

SAFETY EVALUATION FOR LIMITORQUE MOTOR OPERATORS
MOTOR WITHOUT T-DRAIN(S)

1.0 PURPOSE:

The purpose of this analysis is to provide documented evidence that the absence of motor "T"-Drains on the Limitorque actuators referenced below in Section 4.0 would not have jeopardized the intended function of the actuators for the required accident/post-accident period at the Perry Power Plant. The actuators are exposed to the environmental parameters per the applicable environmental design tables B-022 series drawings. This document will analyze the actuators for functional performance requirements (if required) taking into consideration time into accident, position in the plant, extended analysis, etc., during a Design Basis Event in the "as-found" condition at Perry. The analysis will demonstrate that the omission of T-drains would not have prevented the proper actuation of the operator or have violated environmental qualification.

The Limitorque actuators have been qualified per Nuclear Regulatory Regulations, Guides and Industry Standards. The documents substantiating their qualification are provided in Perry's auditable file package systems.

2.0 DESIGN INPUT

1) Perry Environmental Conditions drawing numbers B-022-004, Rev.A, B-022-006, Rev.A, B-022-002/003, Rev.A, B-022-066, Rev.A, B-022-022, Rev.A, and B-022-030, Rev.B.

2) Equipment Qualification Review List.

3.0 REFERENCES:

1) 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), Report #F-C2232-01, dated January 2, 1969, Project 600198.

2) Qualification Type Test Report Limitorque Valve Actuators for Class 1E Service Outside Primary Containment In Nuclear Power Station Service, Report #B-0003, dated June 2, 1976, Project 600461.

4.0 OPERATOR LOCATION/TYPE

<u>MPL</u>	<u>ZONE</u>	<u>TYPE</u>
1E12F0024B	AB-4	* AC-1
1E12F0027A	AB-4	* AC-1
1E12F0042C	AB-4	* AC-1
1E12F0073A	AB-4	* AC-1
1E22F0004	AB-8	* AC-1
1E32F0006	AB-7	* AC-1
1E32F0007	AB-7	* AC-1
1E32F0008	AB-7	* AC-1
1E51F0022	AB-3	DC
1G33F0001	DW-1	* AC-1
1G61F0080	AB-4	* AC-1
1G61F0170	AB-4	* AC-1
1P57F0020B	CT-3	* AC-1

* Inside Containment Configuration.

5.0 OPERATORS BY ZONE AND ACCIDENT ENVIRONMENTAL PARAMETERS:

5.1 ZONE AB-4: Ref. Design Input #2

<u>MPL</u>	<u>NUREG-0588 CATEGORY</u>	<u>FUNCTION TIME</u>	<u>SERVICE</u>
1E12F0024B	c (A3)	J(180 days)	B PUMP TEST SUPPRESSION POOL
1E12F0027A	a (A1)	J(180 days)	PEN #P113 OUTBOARD ISOLATION
1E12F0042C	a (A1)	J(180 days)	LPCI C PEN#P411 OUTBOARD ISOL. PNEU.
1E12F0073A	a (A1)	H(30 days)	RHR Hx SHELL SIDE VENT TO POOL
1G61F0080	a (A1)	C(1 hour)	CONTAINMENT ISOLATION OUTSIDE CONTAINMENT
1G61F0170	a (A1)	C(1 hour)	CONTAINMENT ISOLATION OUTSIDE CONTAINMENT

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT EVENT</u>	<u>DURATION</u>	<u>TEMP. DEG.F</u>	<u>RELATIVE HUMIDITY(%)</u>	<u>PRESSURE (PSIG)</u>	<u>ENVIRONMENTAL MEDIUM</u>
RHR 10" LINE BREAK	<u>NOT A DESIGN BASE ACCIDENT</u>				
LOCA IN CONTAINMENT W/EMERGENCY EQUIPMENT RUNNING IN ZONE AB-4	0 MIN TO 1 HR.	151	90	ATMOSPHERE	AIR
	1 HR. TO 180 DAYS	123	20	ATMOSPHERE	AIR

5.2 ZONE AB-7: Ref. Design Input #2

<u>MPL</u>	<u>NUREG 0588 CATEGORY</u>	<u>FUNCTION TIME</u>	<u>SERVICE</u>
1E32F0006	a (A1)	J(130 DAYS)	STEAM TUNNEL ISOL. VLV.
1E32F0007	a (A1)	J(180 DAYS)	STEAM TUNNEL ISOL. VLV.
1E32F0008	a (A1)	J(180 DAYS)	ANNULUS ISOL. VLV.

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT EVENT</u>	<u>DURATION</u>	<u>TEMP DEG.F</u>	<u>RELATIVE HUMIDITY</u>	<u>PRESS. (PSIG)</u>	<u>ENVIRONMENTAL MEDIUM</u>
MAIN STEAM LINE BREAK IN ZONE AB-7	0 SEC. TO 2 HRS	310	100	8.5	STEAM
	2 HRS TO 5 HRS	160	100	0.0	STEAM/AIR
	5 HRS TO 12 HRS	130	100	0.0	AIR
	12 HRS TO 180 DAYS	117	90	0.0	AIR
LOCA INSIDE CONTAINMENT	1 HR TO 180 DAYS	119	90	ATMOSPHERE	AIR
		110	20	ATMOSPHERE	AIR

5.3 ZONE AB-8: Ref. Design Input #2

<u>MPL</u>	<u>NUREG 0588</u> <u>CATEGORY</u>	<u>FUNCTION</u> <u>TIME</u>	<u>SERVICE</u>
1E22F0004	a (A1)	D (6 HOURS)	HPCS PUMP INJECTION VLV.

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT</u> <u>EVENT</u>	<u>DURATION</u>	<u>TEMP</u> <u>DEG.F</u>	<u>RELATIVE</u> <u>HUMIDITY(%)</u>	<u>PRESSURE</u> <u>(PSIG)</u>	<u>ENVIRONMENTAL</u> <u>MEDIUM</u>
LOCA INSIDE CONTAINMENT	1 HR TO 6 HRS.	126	90	ATMOSPHERE	AIR

5.4 ZONE AB-3: Ref. Design Input #2

<u>MPL</u>	<u>NUREG 0588</u> <u>CATEGORY</u>	<u>FUNCTION</u> <u>TIME</u>	<u>SERVICE</u>
1E51F0022	a (A1)	E(12 hours)	RCIC TO CST ISOL.

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT</u> <u>EVENT</u>	<u>DURATION</u>	<u>TEMP</u> <u>DEG.F</u>	<u>RELATIVE</u> <u>HUMIDITY</u>	<u>PRESSURE</u> <u>(PSIG)</u>	<u>ENVIRONMENTAL</u> <u>MEDIUM</u>
RWCU BREAK IN ZONE AB-5	<u>NOT A DESIGN BASE ACCIDENT</u>				
LOCA IN CONTAINMENT EMERGENCY EQUIPMENT RUNNING IN ZONE AB-3	1 HR TO 180 DAYS	137	90	0.0	AIR

5.5 ZONE DW-1: Ref. Design Input #2

<u>MPL</u>	<u>NUREG 0588</u> <u>CATEGORY</u>	<u>FUNCTION</u> <u>TIME</u>	<u>SERVICE</u>
1G33F0001	a (A1)	B(10 MIN)	PEN #P131 INBOARD ISOL. LRL, PNEU

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT EVENT</u>	<u>DURATION</u>	<u>TEMP DEG. F</u>	<u>RELATIVE HUMIDITY</u>	<u>PRESSURE (PSIG)</u>	<u>ENVIRONMENTAL MEDIUM</u>
LOCA INSIDE CONTAINMENT DRYWELL (LARGE LINE BREAK)	0 SEC TO 1.8 SEC.	145	90	0.0	SPRAY, SUBMERGENCE (FOR 5 SEC)
	1.8 SEC. TO 8 SEC.	330	STEAM	22.1	"
	8 SEC. TO 13 MIN.	250	STEAM	14.8	"
	13 MIN TO 10 DAYS	215	100	12.0	"
	10 DAYS TO 180 DAYS	100	100	0.0	AIR
LOCA INSIDE CONTAINMENT DRYWELL (SMALL LINE BREAK)	0 SEC TO 3 HRS	330	STEAM	15.0	
	3 HRS TO 6 HRS	310	STEAM	14.0	
	6 HRS TO 30 HRS	250	STEAM	10.0	
	30 HRS TO 2 DAYS	238	STEAM	9.0	
	2 DAYS TO 180 DAYS	90	100	0.0	

5.6 ZONE CT-3: Ref. Design Input #2

<u>MPL</u>	<u>NUREG 0588 CATEGORY</u>	<u>FUNCTION TIME</u>	<u>SERVICE</u>
1P57F0020B	a (A1)	I (100 days)	DRYWELL ISOLATION

ACCIDENT ENVIRONMENTAL PARAMETERS: Ref. Design Input #1

<u>SIGNIFICANT EVENT</u>	<u>DURATION</u>	<u>TEMP DEG.F</u>	<u>RELATIVE HUMIDITY</u>	<u>PRESSURE (PSIG)</u>	<u>ENVIRONMENTAL MEDIUM</u>
LOCA INSIDE CONTAINMENT	0 SEC. TO 6 SEC.	98	100	8.8	AIR, SPRAY, SUBMERGENCE
	6 SEC. TO 100 SEC.	125	100	7.3	"
	100 SEC. TO 30 MIN.	165	100	10.3	"
	30 MIN TO 3 HRS.	184.6	100	12.0	"
	3 HRS TO 10 DAYS	160	100	6.3	"
	10 DAYS TO 180 DAYS	90	100	0.0	"

6.0 ANOMALIES/SIMILARITIES

The following section evaluates the anomalies/similarities in the reference reports 600198 and 600461 for their possible impact on Perry's EQ program. A statement of similarity will first be made to contain a synopsis of the operator tested to see if it encompasses the entire family of Limitorque Actuators at the Perry Plant. This will then be followed by the discussion of the anomalies. The reference reports identify the anomalies which were encountered during the type test program. The concern at Perry revolves around the anomalies directed towards the qualification of the Limitorque operator as to having a possible impact on the justification provided herein for the missing motor T-Drain(s), including the operability of the MOV for last 18-months. Subsequent to each anomaly, a justification has been provided for any impact on specific requirements of Perry.

6.1 STATEMENT OF SIMILARITY

All Limitorque 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-Drain(s) and actuator grease-relief valves.

* The equipment tested in the reference 1 report #600198 was (a) a Limitorque valve operator and (b) a motor-brake assembly as identified below:

a) Name Plate Information of Valve Operator

Name: SMB-0
Manufacturer: Philadelphia Gear Corporation
Motor: Reliance/Rad H insulation
Start: 15 ft.-lb.
Run: 3 ft.-lb. (Temp. rise: 75 deg.C)
Voltage: Dual-230/460, AC
Phase: 3 RPM: 1700

b) Torque Motor With Brake: (N/A-not utilized at Perry)

* The equipment tested in the reference 2 report #600461 was (a) a Limitorque valve operator, (b) one test motor #1 and (c) one test motor #2 as identified below:

a) Name Plate Information Of Valve Operator

Name: SMB-0
Manufacturer: Limitorque Corp.
Motor: Reliance/Class B insulation
Start: 25 ft.-lb.
Run: 5 ft.-lb. (Temp. rise: 75 deg.C)
Voltage: Dual-230/460, AC
Phase: 3 RPM: 1700

b) Test Motor #1

Motor: Reliance/Class B insulation
Start: 25 ft.-lb.
Run: 5 ft.-lb. (Temp. rise: 75 deg.C)
Voltage: Dual-230/460
Phase: 3 RPM: 1700

c) Test Motor #2

Motor: Electric Apparatus/Class B insulation
Start: 40 ft.-lb.
Run: 8 ft.-lb. (Temp. rise: 75 deg.C)
Voltage: Dual-220/440
Phase: 3 RPM: 1705

The size SMB-0 actuator is an average mid-size unit, which was used to generically qualify all sizes of Limitorque operators for the environmental test conditions in accordance with the IEEE-Standards. Based on the successful qualification testing of SMB-0 actuator, all other sizes of the type SMB, SB, SBD and SMB/HBE are also deemed qualified. The Limitorque actuators at the Perry are also enveloped as defined by the above criteria.

6.2 DISPOSITION OF ANOMALIES IN REPORT NO. 600198 (ref.1)

a) Description of Anomaly:

The geared limit switch frame had been attacked by the boric acid in the steam environment. This caused the gear frame to corrode and resulted in binding up of the shafts of the geared limit switch where they extend through the geared limit switch housing. This caused the premature failure of the geared limit switch.

Justification of Anomaly:

The anomaly noted above is not applicable to Perry, since the subject motor operators at Perry utilizes bronze housing. Note that, the original 600198 test was unsuccessful when an aluminum housing was utilized. The subsequent Addendum #1 testing utilized the bronze housing. The new geared limit switch successfully completed the seven day test with no sign of wear or deterioration due to the steam pressure, temperature or chemical environment.

b) Description of Anomaly:

Recorded pressure variation in chamber pressure upon reaching the 90 psig level caused by a leak in the pressure Transducer.

Justification of Anomaly:

The anomaly has no bearing on the successful performance of the actuator, since it is evident from figure 4 of the report that the limit switch compartment pressure recorder noted 90 psig indicating the steady state condition (i.e. pressure equalization). In addition, the chamber pressure is a function of the temperature which indicated the pressure at the saturation temperature to be around 90 psig.

6.3 DISPOSITION OF ANOMALIES IN REPORT NO. 600461 (ref. 2)

a) Description of Anomaly:

During the environmental type test, the actuator overran the open limit.

Justification of Anomaly:

The anomaly noted above is not applicable to Perry since the actuator overrun did not occur before or after the test. It was believed a momentary short was caused by localized condensation. Normally the torque switch would have prevented this, but it was not utilized in the test. Perry's actuators utilize the torque switch for opening or closing and therefore, poses no concern.

Note that, as previously mentioned, the documents substantiating the qualification of the actuators for the subject report are provided in Perry's auditable file package systems.

7.0 DISCUSSION/ANALYSIS

The intent of this analysis is not to demonstrate the actuator's qualification but to adequately address the fact that the omission of T-drains would not have prevented proper actuator operation or violate environmental qualification. This report will further substantiate the actuator's performance in the worst case Design Basis Event environmental conditions without the motor T-drains.

The principal purposes for use of the T-drains are, 1) to provide drainage of internal actuator condensation; and 2) to serve as the primary vehicle for internal-to-external actuator pressure equalization. The presence of the T-drain(s) will assure accomplishment of the aforementioned function. However, it should be noted that Limitorque has successfully tested a valve operator under a simulated accident/post accident steam and chemical environment without utilizing T-drains (References 1 & 2). The successful testing further substantiates the fact that the Limitorque operator motor, by virtue of its design, is capable of delivering the necessary torque for the required actuator operation during a Design Basis Event.

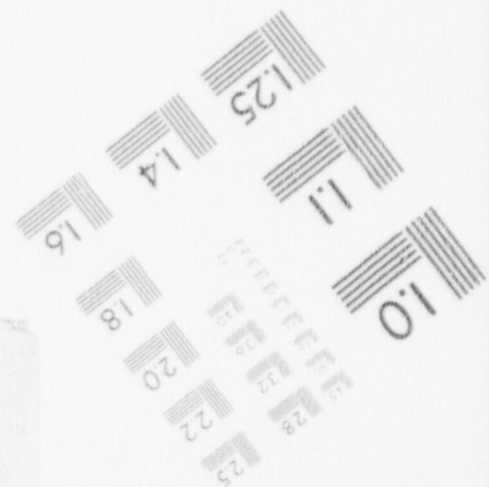
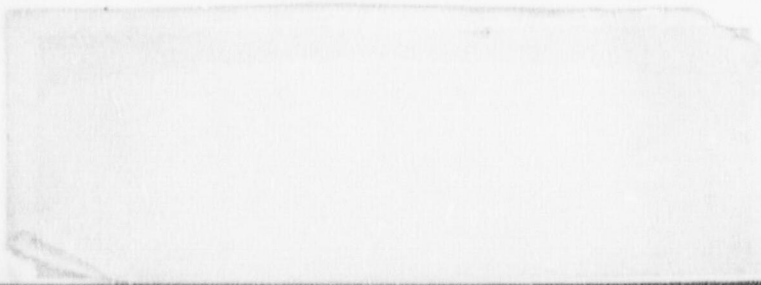
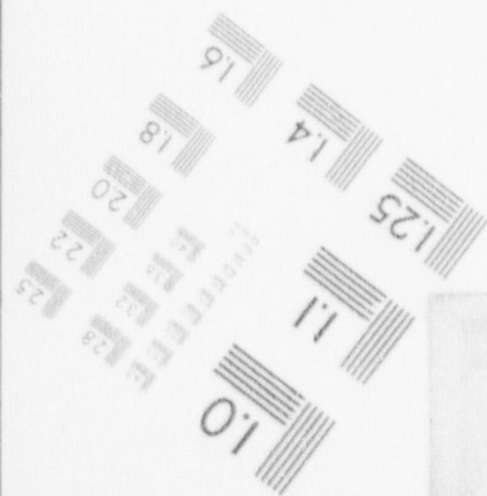
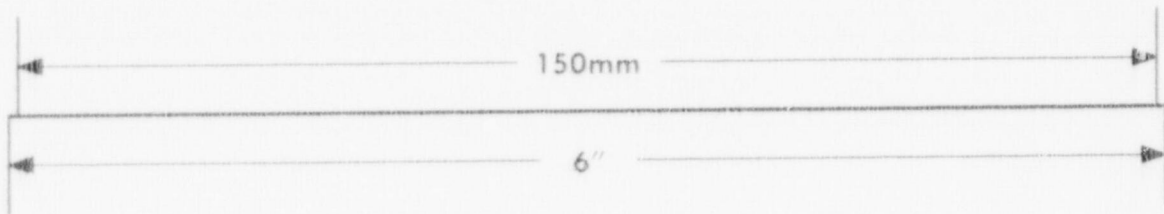
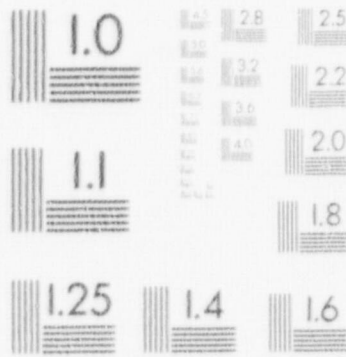
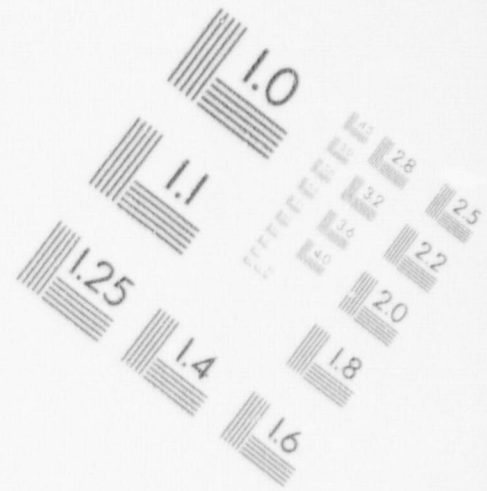
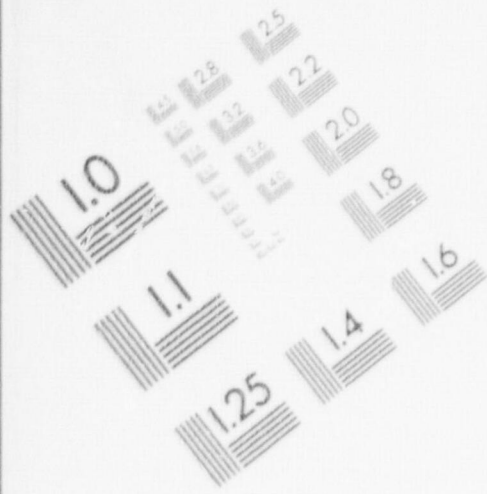
Having established the qualification testing of the actuator without T-drains, the DBE operability analysis for the operators found without T-drains will be discussed. The operator "MPL's" are segregated by the zones and listed in section 5.0 above along with the NUREG 0588 Equipment Category, Function Time, service and the DBE Environmental parameters.

7.1 OPERATORS LOCATED IN ZONE AB-4: (see section 5.1)

The omission of the motor T-drains does not invalidate the operator's environmental qualification since 90% relative humidity level is not severe enough to produce significant amount of condensate. For the "Post DBE" functional requirement of the equipment in this zone, no steam environment is anticipated in the area zone. Steam conditions prevail only during the RHR 10" line break in the aux. building, which is not the Design Base Accident. None of the subject valves are required or will automatically change position upon detection of the 10" line break. The zone environment is enveloped by the Limitorque Qualification for Outside Containment (ref.2), which requires no T-drains. The operator 1E12F0024B

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IMAGE EVALUATION TEST TARGET (MT-3)



is listed as category c (NUREG-0588) and has no functional requirement. Long time operability for the subject operator does not pose an EQ concern due to the absence of condensate/steam environment.

7.2 OPERATORS LOCATED IN ZONE AB-7: (see section 5.2)

Per Reference 1, Limitorque test report no. 600198, dated 01-C-1969, the operator with a Rad H insulation motor without T-drains was subjected to DBA test. The testing lasted for seven days. The Valve operator operated satisfactorily during and after the environmental test. It was also noted in the above test report that a 9-hour preliminary steam test was performed by piping live steam into the conduit taps on the top of the limit switch compartment. One of the bottom conduit taps was left open to drain off any condensate. The motor compartment, however, did not have T-Drains. This configuration would allow steam to enter the bell housing, but not allow drainage of condensate from the motor. Note that the plugs were installed for all testing done other than this 9-hour preliminary steam test. The report indicates that the existence of moisture inside the unit did not prevent adequate actuator performance.

The subject valves are each normally closed but will be opened by operator action from the control room 20 minutes after a LOCA inside containment if the inboard MSIV leakage control (E32) subsystem or inboard MSIV does not operate properly. The valve operators must be capable of surviving a steam line break in the non-safety portion of the main steam lines at the far end of the steam tunnel in order to be operable after the 20 minute time period. Note that with the Main Steam Line Break in the steam tunnel as the only event, the E32 system function is not required. The significant event of the MSLB in the subject zone will generate high temperature and pressure and 100% Relative Humidity/Steam conditions. The LOCA inside containment will generate only high radiation condition. Assuming that the operators have to be opened to mitigate the aforementioned concurrent events, the duration of 20 minutes is too short to produce a significant amount of condensate that would prevent the motor operator from performing its safety function. Furthermore, as stated above, Limitorque successfully tested the motor operator even in presence of live steam for a period of 9-hours. Long time operability for the subject valves during LOCA inside containment does not pose an EQ concern since 90% relative humidity is not severe enough to produce a significant amount of condensate in this zone.

7.3 OPERATOR LOCATED IN ZONE AB-8: (See section 5.3)

The absence of the motor T-drains does not invalidate the operators' environmental qualification since 90% relative humidity will not produce significant amount of condensate. Regarding the "Post DBE" functional requirement for the operator in this zone, no steam is anticipated in the area zone. The post-accident environment is enveloped by the Limitorque report for Outside Containment (ref.2), which requires no T-drains. The omission of T-drains would therefore not have prevented the motor operator from performing its intended safety function. Long time operability for the subject operator does not pose an EQ concern due to the absence of condensate or steam environment.

7.4 OPERATOR LOCATED IN ZONE AB-3: (see section 5.4)

The subject motor operator is located in the test return line to the condensate storage tank. A design flow functional test of the RCIC system is performed during normal plant operation by drawing suction from the condensate storage tank and discharging through the full flow test return line back to the condensate storage tank. The valve remains open during the testing mode. However, if the RCIC system requires initiation while in the test mode, the control system automatically returns to the operating mode. During this phase of operation, the subject valve has to be closed for the system to deliver the rated flow to the reactor within the required 30 seconds. The omission of the motor T-drain does not invalidate the operators environmental qualification since 90% relative humidity is not severe enough to produce a significant amount of condensate within 30 seconds. Furthermore, the "Post DBE" environment for this zone does not experience steam conditions. Steam conditions prevail in this zone only during the RWCU line break in zone AB-5, which is not the Design Base Accident. The zone environment is enveloped by the referenced Limitorque Qualification reports which did not utilize T-drains. It is therefore concluded that the absence of the motor T-drain from the subject operator would not have jeopardized proper actuator operation or violate environmental qualification.

7.5 OPERATOR LOCATED IN ZONE DW-1: (see section 5.5)

The subject operator is an inboard isolation valve and is required to close upon receipt of isolation signal. The motor operator has to accomplish this function within 15 seconds into LOCA and remain close for the required period of 10 minutes. The duration of 10 minutes (max) into the accident with high temperature and pressure and a steam environment is too short to produce a significant amount of condensate that would prevent the operator from performing its safety related function. Furthermore, Limitorque Report 600198 (ref.1) documents the accident testing conducted on a Limitorque operator which did not have T-drains installed in the motor. The test was performed at a peak temperature and pressure of 329 deg.F and 90 psig, respectively. These parameters envelop Perry's drywell peak conditions. In addition, the Limitorque test included saturated steam and chemical spray which allowed moisture to enter the motor compartment and still functioned during DBA conditions. This discussion provides further evidence that the absence of the T-drains would not have prevented the operator from performing its safety function or have violated environmental qualification.

7.6 OPERATOR LOCATED IN ZONE CT-3: (see section 5.6)

The motor operator 1P57F0020B is a safety-related instrument air system valve. Manual switches with status lights are provided in the Control Room for closing this valve if needed during LOCA. This valve has no automatic isolation signal and must be operated manually. It acts as a system isolation valve and is located inside containment in the subject zone (Note that the valve is not a Containment Isolation Valve). This valve is normally open and is required to remain open Post-LOCA. If for

any reason this valve was shut when a LOCA occurred, it would be required to open the valve for up to 100 days Post-DBE. For the "Post-DBE" functional requirement of the equipment in this zone, no steam environment is anticipated in the area zone. Limatorque documents testing in reference 1 report no.600198, where a 9-hour preliminary steam test was performed by piping live steam into the limit switch compartment through the upper conduit taps and draining any condensate via an open bottom conduit taps. The report indicates that the existence of moisture inside the unit did not prevent adequate actuator performance. The tested configuration therefore, represents the worst case condition in comparison to the 'no steam' environment in this zone. Furthermore, the operator motor utilizes Reliance RH insulation which is considered far more superior than the Rad H class insulation used in the Limatorque testing. This further substantiates the fact that the operator motor, by the virtue of its design, would not have prevented the operator from performing its safety function. In addition, this actuator is configured such that the limit switch compartment is lower than the motor. A T-Drain was installed in the bottom conduit taps of the limit switch compartment, which would allow drainage of condensation.

8.0 CONCLUSION:

Based on the analysis and the documented evidence presented herein, it is concluded that the omission of the motor T-drains did not invalidate the environmental qualification of the operators and that the operators, when subjected to the worst case DBE environmental parameters in the respective zones at Perry, will perform the required safety function. However, motor T-drains have been installed as recommended by Limatorque to put the operators into the "as tested" configuration.

Prepare by S. C. Patil 16/23/89
S. C. Patil Date

Approved by S. W. Litchfield 16/23/89
S. W. Litchfield Date