

ORGANIZATION: LIMITORQUE CORPORATION
LYNCHBURG, VIRGINIA

REPORT NO.: 99900100/90-01	INSPECTION DATE: June 12-14, 1990	INSPECTION ON-SITE HOURS: 17
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NUCLEAR INDUSTRY ACTIVITY: Limitorque produces motorized valve actuators and their replacement parts. Those manufactured under Limitorque's nuclear Quality Assurance (QA) program are available as suitable for safety-related nuclear power plant applications. Limitorque also provides technical services to the industry including testing and maintenance and technical training.

ASSIGNED INSPECTOR: Stephen D. Alexander 6/21/90
Date
Stephen D. Alexander, Reactive Inspection Section
No. 2, (RIS-2) Vendor Inspection Branch, DRIS,
NRR

APPROVED BY: Chris Vandenburg 10/2/90
Date
Chris Vandenburg, Chief, RIS-2, Vendor Inspection Branch
DRIS, NRR

INSPECTION BASES AND SCOPE:

- A. BASES: 10 CFR Part 50, Appendix B and 10 CFR Part 21
- B. SCOPE: To review corrective actions from the previous inspection, to followup on 10 CFR Part 21 reports, to review current technical issues, and to obtain information relevant to establishing the scope of a planned future team inspection.

PLANT SITE APPLICABILITY: Potentially generic.

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A. VIOLATIONS:

None.

B. NONCONFORMANCES:

Contrary to the requirements of Criterion V, "Instructions, Procedures, and Drawings," of Appendix B to 10 CFR Part 50, Limitorque failed to establish appropriate, documented instructions and procedures to prescribe an activity affecting quality in that the procurement of technical services (specifically, material verification testing) directly related to the quality of safety-related Limitorque valve actuators was not governed by documented procedures of sufficient detail to ensure that the appropriate technical requirements were included in the procurement documents. (99900100/90-01-01)

C. UNRESOLVED ITEMS:

1. Limitorque valve actuator motor pinion shaft key failures (as well as keyway deformation) have been the subject of several 10 CFR Part 21 notifications by Limitorque and affected licensees. This problem has been extensively investigated by Limitorque and some of the affected utilities. Some individual failures have been attributed to the wrong key material being used, while others appear to be cases of misapplication. Limitorque has initiated measures to better assure that the material specified is installed and also has made specification changes to stronger materials in the most severe applications. However, unexplained instances remain in which the failures in the field could not be reproduced in the laboratory. As discussed in paragraph E.12.a below, the inspector reviewed an analysis of keyway deformation that was not reproducible in the laboratory documented in Limitorque Engineering Design Document EDD-8.

While these investigations continue and several plausible theories have been developed, the information developed thus far has been inconclusive in that, the test data have been largely inconsistent. As a result, a root cause (or causes) has not yet been identified. Because there was insufficient information available during this inspection to determine whether the unexplained failures involved QA deficiencies at Limitorque, this issue has been designated Unresolved Item 99900100/90-01-02.

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2. Limitorque valve actuator torque switch spring pack relaxation, similar to the key failure issue, is still under investigation by Limitorque. The vendor is conducting tests designed to simulate field operating conditions and attempt to reproduce the spring relaxation observed in certain installed Limitorque actuators. The testing conducted thus far has not produced meaningful results. Instances of this problem attributable to Limitorque QA deficiencies remain undetermined; therefore, this issue is designated Unresolved Item 99900100/90-01-03.

D. STATUS OF PREVIOUS INSPECTION FINDINGS:

1. (Closed) Nonconformance 99900100/85-01-05. Limitorque had not revised its QA Manual to address training of non-quality control (QC) personnel. The revised QA manual was reviewed and found satisfactory during the 1988 inspection (NRC Inspection Report 99900100/88-01), but training had not been completed. In a letter, dated October 31, 1988, Limitorque reported completion of training and enclosed copies of training schedules and attendance records as objective evidence. Training records were reviewed during this inspection and found acceptable. Nonconformance 99900100/85-01-05 is closed.
2. (Closed) Nonconformance 99900100/86-01-04. Limitorque lacked procedures for processing spare parts orders and for issuing certificates of compliance (COCs). Spare parts order processing procedure QCP-21, Revision 4, dated February 20, 1988, was reviewed during the 1988 inspection (Inspection Report 99900100/88-01), but draft COC procedure QCP-27 had not been issued. In a letter, dated October 31, 1988, Limitorque reported issuance of QCP-27, enclosing a copy which was reviewed and found responsive to NRC concerns. Nonconformance 99900100/86-01-04 is closed.
3. (Closed) Nonconformance 99900100/86-01-05. Limitorque had not processed an order for environmentally qualified terminal blocks under controlled conditions and consequently had sold Buchanan 724 terminal blocks to Arkansas Power & Light (AP&L) and erroneously certified them to be qualified replacements for Buchanan 524 blocks. At the time of the 1988 inspection (Inspection Report 99900100/88-01), Limitorque had improved measures to control order processing to prevent recurrence of this nonconformance, but had not completed its review of previous orders to identify any similar occurrences. On June 1, 1989, Limitorque issued a 10 CFR Part 21 notification in which it reported completion of this review. Limitorque had identified one other

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involved shop order (number 3P3306 for Westinghouse - shipped to Wolf Creek) in addition to the one for AP&L, and had conducted training of the personnel involved to prevent recurrence. Non-conformance 99900100/86-01-05 is closed.

4. (Closed) Nonconformance 99900100/88-01-01. Contrary to Criterion III, "Design Control," of 10 CFR Part 50, Appendix B, Limitorque had not established measures to ensure that motor pinion shaft keys and electrical terminal blocks (TBs) that had been and were being procured by Limitorque as commercial-grade items (CGIs) and used in safety-related motorized valve actuators, conform to all design requirements; i.e., that keys are made of ASTM-1018 or ASTM-4140 stainless steel, as required, and that TBs are the same as (or sufficiently similar for EQ purposes) those tested by Limitorque and reported in Limitorque Qualification Report B0119.

In an August 30, 1988, response letter to NRC Inspection Report 99900100/88-01, Limitorque reported its plans to: (a) expand receiving inspection processes to include key material verification, (b) establish a reasonable level of confidence in on-hand stock by testing on a sample basis, (c) request information from the TB manufacturer, Marathon Special Products, Inc., (Marathon) on material changes since Limitorque prototype testing to establish a baseline, and (d) revise receiving inspection procedures to provide for material verification on a periodic basis. These proposed corrective actions were deemed acceptable in an NRC acknowledgement letter to Limitorque, dated September 30, 1988.

To verify implementation of these corrective actions during this inspection, the NRC inspector reviewed the following:

- a. A Limitorque internal memorandum from the QC Manager to the receiving inspection staff, dated August 30, 1988, which required that receiving inspection include verification of key material. Before release of material for use, receiving was to provide a sample to the QA Manager for testing at Applied Technical Services, Inc., (ATS) for chemical analysis and identification.
- b. A Limitorque QC Manager memorandum, issued at the same time, directing that sample keys in 10 sizes of ASTM-1018 and 4 sizes of ASTM-4140 stainless steel be pulled from stock and sent to ATS for material verification testing with a certified test report to be provided. Limitorque explained that it was their practice not to segregate keys by lot once accepted; therefore, no lots were identified.

- c. The ATS test report on these samples, which indicated they were of the proper material.
- d. The purchase orders (POs) to and invoices from Revcar, Inc., the key supplier.
- e. The revisions of procedures QCP-10, "Procurement," and QCP-3, "Receiving," Revision 15, dated May 15, 1990, paragraph 3.m, "Special Inspection Lists."
- f. The Special Inspection List and Addendum, both dated March 16, 1990, listing Inspection Plan IP-015, "Keys JE, JF, JG," Revision 0.
- g. The receipt inspection reports (RIRs).
- h. The POs and reports to/from ATS.
- i. The report of the ATS audit.
- j. The release documents pursuant to procedure (certified test report is annotated for release by QC Manager).

The inspector noted one test report in which material presumed to be ASTM-1018 was identified as type 12L14, which resulted in issuance of Limitorque Variation Report VR-95958, appropriately indicating disposition as, "scrap - Revcar will replace complete - no charge."

Additionally, the inspector reviewed testing records of TBs by ATS to verify similarity with TBs qualified under Limitorque Qualification Report B0119 and the program that was established to continue to verify similarity on a periodic basis. The records were found to be acceptable. The inspector also examined the Marathon 300 TBs tested by ATS for Limitorque under ATS project number C10290. The three specimens consisted of (1) one half of one of the actual B0119 samples, marked "Sample 1A," (2) one half of one of the old style Marathon 300s from stock, marked "Sample 1B" (pressure molded and of the same design as the B0119 sample), and (3) one half of Sample 1C, one of the new style from stock (injection molded), noting that the new style appeared similar with the exception of having higher inter-pole barriers.

As a result of this review, the NRC inspector determined that Limitorque had implemented measures to ensure use of correct shaft pinion key material and terminal blocks. Accordingly, Nonconformance 99900100/88-01-01 is closed.

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5. (Closed) Nonconformance 99900100/88-01-02. Because of lack of adequate controls, failures attributed to defective shaft keys and spring pack relaxation were not fully evaluated and reported to appropriate levels of management. Limitorque lacked a system to ensure evaluation and resolution of deviations reported via field service or customer problem reports. In a letter, dated August 30, 1988, Limitorque reported that its 10 CFR Part 21 Review Committee had concluded that further investigation was necessary to determine the root cause of the shaft key failures and spring pack relaxation. The inspector noted that such an investigation had been initiated. Limitorque also reported that its 10 CFR Part 21 procedure, QCP-22, was revised to require evaluation of Variation Reports and similar reports from the field for significance and forwarding of significant reports to the 10 CFR Part 21 Review Committee for their evaluation. The response letter also described plans to implement a Part 21 evaluation log, to provide periodic status reports to management, to develop a nuclear customer failure notification (CFN) form and revise QCP-22 to implement use of the form, to require distribution of all CFN and field service reports to the QA Manager, and to define the Technical Manager's responsibilities with respect to review and root cause determination on customer failure notifications.

To verify implementation of these corrective actions, the NRC inspector reviewed the revised QCP-22 and Limitorque's 10 CFR Part 21 Log, noting that Limitorque had decided to use existing means instead of a new form for customer failure notification. Limitorque's corrective actions on this nonconformance were found to be acceptable; therefore, Nonconformance 99900100/88-01-02 is closed.

E. FINDINGS AND OTHER COMMENTS:

1. Purpose.

The purpose of this inspection was to (1) review Limitorque's actions on previous inspection findings (discussed in paragraph D. above), (2) conduct a scoping review for a future team inspection, and (3) followup on current 10 CFR Part 21 notifications and other pending technical issues.

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2. Procurement of Technical Services.

During the review of Limitorque's corrective actions on previous inspection findings, the inspector noted that Limitorque PO 4377, dated February 21, 1989, issued to ATS for key material verification testing, was unlike some other ATS POs because it contained the same language used in POs to the key supplier; some of which was inappropriate for a PO to a testing laboratory. Upon further inquiry as to the procedures governing preparation of quality-related procurement documents, the inspector found that there was no procedure for this activity affecting quality. Although the services received (as evidenced by the associated ATS test report) were apparently satisfactory, the inspector concluded that the lack of instructions and procedures appropriate to the circumstances (i.e., of sufficient specificity to ensure the inclusion of appropriate technical requirements, and no others, in procurement documents for technical services) resulted in this PO being issued with inappropriate technical requirements. Nonconformance 99900100/90-01-01 was identified in this area; however, the inspector noted that on June 14, 1990, Limitorque prepared Immediate Revision Notice 01 to QCP-10 on procurement as their initial corrective action on this nonconformance. The inspector found this revision to be acceptable.

3. Critical Items List.

Limitorque has developed a critical items list for their nuclear safety-related actuators in order to enhance the procurement and dedication of component parts that Limitorque does not manufacture itself, most of which can only be obtained as commercial-grade items. The items on this list are subject to special procurement procedures (including traceability, special receipt inspection, and testing) in order to assure adequate quality. The applicable special procedures are listed for each critical component and are implemented by various quality control procedures directly.

The inspector reviewed the Critical Items List effective the week of July 9, 1990, including the procedures governing inclusion of items and use of the list contained in Engineering Evaluation ECC-0001, Revision 1, dated January 12, 1990. The inspector noted that the line item called "molded, non-metallic parts" referred to Inspection Procedure IP-099. The inspector reviewed Revision 0 of this procedure, dated March 30, 1990, and noted that the scope included limit switch and torque switch insulating

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materials, "Durez" and "Fibrite", but omitted TBs. Although Limitorque does have controls on the procurement of TBs, the QA manager prepared a revision to the procedure to correct this oversight during the inspection. The inspector also noted that wiring and insulated lugs and connectors are handled in a separate category, but questioned the omission from the list of seals and O-rings. Limitorque stated their position that, on the basis of environmental qualification tests, they did not consider these items to be critical.

4. Material Verification and Traceability.

During the review of procurement and testing of motor pinion shaft keys, the inspector noted that documentation provided by the key supplier, including certified mill test reports, was inadequate to establish material traceability. In recognition of this, Limitorque stated that no credit was taken for this documentation, even though it was requested in the procurement documents. Instead, Limitorque accepted the material for use in safety-related actuators on the basis of their own dimensional and hardness checks augmented by periodic sample material verification testing (chemicals and physicals) by ATS.

The inspector examined examples of receiving inspection records, including documentation of dimensional and hardness checks. The inspector also reviewed ATS test reports and the report of the audit of ATS conducted by a Limitorque QC Engineer on September 12, 1990, to establish ATS as an approved supplier of safety-related technical services. No deficiencies were noted with the dimensional and hardness checks. However, in reviewing the ATS audit report, the inspector noted that under Section 12.0, "Calibration," Item 6.0 asked if an out-of-tolerance condition has been discovered and how was it handled. Neither the blank labeled "satisfactory" nor the one labeled "unsatisfactory" was marked, and the objective evidence sheet did not address this issue. Therefore, it was not clear how or whether ATS would notify Limitorque in the event of their finding test equipment out of tolerance during the calibration of the test equipment following its use in testing material for Limitorque. This issue will be reviewed further during a future NRC inspection.

5. Pinion Shaft Key Sample Discrepancies.

Further review of the internal memorandum (discussed in paragraph D.4 above) which directed QC to pull key samples for testing and comparison with the Limitorque shaft key part number list, dated

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July 28, 1989, revealed certain discrepancies. The memorandum listed the ASTM-4140 keys by their 10-digit Limitorque part numbers (60-563-0154-1, -0155-1, and -0156-1). However, the key list did not include part number 60-563-0156-1. Instead, it listed part number 60-563-0177-1 for certain SMB-5 actuator motor shaft pinions. The inspector checked Limitorque Drawing Number 60-563-0177-1, Revision B, for SMB-5 motor pinion shaft keys to verify the number and also noted that ASTM-4140 stainless steel was specified. Limitorque agreed to resolve this discrepancy, and this issue will be reviewed further in a future NRC inspection.

6. Quality Assistance Program Review.

Limitorque has been implementing major revisions to their QA program and procedures, some of which were briefly reviewed in this inspection in connection with the review of corrective action on previous nonconformances. However, the extensive scope of the revisions warrants a comprehensive, performance-based review which will be conducted during a future NRC inspection.

7. Limitorque Maintenance Updates.

In order to provide a forum for generic response to the numerous customer requests (and NRC recommendations) for technical information, Limitorque established publication of "Maintenance Updates", the first of which was issued in August 1988. The inspector reviewed these technical bulletins because they documented Limitorque's response to several of the technical issues under review during this inspection. The first one (commonly known as Maintenance Update 88-1) addressed the issues of (1) SMA-type torque switches in some early SMB actuators; (2) spring pack relaxation; (3) improper use of the de-clutch lever; (4) DC motor starting resistors, cable sizing, and discharge resistors; (5) gasket material; and (6) excerpts from selected maintenance procedures. Maintenance Update 88-2 dealt exclusively with spring pack hydraulic lock and discussed the history and Limitorque's evaluation, corrective modifications, and installation and maintenance recommendations. Maintenance Update 89-1 covered torque switch limiter plates and settings and special SB-1 actuator maintenance topics. Finally, Maintenance Update 90-1 provided the latest information on hydraulic lock and spring pack relaxation, and gave detailed information on spring pack replacement, configuration, and preloading.

8. Notifications Pursuant to 10 CFR Part 21

- a. NRC Inspection Report 99900100/88-01 discussed a 1986 10 CFR Part 21 notification from the Tennessee Valley Authority (TVA) that reported shaft key and keyway deformation leading to actuator failures at the Watts Bar Nuclear Plant (WBN). Inspection Report 99900100/88-01 stated that Limitorque was scheduled to conduct testing and root cause analysis on this problem in May 1988. Several 10 CFR Part 21 reports and NRC Information Notices have been issued on this subject. The latest 10 CFR Part 21 report (NRC Log No. 89-194) was issued November 16, 1989.

During this inspection, the inspector reviewed Limitorque Engineering Design Document EDD-8 which described the testing and results. Unlike the cases of key failure such as at South Texas Project, in which keys were found to be other than the specified AISI-1018 steel, the WBN keys were as specified by the Limitorque design drawings. EDD-8 also stated that WBN still reported excessive keyway deformation, although the shafts from SB-3 actuators at WBN were of the upgraded type using AISI-4140 high strength stainless steel instead of AISI-1144 as used previously and the AISI-1018 keys had been replaced per another Limitorque design change with AISI-4140. Additionally, the bill of materials for the shop order numbers of the SB-3 actuators for WBN indicated that they had been built with the more stressful "hammer-blow" feature instead of the "no-lost-motion" feature which was normal for SB actuators. Although MOVATS testing had confirmed a double impact loading from the drive sleeve, Limitorque was unable to reproduce on the test stand the relatively large deformation experienced in the field. Only when the motor was stalled from speed on the motor tester 15 times (open and closed) was field-comparable deformation of about 0.025 inch produced. Because Limitorque had been unable to duplicate the field conditions, EDD-8 concluded that the cause probably involved an unusual load profile in the WBN applications. EDD-8 also stated that on the basis of testing and calculations, a 0.008-inch maximum keyway deformation was considered acceptable. These results (though not necessarily the conclusion) were confirmed in the latest 10 CFR Part 21 report from TVA on this issue (NRC Log No. 89-194). Pending further review in a future NRC inspection, this issue was designated as Unresolved Item 99900100/90-01-02 in paragraph C.2 above.

- b. As previously reported in NRC Inspection Report 99900100/88-01, Limitorque issued a 10 CFR Part 21 report to the NRC on cracked worm gears in HB3C actuators at Comanche Peak and committed to notify all nuclear utilities by May 13, 1988, pending receipt of an NRC mailing list. The inspector noted that the NRC had provided a list for this purpose on April 7, 1988. Limitorque had no forwarding cover letter on file, but showed the inspector the mailing list annotated to indicate that the 10 CFR Part 21 Report was to be mailed to all addressees except certain ones which were deleted as not applicable. Limitorque stated that all nuclear customers were sent the notification as indicated.
- c. NRC Inspection Report 99900100/88-01 discussed a June 5, 1987, 10 CFR Part 21 report by Public Service of Colorado (PSC) regarding cracked worm threads on actuators at their Fort Saint Vrain Nuclear Generating Station. Although Limitorque had since instituted dye penetrant testing and had no other similar reports, they were to contact PSC and obtain the affected worms for analysis. This issue is to be included in the scope of the next NRC inspection at Limitorque.

F. PERSONS CONTACTED:

- *Thomas S. Mignogna, President, Limitorque Corporation
- *Robert J. Kornsey, Executive Vice President
- *Ivan E. (Gene) Wilkinson, Ph.D., Vice President, Engineering
- *Rory D. Segen, Quality Assurance Manager
- *Patrick G. McQuillan, Nuclear Project Manager
- Daniel S. Warsing, Technical Manager, Engineering
- William J. Miluszusky, Quality Control Manager
- Frank J. Napoli, Quality Assurance Engineer