.

LIMITORQUE

1. Actuator Size:

Limitorque philosophy is that a full range of actuators are qualified by the mid-size actuators (SMB-0) which have been used in all EQ testing. This range includes the full spectrum of SMB and SB units.

In Section 2.1 of Report B0058, Limitorque states:

"The qualifications were conducted to encompass the entire family of Limitorque actuators - SMB, SB, SBD, and SMB/HBC in all available unit sizes (SMB-000 to SMB-5). This was accomplished by conducting the qualification testing on a mid-size unit (SMB-0) subjecting the actuator to simulated seating loads equivalent to the actuators published unit rating during the test procedure."

Actuator Size Data:

- | | | |
|-----|----------|------------------------------|
| (1) | 600198: | SMB-0-15 |
| (2) | 600376A: | SMB-0-25 |
| (3) | 600456: | SMB-0-40 |
| (4) | B0009: | SMB-0-25 |
| (5) | B0003: | SMB-0-25 |
| (6) | F-C3271: | SMB-0-10 |
| (7) | B0027: | SMB-00-15 |
| (8) | B0212: | SMB-00-15 |
| (9) | B0119: | N/A (used as a fixture only) |

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2. Orientation:

All actuators tested by Limitorque were oriented with the limit switch compartment vertically up, the motor horizontal and actuator stem, horizontal. Based on experience, historical data, and screening tests, this position was selected by Limitorque to represent the worst case position. The basis for this selection was to expose the motor (as the lowest electrical component) to the highest levels of moisture collection and steam intrusion.

In Section 4.1.3 of Report B0058 Limitorque states:

"The mounting position of the actuator was chosen with the limit switch compartment up and the motor horizontal. This is considered the worst possible position because it allows any condensate that collects in the unit to flow through the motor to provide the most damaging effect on its insulation system."

Limitorque, based on its testing and analysis, considers actuators qualified for all orientations, but installations with the motor or limit-switch compartment aligned vertically down should be minimized. Although environmentally qualified in these orientations, unanticipated failure of certain seals or gaskets during normal or accident conditions could permit grease to accumulate in or on electrical components.

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3. Motor Size/Manufacturer:

In all tests, with the exception of those involving Class B AC motors, the Limitorque tested motor is the same manufacturer/design which is supplied with the units certified to the applicable test report.

For the Class B units tested in B0003 and F-C3271, the purpose of the test was to demonstrate the inherent capability which exists in generic commercial grade UL standard Class B systems to function during the tested conditions. During the B0003 test three motors of different manufacturers were tested. Peerless

~~Class B AC motors were not tested. However, Limitorque utilizes a similarity analysis originally developed by others for the LITCO Shoreham unit to qualify by similarity these units.~~

Limitorque noted that Peerless Class B AC motors have not been supplied since approximately 1973.¹

1/Although not formally incorporated into this summary, please note that a Peerless Class B AC motor with Dings brake was tested in WCAP 7410-L, Appendix D (F-C 2485-01)

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Motor Data:

- (1) 600198: Reliance Rad H (nameplate "H"), (connected to unit), dual voltage, AC²
Reliance Rad H (nameplate "~~H~~") with Dings brake(operated in chamber), dual voltage, AC
- (2) 600376A: Reliance RH, 1800 rpm, dual voltage, AC
- (3) 600456: Reliance RH, 1800 rpm, single voltage, AC
- (4) B0009: Peerless RH (nameplate "H"), DC
- (5) B0003: Reliance B (connected to actuator), dual voltage, AC
Electric Apparatus B (operated in chamber) AC
Paramount B (operated in chamber), AC
- (6) F-C3271: Reliance B with Reliance brake, dual voltage, AC
- (7) B2027: Reliance RH, AC
- (8) B0212: Reliance LR, single voltage, AC
- (9) B0119: N/A

2/Limitorque no longer supplies Reliance Rad H motors certified to 600198. The replacement Reliance RH motors are supplied with certification to 600376A, 600456, (or 600198 if requested). No RH motors, provided with brakes, will be certified to these reports (See discussion of motor brakes).

4. Motor Orientation/T-Drains:

All tested motors were horizontal, motor T-drains were utilized in certain tests as tabulated below. The principal purposes for use of the T-drains were, 1) to provide drainage of internal actuator condensation; and 2) to serve as the primary vehicle for internal-to-external actuator pressure equalization. The T-drains were the principal pathways for steam and moisture intrusion into the actuator. In order to function as drainage pathways, the motor T-drains should be installed at the motor low point ports.

For motors covered by tests utilizing two T-drains, their location should be as follows:

- (1) motor principal axis horizontal - one (1) T-drain on each motor-end bell at the lowest available point. If the motor lead wireway to limit switch compartment occupies one of these positions (e.g., for a horizontally mounted motors with limit switch compartment facing down) it will function as a motor drain. In this case the associated T-drain may be omitted or placed at the next available point to facilitate motor drainage.

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- (2) motor principal axis vertical - two (2) T-drains on lowest motor-end bell. (Four plugged ports are typically provided in each end bell which can be used to locate the T-drains).

For actuator motors tested with one motor T-drain, it should be placed at the lowest available end bell port. Multiple ports are not typically provided in these motors. Plugs should be installed in unused end-bell ports.

~~For actuator motors tested without T-drains, Reference Rad H and Class B motor T-drains are not required nor are they recommended by Limitorque.~~

Limitorque notes that all tested actuators were essentially equivalent with electrical component differences limited to motors, terminal blocks, torque and limit switch materials. Terminal blocks are generically addressed B0119. ~~For all in-containment tested actuators the torque and limit switch materials are equivalent. It is, therefore, possible when utilizing replacement RH motors to upgrade a 600198 actuator's or motor's qualification to more recent reports. In these case, installed motors should be equipped with T-drains per the~~

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~~referenced motor report. Limitorque recommends that the
installed motors be provided with T-drains to represent the
referenced motor's tested configuration.~~

3/The NUGEQ notes that in locations which do not experience temperature and humidity increases due to steam line breaks (e.g., mild environments or radiation only harsh environments) the pressure equalization and drainage provided by the T-drains would not be necessary. In these cases, the NUGEQ believes the absence of T-drains is justified. The omission of T-drains in other situations will not necessarily prevent proper actuator operation or violate environmental qualification. Examples of situations which, based on utility-specific analysis, may be considered acceptable include:

- 1) Operability only required for a short duration immediately post-accident, or
- 2) Motor orientations which would preclude moisture collection in the motor (e.g., drainage into the limit-switch compartment would occur), or
- 3) The required environmental parameters are bounded by other reports (e.g., 600198, B0003 or F-C3271) which did not utilize T-drains. Since the RH and LR class insulating systems which were tested with T-drains are considered superior to the Rad H and B Class systems, this extrapolation of the 600198, B0003 and F-C3271 reports can be made.

Motor T-Drain Data:

(1) 600198: None

(2) 600376A: 2

~~(3) 600476: 2~~

(4) B0009: 1

~~(5) B00031: None~~

(6) F-C3271: None

(7) B0027: 2

(8) B0212: 2

(9) B0119: 2

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5. Motor Rotors:

Magnesium rotors only exist on certain Reliance AC motors. Both aluminum and magnesium rotor motors have been tested as tabulated below. Since magnesium rotor motors acceptably passed the 600456 and B0212 steam test conditions, Limitorque has concluded that rotor materials do not affect the level of motor qualification. Limitorque certifies the performance of magnesium rotor motors to all referenced tests.

If requested, Limitorque will provide for a fee, utilities with information on rotor materials for installed motors. Limitorque requires the motor ID number (serial number). Reliance may also be contacted to provide this information. As

general guidance, magnesium rotors should exist on 180 FRAME size and larger motors, aluminum rotors should exist on 48 and 56 FRAME sizes.

Limitorque is not completely aware of details associated with the GE/Wyle testing which formed the basis for issuing IEN 86-02.

Magnesium Rotor Motor Data

- (1) 600456: magnesium
- (2) B0212: aluminum (connected to actuator)
magnesium (operated in chamber)
- (3) all others: aluminum

6. Motor Brakes:

Reliance motors with brakes were tested in 600198 (Dings brake) and F-C3271 (Reliance brake). In both tests, the units successfully functioned during the test conditions and are considered by Limitorque as qualified to these reports. ~~It was noted that radiation was not included as a test parameter and, based on the particular application, should be analyzed.~~

Due to design improvements, Limitorque recommends replacing/modifying SMB actuators requiring motor brakes with the SB design. Although the actuator modifications may be performed in the field, Limitorque recommends factory modification. Limitorque's factory will support refueling outage schedules. It was noted that replacement SB units are slightly heavier than the equivalent SMB unit.

~~Limitorque stated that while it is possible to modify the actuator to render the brakes inoperative, it requires careful readjustments, introduces other potential problems, and is not recommended.~~ Simple de-termination of the brake leads does not render the brakes inoperative and in fact will make the brake drag. ~~Limitorque noted it will not supply replacement EQ certified motors with brakes.~~

Motor Brake Data

- (1) 600198: Reliance with Dings brake (operated in chamber)
- (2) F-C3271: Reliance with Reliance brake
- (3) all others: no brakes

7. Motor Leads, Connections and Terminations:

All motors are supplied with leads identical to those used in the referenced test motor. To avoid motor lead abrasion Reliance RH motor leads are covered with a heat shrinkable polyolefin which was included in the tested configuration.

All tested motors had their power leads terminated with crimp-type lugs to the power terminal blocks located within the limit switch compartment. Since dual voltage motors were tested at the higher voltage rating (460v), splicing of certain leads was necessary. Limitorque fabricated the motor test splices in accordance with its factory standards which utilize insulated blind barrel crimp splices in the same product families as the crimp-type lugs. (See Section 18, Terminal Blocks, and Section 19, Wiring Connections, for further clarification).

Unless otherwise requested in the applicable purchase documents, Limitorque provides motor leads terminated per the referenced test report. Limitorque indicated that motor terminations utilizing nuclear grade splices, qualified by others, are also considered an acceptable termination method.

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8. Motor Internal Overloads (Thermogards):

Limatorque indicated that to the best of their knowledge integral motor overloads have not been supplied on any nuclear grade motors certified to the various Limatorque test reports.

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9. Motor Heaters:

The motor heaters are small flat discs which are attached within the motor-end bell with leads extending into the limit-switch compartment.

~~Motor heaters were not included in any environmental or seismic testing conducted by Limitorque.~~ If requested in purchase documents, they have been provided in nuclear-qualified units but should not be considered as qualified by Limitorque.

Limitorque recommends that the heaters only be energized during storage. Limitorque has not analyzed the effect that the heaters may have on environmental or seismic qualification, but offered the following perspectives:

- (1) If energized, the heaters could increase the motor ambient temperature. No data was available, from Limitorque. The effect on motor qualified life, or survival under DBE conditions, has not been analyzed by Limitorque.⁴
- (2) Un-energized heaters should not affect environmental qualification due to their location and materials of construction.
- (3) Seismic qualification should not be affected by the presence of the heaters due to their low mass and location.

4/A review of B0058 suggests that for most applications an acceptable qualified life (40 years) with substantial margin should still be available for units with minor temperature increases above typical plant ambient conditions. See B0058, Section 3.2, Thermal Aging.

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10. Lubricants:

Lubricants that can be used in the Limitorque actuators are identified in the appropriate instruction manual and Lubrication Data Form LC8. The actual greases utilized during Limitorque testing are tabulated below. Other lubricants with the appropriate properties may be substituted for those tested or certified by Limitorque; however, testing, analysis and qualification of these substitute lubricants should be established by the user.

The main gearboxes were tested and are supplied for in-
containment applications with Exxon Nebula EPO grease, although
Nebula EPl can be mixed with or used in place of the EPO.
Limitorque does not recommend mixing the Nebula EPO and EPl with any other type lubricant. This lubricant is light tan in color and appears to have a smooth texture.

For SMB-000, SMB-00 and SMB-5 actuators certified to the
out-of-containment tests, the main gear box can also be
lubricated with Sun Oil Company 50 EP (XC-421-39) instead of the
Exxon Nebulas identified above. Limitorque originally supplied
the Sun Oil for the out-of-containment certified SMB-00 and SMB-
000 units with serial numbers below 295810. The Sun Oil
lubricant continues to be used for out-of-containment certified
SMB-5 units. This lubricant shall not be mixed with the Exxon
Nebulas and it is recommended that utilities use Exxon Nebula EPO
for all applications with the exception of SMB-5. Limitorque has

subjected the Sun Oil EP to 225 megarads and performed an independent analysis on the grease's lubricity. The analysis indicated acceptable performance of the Sun Oil grease. The Sun Oil lubricant is black in color with a stringy texture.

Limitorque has tested and supplied Beacon 325 and Mobil 28 greases for the limit switch gear housing. The Mobil 28 is reddish-brown in color. The Beacon 325 is a light grey/beige. Limitorque noted that the Beacon and Mobil greases should not be mixed. Finally, Limitorque suggests that the Mobil 28 be used in applications where normal operating temperatures are greater than 150°F.

Lubricant Data: (main gearbox/limit switch gears)

- (1) 600198: Humble Nebula EP1/Beacon 325⁵
- (2) 600376A: Exxon Nebula EP1/Beacon 325
- (3) 600476: Exxon Nebula EP1/Beacon 325
- (4) B0009: Exxon Nebula EP1/Beacon 325
- (5) B0003: Exxon Nebula EP1/Beacon 325
- (6) F-C3271: Humble Nebula EP1/Beacon 325
- (7) B0027: N/A
- (8) B0212: Exxon Nebula EP0/Mobil 28
- (9) B0119: N/A

5/The original Humble Nebula is equivalent to Exxon Nebula since Humble was acquired by Exxon.

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Gear Box Relief Valve Data:

- (1) 600198: Installed
- (2) 600376A: Installed
- (3) 600476: Installed
- (4) B0009: Installed
- (5) B0003: Not Installed
- (6) F-C3271: Not Installed
- (7) B0027: Installed
- (8) B0212: Installed
- (9) B0119: Installed

12. Seals and Gaskets:

Per Limitorque, the seals and gaskets are not critical to qualification since the actuator does not depend on absolute sealing to survive DBE conditions.⁷ Limitorque suggests that the same type seals and gaskets, as used in the referenced test configuration, be used during plant operations.

In B0058 Section 3.2.3 Seals, Limitorque states:

"Limitorque actuators for Nuclear Plant application are designed to permit them to survive normal and accident conditions without depending on absolute sealing. In fact, the ambient is not absolutely restricted from entering the actuator. The seals are of no importance for qualification and, therefore, require no consideration for the qualification."

Seals/Gaskets Data: (Seal/Gasket)

- (1) 600198: Viton/Anchorite
- (2) 600376A: Viton/Anchorite
- (3) ~~600476: Viton/Anchorite~~
- (4) B0009: Viton/Anchorite
- (5) B0003: Buna-N/Anchorite
- (6) F-C3271: Buna-N/Anchorite
- (7) B0027: N/A
- (8) B0212: Viton/Anchorite
- (9) B0119: N/A

7/All inside-containment qualification testing was performed with Viton seals whereas Buna-N was used during outside containment testing. Viton was selected for in-containment applications due to additional material margins to failure. Viton seals can be used in all actuator applications. ~~Other gaskets for all tested actuators were fabricated of Anchorite Part #425 by Anchor Packing Company.~~

13. Handwheels:

The use, location, and configuration of handwheels do not appear to have an effect on the units' environmental qualification. Limitorque has been unable to develop any handwheel failure mechanisms that would preclude the actuator from performing its function.

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14. Local Position Indicator (LPI):

Unless required by procurement documents, LPIs are not normally supplied on environmentally qualified units. However, an LPI was installed on actuators tested in 600198 and 600376A. Installation of the LPI does not affect the qualification of actuators certified to other test reports. The LPI is a gear-driven mechanical device which is attached to the limit switch compartment. It has no safety function, nor should its performance affect other actuator components. Limitorque notes that since actuators were qualified with moisture intrusion into the limit switch compartment, physical integrity of the LPI window is not critical to actuator performance.

LPI DATA:

- (1) 600198: LPI
- (2) 600376A: LPI
- (3) 600476: NO LPI
- (4) B0009: NO LPI
- (5) B0003: NO LPI
- (6) F-C3271: NO LPI
- (7) B0027: NO LPI
- (8) B0212: NO LPI
- (9) B0119: NO LPI

15. Limit Switch Compartment Orientation:

As previously discussed, the orientation of all tested actuators was with the Limit Switch Compartment (LSC) vertical at the top of the actuator. In this configuration, excess condensation drained from the limit switch compartment into the motor housing via the actuator's internal motor lead wireway.

~~Limitorque stated that this configuration qualified the unit for all LSC orientations.~~

16. Limit Switch Compartment Cover and Gasket Materials:

Both the aluminum and cast-iron Limit Switch Compartment (LSC) covers supplied by Limitorque have been tested. Since Limitorque has not tested aluminum covers for PWR chemical spray conditions, it is recommended that the actuators for PWR in-containment applications use cast iron covers.⁸

The LSC gasket, in all applications, is Anchorite Part #425. Limitorque noted that this gasket material is permeable to gases, possibly including steam. See additional discussion under Section 12, Seals and Gaskets.

LSC Cover Data:

- (1) 600198: NO DATA
- (2) 600376A: CAST IRON
- (3) ~~600476A: CAST IRON~~
- (4) B0009: CAST IRON
- (5) ~~B0001: ALUMINUM~~
- (6) F-C3271: ALUMINUM
- (7) B0027: CAST IRON
- (8) B0212: CAST IRON
- (9) B0119: CAST IRON

8/ The NUGEO notes that the concern with aluminum in this application is the effect of the long-term caustic spray on the cover material's integrity. If adequately analyzed by utilities for external corrosive effects, aluminum covers may be acceptable for PWR in-containment applications.

17. Limit Switch Compartment Drains/Seals/Conduit Connections:

For tests utilizing motor T-drains, the external test environment entered the limit-switch compartment from the motor housing via the motor lead wireway. For actuators tested without motor T-drains, the external steam environment entered the actuator via the gas permeable Anchorite gaskets and via the conduit fittings which were not installed to provide pressure-tight seals. Limitorque noted that in all the actuator tests without T-drains, moisture and steam intrusion was evident from the small pool of condensate that collected in the LSC. For tests without T-drains, pressure recordings document actuator pressure equalization at test-chamber pressure and demonstrate that leakage occurred in all referenced tests. It was also noted that in the 600198 test (which tested units without motor T-drains) a 9-hour preliminary steam test was performed by piping live steam into the LSC via upper conduit taps and draining condensate with an open lower conduit tap. That report indicates that the test was successful with no noticeable effect on the function of any parts in the LSC. In all the Limitorque tests, the existence of moisture inside the unit did not prevent adequate actuator performance.

During the testing, test leads (both power and control) exited the LSC via two conduit openings (one for power and one for control). The configurations of these openings are tabulated below. Unused openings were closed with threaded pipe plugs. No

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external Limit Switch Compartment (LSC) drains were provided during any of the referenced EQ tests. As previously discussed, for the tested configurations, excess condensation during testing drained from this compartment via the internal wireway into the motor housing. The exact location of the wireway varies with actuator model number (SMB-0, SMB-00, etc.), but is located roughly at 3/4 of the compartment height when the LSC is mounted horizontally. (See Figure 1 attached.)

For installations that reference tests utilizing motor T-drains, Limitorque indicated that the use of LSC drains although not required does not affect qualification since, during the tests, the external environment enter the LCS via the motor T-drains.

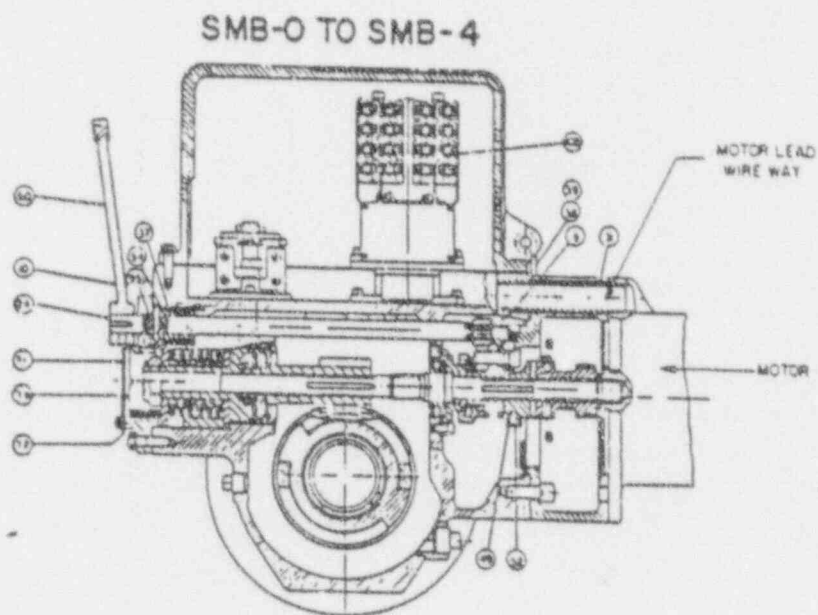
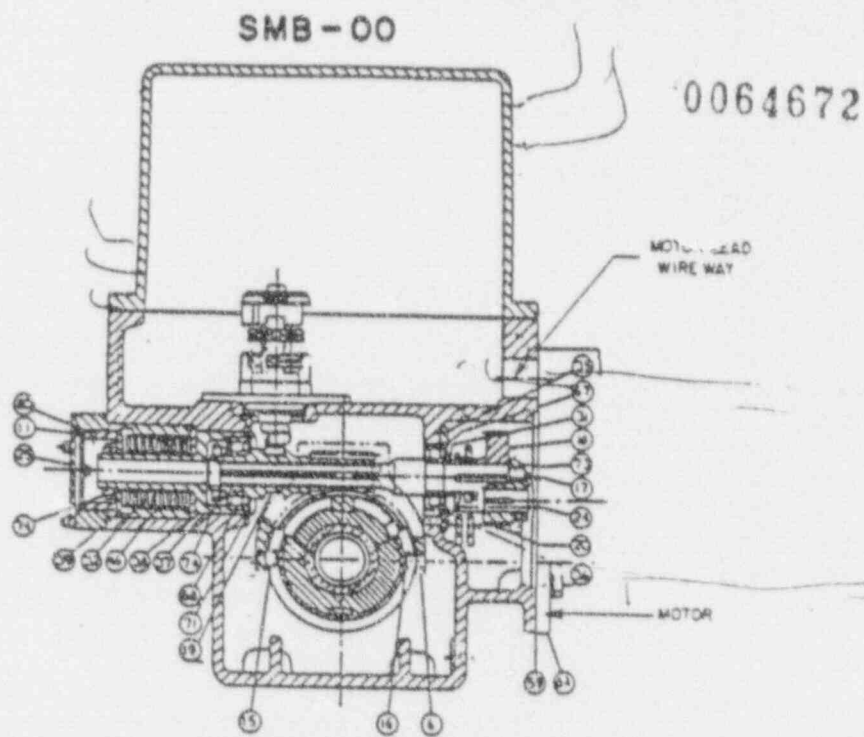
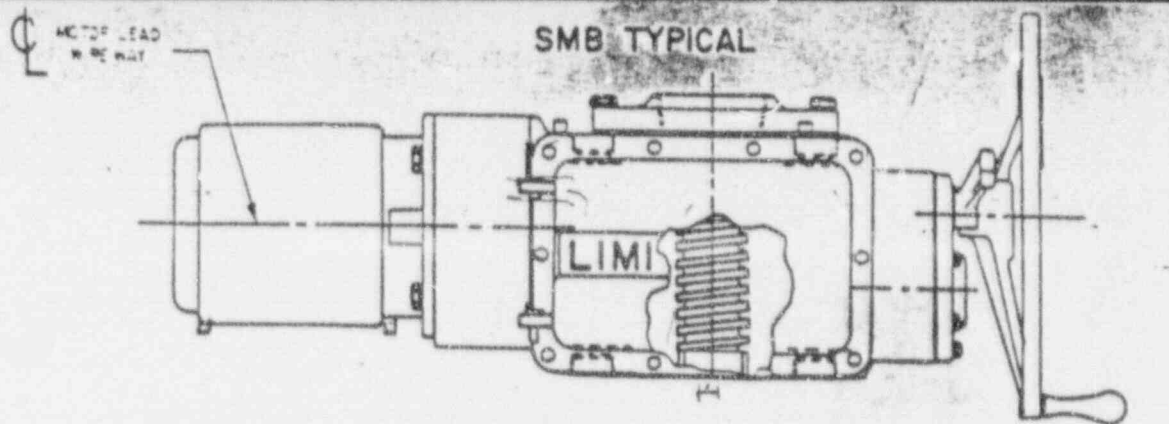
LSC Conduit Interface Data:

Three conduit wiring configurations were used in the various tests as follows:

- TYPE A Non-nuclear grade Conax seals at both the limit switch compartment conduit opening and test at chamber wall.
- TYPE B Non-nuclear grade Conax seals at test chamber wall. High pressure teflon hose threaded to both the Conax seal and the LSC conduit openings. The teflon hose was used to minimize abrasion to the internal test wiring during the qualification testing.
- TYPE C Non-nuclear grade Conax seals at test chamber wall. Steel tubing with threaded fittings connected to both the Conax seal and the limit switch compartment conduit opening. The purpose of the tubing was to minimize wire abrasion during testing.

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- (1) 600198: TYPE C
- (2) 600376A: TYPE A
- (3) 600476: TYPE B
- (4) B0009: TYPE B
- (5) B0003: TYPE B
- (6) F-C3271: TYPE C
- (7) B0027: TYPE B
- (8) B0212: TYPE B
- (9) B0119: TYPE B



NOTE:
DRAWINGS EXTRACTED FROM
VARIOUS LIMITORQUE PUBLICATIONS.

FIGURE -1

18. Terminal Blocks (Power and Control):

Terminal Blocks were used in all Limitorque tests to interface the motor power leads with the test chamber wires. Terminal Blocks were not used in any Limitorque tests for control circuit wiring. The wire termination points, which are integral parts of limit and torque switches, were qualified as part of these assemblies. Limitorque terminated the test chamber control wires directly to both the limit switches and torque switches, and developed the necessary circuit interconnections (jumpers) external to the test chamber. Testing in this manner facilitated monitoring of individual switch performance.

In addition to testing power terminal blocks during the standard Limitorque tests, a special test B0119 was performed to specifically test the range of terminal blocks and crimp-type terminations used by Limitorque. During the testing, IR measurements were made and actuator operability verified to determine the level of performance provided by the various terminal block types.

Limitorque stated that it will certify the performance of terminal blocks to the applicable test reports including B0119. Limitorque also noted that it will certify terminal blocks to other reports based on material similarities and comparable performance in the B0119 testing.

It was noted that the Marathon 300 blocks were rated by UL from 600V to 100V. This resulted in Limitorque's decision to use every other terminal point, e.g. alternate vs. adjacent, for power wiring in subsequent Limitorque tests. Both Limitorque and the discussion group members present agreed that the use of alternate vs. adjacent wiring does not affect the performance or level of qualification provided for the Marathon 300 blocks based on the B0119 testing.

Finally, Limitorque stated that the use of environmentally qualified splices in lieu of terminal blocks, in both power and control circuits, was an acceptable configuration.

Terminal Block Data

- (1) 600198: - Buchanan 0524 (adjacent)
- (2) 600376A: - Buchanan 0524 (adjacent)
- (3) 600456: - Marathon 300 (alternate)
- (4) B0009: - Marathon 300 (alternate)
- (5) B0003: - Marathon 300 (alternate)
- (6) F-C3271: - Buchanan 0524 (adjacent)
- (7) B0027: - N/A
- (8) B0212: - Marathon 300 (alternate)
- (9) B0119: - Marathon 300 (adjacent)
 - Marathon 300 (alternate)
 - Buchanan 0524 (alternate)
 - Buchanan 0222 (adjacent)
 - GE EB-5 (adjacent)
 - Marathon 1600 (adjacent)
 - Curtis Type L (adjacent)

824 NON QUAL (152)
(5772)

It was noted that the Marathon 300 blocks were rated by GE from 100V to 300V. This resulted in Limitorque's decision to use every other terminal point, i.e., alternate vs. adjacent, for power wiring in subsequent Limitorque tests. Both Limitorque and the discussion group members present agreed that the use of alternate vs. adjacent wiring does not affect the performance or level of qualification provided for the Marathon 300 blocks based on the B0119 testing.

Finally, Limitorque stated that the use of environmentally qualified splices in lieu of terminal blocks, in both power and control circuits, was an acceptable configuration.

Terminal Block Data

- (1) 600198: - Buchanan 0524 (adjacent)
- (2) 600376A: - Buchanan 0524 (adjacent)
- (3) 600456: - Marathon 300 (alternate)
- (4) B0009: - Marathon 300 (alternate)
- (5) B0003: - Marathon 300 (alternate)
- (6) F-C3271: - Buchanan 0524 (adjacent)
- (7) B0027: - N/A
- (8) B0212: - Marathon 300 (alternate)
- (9) B0119: - Marathon 300 (adjacent)
 - Marathon 300 (alternate)
 - Buchanan 0524 (alternate)
 - Buchanan 0222 (adjacent)
 - GE EB-5 (adjacent)
 - Marathon 1600 (adjacent)
 - Curtis Type L (adjacent)

824 NON QUAL (1EP
(7772)

19. Wiring Connections

Limitorque stated that only three types of terminal lugs have been used in the fabrication of Limitorque actuators (including the tested units). These are:

Thomas and Betts: RB873

Burndy: YAE-14N53

Hollingsworth: XSS-20826

Crimp-type lugs were used to terminate motor leads during all Limitorque testing. The exact type of lugs used in each test was not formally documented. Limitorque, however, has included the 3 terminal-lug types in its B0119 testing. Although not stated in the report, each lug was attached to a short length of stranded wire. At the conclusion of the test, the terminal lugs were evaluated and the following observations made:

- (1) The resistance across the crimp joint was measured with an ohm-meter as "0" ohms.
- (2) The integrity of the wire joint crimping was retained.
- (3) Surface cracks were noted on the terminal lug insulation; however, all insulation remained intact.

On the basis of these observations, Limitorque concludes that the terminal lugs utilized by Limitorque are qualified to all test report service conditions based on the performance demonstrated during the B0119 testing.

Crimp Lug Data

(1) B0119: Thomas and Betts: RB873
Burndy: YAE-14N53
Hollingsworth: XSS-20826

(2) All others: One of the above 3 types was utilized but
not documented

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20. Actuator Wiring:

Limitorque confirmed previous Group information regarding power and control wiring as follows:

- (1) No power wiring, other than integral motor leads were tested or are used by Limitorque.
- (2) Control wiring was not qualified by Limitorque as part of its actuator testing.

Limitorque has supplied different types of internal control wire based on various factors including procurement documentation requirements. Table I provides a general categorization of the wiring types used. Limitorque has used Raychem Flamtrol, Rockbestos Firewall III and wire specified as Canadian Standards Association (CSA) Type TEW wire for the limit switch compartment jumper and control circuit wiring. Limitorque's selection and use of the Raychem and Rockbestos wiring was based on the availability of separate vendor qualification test reports. The CSA type TEW wire and its various equivalents (e.g., TW and TFF), which are PVC insulated, have historically been used by Limitorque for all commercial-grade Limitorque actuators. Limitorque likely used the TEW for all actuators fabricated prior to 1970 and for all pre-1978 safety-related, outside-containment actuators.

Limitorque- stated that it was not the purpose of the Limitorque test reports to qualify control wiring, and that the wires must be qualified separately based on other test reports or analysis.

For procurement of a new actuator Limitorque indicated, if requested, it would identify the specific wiring used and the test report which Limitorque believes is applicable.

Limitorque stated that it was not the purpose of the Limitorque test reports to qualify control wiring, and that the wires must be qualified separately based on other test reports or analysis.

For procurement of a new actuator Limitorque indicated, if requested, it would identify the specific wiring used and the test report which Limitorque believes is applicable.

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TABLE 1

TYPE	PRE 1970	1970 - 1978	1978 - PRESENT
Standard Actuators	TEW	TEW	TEW
In-Containment Actuators	TEW	Raychem or Rockbestos	Rockbestos
Outside Containment Actuators	TEW	TEW	Rockbestos

Notes:

- (1) TEW denotes CSA wire designation TEW which is 105°C PVC insulated wiring. Recent plant inspections and Limitorque research have indicated that types TW and TFF, which are PVC insulated 60°F wiring, have also been used. Equivalent wire and insulation design permit substitution of these various PVC insulated types.
- (2) Raychem denotes Flamtrol wiring.
- (3) Rockbestos denotes Firewall III chemically or radiation cross-linked wiring.
- (4) Prior to 1973-1974, Limitorque records will likely not identify the type of wiring which was used. Limitorque believes that it is highly likely that PVC wiring was used for all actuators except safety-related in-containment units. It was Limitorque's policy after 1970 to use Raychem wire for units clearly identified as safety-related in-containment units. Limitorque records after 1974 will document the type of wiring utilized.

21. Limit Switch Materials:

Limitorque stated that all in-containment tests were conducted with a bronze intermittent gear limit switch housing.⁹ All outside containment tests utilized an aluminum housing. The limit switch aluminum housings which are anodized appear as a smooth bronze-colored surface. The bronze housings are sand cast and appear as a pebbly-bronze surface.

Limitorque recommended that utilities maintain field actuator configurations which are consistent with the referenced test report. However, bronze limit switch intermittent gear housings are acceptable for all applications.

The limit switch non-metallic tested in all in-containment reports, except B0212, was a whitish-grey Melamine. The B0212 test utilized a brown Fibrite proprietary material. Melamine is no longer available. All replacement parts now supplied by Limitorque utilize the Fibrite material. Limitorque will certify the Fibrite to B0212 or any report which originally utilized Melamine.

9/The original 60C198 test was unsuccessful when an aluminum housing was utilized. The subsequent Addendum #1 testing utilized the bronze housing.

Outside containment tests utilized a red or black Durez phenolic. The phenolic material continues to be used for replacement parts. The Fibrite or Melamine material may also be used on units certified to the outside containment reports.

Limit Switch Material Data:

- (1) 600198: Bronze/Melamine
- (2) 600376A: Bronze/Melamine
- (3) 600456: Bronze/Melamine
- (4) B0009: Bronze/Melamine
- (5) B0003: Aluminum/phenolic
- (6) F-C3271: Aluminum/phenolic
- (7) B0027: Bronze/Melamine
- (8) B0212: Bronze/Fibrite
- (9) B0119: N/A

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22. Torque Switch Materials:

Torque switch non-metallic materials for both test and field units are identical to those utilized in the limit switches (eg. Melamine, Fibrite, and Durez phenolic). Limitorque has utilized and provided aluminum, aluminum with bronze bushings and all-bronze construction for limit switch units certified to the various tests. ~~All 3 types of construction can be utilized for~~

~~in-containment applications. Although, the aluminum with bronze bushing and all-bronze units are preferred.~~

Limitorque noted that replacement torque switches are now only provided in the all-bronze construction for in-containment units. Limitorque also stated that the commercial-grade torque switches used in the outside containment tests are fabricated of aluminum and do not contain the bronze bushing. The in-containment-type torque switches can be utilized for all applications.

Torque Switch Material Data:

- (1) 600198: Aluminum/Melamine
- (2) 600376A: Aluminum with bronze bushings/Melamine
- ~~(3) 600456: Aluminum with bronze bushings/Melamine~~
- ~~(4) B0009: Aluminum with bronze bushings/Melamine~~
- (5) B0003: Aluminum/Phenolic
- (6) F-C3271: Aluminum/Phenolic
- (7) B0027: N/A
- (8) B0212: Bronze/Fibrite
- (9) B0119: N/A

23. Limit Switch Compartment Heaters:

Limitorque did not have Limit Switch Compartment (LSC) heaters installed during any environmental qualification tests. Limitorque has, however, conducted screening tests and evaluations of the heaters. The heaters provided by Limitorque are principally of a wire-wound/ceramic construction, although some are of a carbon-film/ceramic construction. The heaters are stud mounted with wiring bolted to two contact ears located at the opposite ends of the resistor. Limitorque had no data on the temperature rise created by energized heaters.¹⁰

In November 1978, a Limitorque test was conducted by applying proper voltage to a Ward Leonard space heater allowing the surface temperature to stabilize (measured at 250 degrees F), and a glass of tap water was poured over the heater (temperature measured at 68 degrees F). This was repeated a second time, once again without ill effect. When inspected at the conclusion of the test, no damage was noted.

¹⁰/A review of B0058 suggests that for most applications an acceptable qualified life (40 years) with substantial margin should still be available for units with minor temperature increases above typical plant ambient conditions. See B0058, Section 3.2, Thermal Aging.

Limitorque indicated that this screening test, combined with the non-organic materials of construction, suggests that the heaters would likely tolerate EQ-type test conditions although no certification of this capability could be provided. Limitorque stated that the heaters need not be energized after actuators are installed since the units are fully-qualified without the use of heaters.

Limitorque has provided heaters in actuators if they were specified in the purchase documents. EQ certification of these actuators does not include heaters so supplied, although the heaters need not be physically removed when the actuators are placed in service.

24. Remote Position Indicators Slidewire Potentiometers:

No Remote Position Indicators (RPIs) were included in any Limitorque EQ testing although RPIs were tested as part of certain seismic tests. Limitorque would have provided RPIs in actuators, if they were specified in the purchase documents. The EQ certification, however, did not include the RPIs so supplied.

Limitorque believes that RPIs do not affect actuator environmental qualification due to the low voltages used in the indicator circuit (10 volts) nor the RPI short circuit condition (~ 0 ohms) which is used to indicate one extreme of valve position.

25. Miscellaneous Control Components:

No other control components, i.e. integral starters, indicating lights, push buttons, etc., were included in the Limitorque EQ tests. Limitorque is also unaware of any "EQ-qualified" Limitorque actuators supplied with such components.

26. Submergence:

Limitorque stated that the actuators have not been tested for operation in a submerged condition. In test 600376A, the actuator was accidentally submerged when grease plugged the test chamber drain. During that test, the limit switch compartment filled with sufficient water to submerge the switch rotors. At that time, the control circuits failed. Control circuit operation resumed after the chamber was drained and water removed from the limit switch compartment by air purging through a transducer tubing connection.

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27. Replacement Parts:

- (1) Seals: Replacement seals are provided, as requested, in either Viton or Buna-N (red dot on Viton seal).
- (2) Gaskets: Replacement gaskets for nuclear-grade service are provided as Anchorite 425.
- (3) Limit Switches: Limit switch replacements for reports using the whitish-gray Melamine insulation/bronze bodies are now supplied as Fibrite insulation/bronze bodies. Limitorque will certify these replacements to any report utilizing the Melamine switches.

Limit switch replacements for the red/black phenolic insulation/aluminum bodies are identical to the tested units and will be certified to the applicable reports. The Fibrite bronze switches may also be used in this service.
- (4) Torque Switches: Torque switch replacement criteria is similar to that discussed under Limit Switches above, with Fibrite now used to replace Melamine, and phenolic still used for outside containment applications. All in-containment replacement switches are fabricated of bronze.
- (5) Motor Replacements: AC replacement motors are only supplied as Reliance RH class, LR class or B class. The Rad H class used in Report 600198 is no longer provided. RH class motors are used as the replacement motors for the Rad H class and will be certified to the applicable test report including 600198, if requested. All DC replacement motors are supplied as Peerless RH class.

28. Recommended Periodic Maintenance and Replacement:

All actuators were designed and tested to provide, without component replacement, a 40-year qualified life. Limitorque has identified in its maintenance manuals, Form LC8 and LC9, guidance on suggested maintenance practices and intervals. Limitorque stressed that these recommendations can and should be varied based on actual field experience and historical data. Appropriately varying suggested maintenance does not render the actuator units unqualified.

Limitorque further stated that all motors were designed to obviate the need for any maintenance. The bearings are sealed-continuous-duty units which do not require replacement. DC motors are designed for 500 hours of maintenance-free service which should envelope 40 year applications.

Limitorque stated that all motors are manufactured for Limitorque, to Limitorque standards, by various vendors. Repairs, or rewinds, on these "Limitorque" motors should only be performed through Limitorque, by the applicable motor manufacturer. Limitorque will only assure qualification for motors repaired in this fashion. Although repairs or rewinding of motors conducted by others when properly controlled and conducted may provide an acceptable level of quality, Limitorque will not certify those motors to its test reports.¹¹

¹¹/For example, since the outside containment Class B tests (see Section 3) were performed to demonstrate generic capability, it may be possible for utilities to perform an analysis which combined with these reports, would demonstrate the capability of motor rewinds performed by others.

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29. Aging Analysis:

The following activation energy information was provided:

(1) Motors:

- Reliance Class B (generic to all Class B motors) - 0.93V
- Reliance Class RH - 1.02eV
- Reliance Class LR - 1.53eV

(2) Switches:

- Durez Phenolic - 1.02eV
- Fibrite - 1.78eV
- Melamine - unknown¹²

(3) Terminal Blocks:

- Marathon 300 - 1.63eV

¹²/The thermal aging analysis contained in B0058, Section 3.2.2, Switch Materials, also applies to Melamine except that the temperature index of Melamine is 130°F, with its 50% property point reached in 7.68×10^6 hours. Forty years, therefore, represents less than 5% of its available life.

APPENDIX A
LIMITORQUE TEST CONFIGURATION DATA SUMMARY

	600198	600176A	600476	B0009	B0004
1. ACTUATOR SIZE	SMB-D-15	SMB-D-25	SMB-D-40	SMB-D-25	SMB-D-25
OPERATION (SEE NOTE 1)	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON.
MOTOR/ACTUATOR	<ul style="list-style-type: none"> o RELIANCE RAD H (NAMEPLATE "H") (CONNECTED TO ACTUATOR), DUAL VOLTAGE, AC o RELIANCE RAD H (NAMEPLATE "H") WITHIN BRAKE (OPERATED IN CHAMBER) DUAL VOLTAGE, AC 	<ul style="list-style-type: none"> o RELIANCE RH 1800 RPM, DUAL VOLTAGE, AC 	<ul style="list-style-type: none"> o RELIANCE RH 1800 RPM, SINGLE VOLTAGE, AC 	<ul style="list-style-type: none"> o PEERLESS RH (NAMEPLATE "H"), DC 	<ul style="list-style-type: none"> o RELIANCE B (CONNECTED TO ACTUATOR), DUAL VOLTAGE, AC o RELIANCE B (NAMEPLATE "H") OPERATED IN CHAMBER, AC o PARASYN B (OPERATED IN CHAMBER), AC
2. DRIVE DRAINS	NONE	2	2	1	NONE
3. MOTOR MOUNT	ALUMINUM	ALUMINUM	MAGNESIUM	ALUMINUM	ALUMINUM
4. MOTOR BRAKES	RELIANCE WITH DINGEN BRAKE (OPERATED IN CHAMBER)	NO BRAKES	NO BRAKES	NO BRAKES	NO BRAKES
5. MOTOR LEADS, CABLE TURNS, & TERMINATIONS	REFER TO SECTION 7 TEXT (ALSO SEE ITEMS 18, & 19.)	REFER TO SECTION 7 TEXT (ALSO SEE ITEMS 18, & 19.)	REFER TO SECTION 7 TEXT (ALSO SEE ITEMS 18, & 19.)	REFER TO SECTION 7 TEXT (ALSO SEE ITEMS 18, & 19.)	REFER TO SECTION 7 TEXT (ALSO SEE ITEMS 18, & 19.)
6. MOTOR INTERNAL OVERLOADS (THERMISTORS)	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED

APPENDIX A
LIMITORQUE TEST CONFIGURATION DATA SUMMARY

	F-C3271	B0027	B0212	B0119
ACTUATOR SIZE	SMB-0-10	SMB-00-15	SMB-00-15	N/A (USED AS A FIXTURE ONLY)
ORIENTATION (SEE NOTE 1)	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON. 	<ul style="list-style-type: none"> o LSC - VERTICALLY (UP) o MOTOR - HORIZON.
TESTING MOTOR	RELIANCE B WITH RELIANCE BRAKE, DUAL VOLTAGE, AC	RELIANCE 500, AC	RELIANCE LR, AC	N/A
TESTING BRAKE	NONE	2	2	2
TESTING MOTOR	ALUMINUM	ALUMINUM	<ul style="list-style-type: none"> o ALUMINUM (CONNECTED TO ACTUATOR) o MAGNESIUM (OPERATED IN CHAMBER) 	ALUMINUM
MOTOR BRAKES	RELIANCE WITH RELIANCE BRAKE	NO BRAKES	NO BRAKES	NO BRAKES
TESTING LEADS, CONNECTIONS, TERMINATION	See Items 3, 18, 19	See Items 3, 18, 19	See Items 3, 18, 19	See Items 3, 18, 19
MOTOR INTERNAL OVERLOADS (FOR MOTORING)	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED

LIMB TORQUE TEST CONFIGURATION DATA SUMMARY
APPENDIX A

60010B	600376A	600456	60007	60008
NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED
HUMBLE NEBU LA EP1/ BEACON 325	EXXON NEBU LA EP1/ BEACON 325	EXXON NEBU LA EP1/ BEACON 325	EXXON NEBU LA EP1/ BEACON 325	EXXON NEBU LA EP1/ BEACON 325
INSTALLED	INSTALLED	INSTALLED	INSTALLED	NOT INSTALLED
VITON/ANCHORITE	VITON/ANCHORITE	VITON/ANCHORITE	VITON/ANCHORITE	DIPLO-61/ANCHORITE
LPT TESTED	LPT TESTED	NO LPT INSTALLED OR TESTED	NO LPT INSTALLED OR TESTED	NO LPT INSTALLED OR TESTED
NO DATA/FIBRE	CAST IRON/FIBRE	CAST IRON/FIBRE	CAST IRON/FIBRE	ALUMINUM/FIBRE
TYPE C	TYPE A	TYPE B	TYPE B	TYPE B
BUCHANAN 0524 (ADJACENT)	BUCHANAN 0526 (ADJACENT)	MARATHON 300 (ALTERNATE)	MARATHON 300 (ALTERNATE)	MARATHON 300 (ALTERNATE)

TABLE 1

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A P P E N D I X A
L I M I T E D T E S T C O M P L I C A T I O N D A T A S U M M A R Y

	F-13271	BH027	BH212	BH119
1. 100% SH-2 FPS	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED
2. 100% SH-2 FPS	HUMBLE NFBUA FP1/ BEACON 125	N/A	F-100 NFBUA FP1/ MODEL 28	N/A
3. 100% SH-2 FPS	NOT INSTALLED	INSTALLED	INSTALLED	INSTALLED
4. 100% SH-2 FPS	BINA N/A/CHORITE	N/A	VICOR/AMCHORITE	N/A
5. 100% SH-2 FPS	NO LPI INSTALLED OR TESTED	NO LPI INSTALLED OR TESTED	NO LPI INSTALLED OR TESTED	NO LPI INSTALLED OR TESTED
6. 100% SH-2 FPS	ALUMINUM/FIBRETE	CAST IRON/FIBRETE	CAST IRON/FIBRETE	CAST IRON/FIBRETE
7. 100% SH-2 FPS	TYPE C	TYPE B	TYPE B	TYPE B
8. 100% SH-2 FPS	BUCHANAN 0524 (ADJACENT)	N/A	MARATHON 300 (ALTERNATE)	0 MARATHON 300 (ADJACENT) 0 MARATHON 300 (ALTERNATE) 0 BUCHANAN 0524 (ALTERNATE) 0 BUCHANAN 0222 (ADJACENT) 0 GE ER-5 (ADJACENT) 0 MARATHON 1600 (ADJACENT) 0 CURTIS TYPE L (ADJACENT)

APPENDIX A
LIMITORQUE TEST CONFIGURATION DATA SUMMARY

	600198	600376A	600456	80009	80001
EXTERNAL LUGS	LUGS UNDOCUMENTED	LUGS UNDOCUMENTED	LUGS UNDOCUMENTED	LUGS UNDOCUMENTED	LUGS UNDOCUMENTED
ACTUATOR WIRING	ACTUATOR CONTROL WIRING TESTED BUT TYPE & MFR. NOT IDENTIFIED	ACTUATOR CONTROL WIRING NOT TESTED	ACTUATOR CONTROL WIRING NOT TESTED	ACTUATOR CONTROL WIRING NOT TESTED	ACTUATOR CONTROL WIRING NOT TESTED
LIMIT SWITCH MATERIAL	BRONZE/MELAMINE	BRONZE/MELAMINE	BRONZE/MELAMINE	BRONZE/MELAMINE	ALUMINUM/MELAMINE
LIMIT SWITCH MATERIAL	ALUMINUM/MELAMINE	ALUMINUM WITH BRONZE BUSHINGS/MELAMINE	ALUMINUM WITH BRONZE BUSHINGS/MELAMINE	ALUMINUM WITH BRONZE BUSHINGS/MELAMINE	ALUMINUM/MELAMINE
LIMIT SWITCH COMPARTMENT	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED
CABLE POSITION INDICATOR	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED
REPLACEMENT PARTS	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED	NONE INSTALLED OR TESTED
SUBMERGENCE	NOT SUBMERGED	SUBMERGED	NOT SUBMERGED	NOT SUBMERGED	NOT SUBMERGED

1.1.1. LSC - LIMIT SWITCH COMPARTMENT

1.1.1.1. VPE A: NON-NUCLEAR GRADE CONAX SEALS AT BOTH THE LIMIT SWITCH COMPARTMENT CONDUIT OPENING AND TEST CHAMBER WALL.

TYPE B: NON-NUCLEAR GRADE CONAX SEALS AT TEST CHAMBER WALL. HIGH PRESSURE TEFLON HOSE THREADED TO BOTH THE CONAX SEAL AND THE CONDUIT OPENING. THE TEFLON HOSE WAS USED TO MINIMIZE ABRASION TO THE INTERNAL TEST WIRING DURING THE QUALIFICATION TESTING.

TYPE C: NON-NUCLEAR GRADE CONAX SEALS AT TEST CHAMBER WALL. STEEL TUBING WITH THREADED FITTINGS CONNECTED TO BOTH THE CONAX AND THE LIMIT SWITCH COMPARTMENT CONDUIT OPENING. THE PURPOSE OF THE TUBING WAS TO MINIMIZE WIRE ABRASION DURING TESTING.

1.1.1.2. REFER TO TEXT FOR INFORMATION ON 14. HANDWRITING; 15. LIMIT SWITCH ORIENTATION; 26. REPLACEMENT PARTS; 28. RECOMMENDED 14.1 MAINTENANCE AND REPLACEMENT; AND 29. AGING ANALYSIS.

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