Attachment 4 to
U-600429

ILLINOIS POWER COMPANY

CLINTON POWER STATION UNIT 1

ENVIRONMENTAL QUALIFICATION OF LIMITORQUE OPERATORS MODELS NOS. SMB-0, SMB-00, SMB-000 SMB-1, SMB-3, SMB-4 & SMB/HBC

VOL. 1 OF 2

Compiled by

THE COMPONENT QUALIFICATION DIVISION

SARGENT & LUNDY ENGINEERS

Project No.: 4536-32

CQD No.: CQD-002366

Volume: EQ-CL009

Rev. 13 Date: 1/6/86

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ISSUE SUMMARY

COMPONENT QUALIFICATION DIVISION

III 8

SARGENT & LUNDY ENGINEERS

PROJ. NO.: 4536-32

CQD- 002366

JUSTIFICATION/ANALYSIS

Calc. No: CQD-002366
Rev: 13 Date: 1/6/86
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Project No.: 4536-32

Volume: EQ-CL009

CQD No.: CQD-002366

Rev. 13 Date: 1/6/86

PROJECT: Clinton - Unit 1

PROJECT NO: 4536-32

CALC. NO.: COD- 002366 REVISION: 13

REVIEWED BY: M. T. Spera (signature) DATE: 1/6/86

A. CONCLUSION OF REVIEW

☒ Accepted ☐ Rejected

Comments: _____

B. DESIGN INPUT DATA

B1. Has the input data been approved for use?

☒ Yes ☐ No

Comments: _____

B2. Is the input data applicable for this analysis?

☒ Yes ☐ No

Comments: _____

C. DOCUMENTATION

C1. Does the analysis include, as applicable, purpose, input data, assumptions, and references?

☒ Yes ☐ No

Comments: _____

C2. Is the analysis properly documented, in accordance with Quality Assurance Procedure GQ-3.08?

☒ Yes ☐ No

Comments: _____

D. TYPE OF ANALYSIS (Check one or both, as applicable)

☒ Hand-prepared design calculation.

☐ Computer-aided design calculation.

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E. TECHNICAL ADEQUACY

E1. Assumptions. Are the assumptions used valid? ☒ Yes ☐ No

Comments: _____

PROPRIETARY

Form MAS-COD-2.1 Approved by _____ Dept. Mgr.
Rev. Orig. (11-11-82)

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MECHANICAL DEPARTMENT STANDARD

CHECKLIST FOR NONSTANDARD NUCLEAR SAFETY-RELATED ANALYSES

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SARGENT & LUNDY ENGINEERS

E2. Model. Is the analytical model(s) used adequate for this application?

[X] Yes [ ] No

Comments: _____

Complete E3 and/or E4, depending on the type of calculation.

E3. Hand-prepared calculation

E3.1 Method of review. The review was conducted using: .

[X] A detailed review of the original calculation.
[ ] A review by an alternate, simplified or approximate method of calculation.
[ ] A review of a representative sample of repetitive calculations.
[ ] A review of the calculation against a similar calculation previously performed.

E3.2 Are the hand-prepared calculations technically adequate?

[X] Yes [ ] No

Comments: _____

E4. Computer-aided design calculation

E4.1 Program Acronym: N/A Program Number: _____

E4.2 Run I.D.(s)/Date(s): _____

E4.3 Is the computer program applicable for this calculation ?

[ ] Yes [ ] No

E4.4 Is the program maintained in Computer Services Division-controlled files?

[ ] Yes
[ ] No-Has the program been validated in accordance with Appendix H of CSD Standards and Procedures Manual (GOP 4-1)?
  [ ] No
  [ ] Yes-a) Provide validation documentation file no.: _____
    b) Has it been documented that the program used is identical to the one validated?
      [ ] Yes [ ] No

E4.5 Is the computer program input correct?

[ ] Yes [ ] No

E4.6 Does the program input contain sufficient accuracy to produce results within any numerical limitations of the program?

[ ] Yes [ ] No

E4.7 Are the computer results consistent with the input?

[ ] Yes [ ] No

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PROPRIETARY

Form MAS-CQD-2.1
Rev. Orig. (11-11-82)

PROJECT NO 4536-32	CALC. NO. CQD-002366 REVISION 13

E4 8 Are the results correct and within stated assumptions and limitations of the program?

☐ Yes ☐ No

E4 9 Are the computer-aided calculations technically adequate?

☐ Yes ☐ No

Comments: _____

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F COMMENTS

PROPRIETARY

Form MAS-CQD-2.1
Rev Orig. (11-11-82)

D. Analysis of Limitorque's Qualification Method

Type testing was performed on a model SMB-0. It is intended through this program to qualify the entire family of Limitorque Actuators - SMB, SB, SBD, and SMB/HB in all unit sizes (SMB-000 to SMB-5). The following summarizes the testing performed.

Thermal Aging:

The description of thermal aging will be provided based on the following breakdown of the test sample assembly:

a) Motor
b) Actuator
c) Contact blocks, torque, and limit switches

a) Motor: The stator of the Reliance motor with class RH insulation was heat aged at 180°C for 100 hours by Reliance Electric. Certification to this affect is contained in Appendix C of Appendix B to B0058. Based on the regression line for the insulating material contained in Section 3.2.1.2 of B0058, the stated aging parameters equate to a motor temperature of 162°F for 40 years.

b) Actuator: The actuator was not thermally aged. A review of the parts lists for the actuator (REF Limitorque Bulletin 871) indicates non-metallic internal parts consist of lubricants, seals and gaskets. Limitorque has stated that the seals and gaskets are used in the actuator to retain the grease in the gear box. Since the actuator is permitted to breath during a DBE, the seals and gaskets do not have to completely seal the actuator; therefore, failure of seals and gaskets would not deter the actuator from performing its safety function. It should also be noted that grease instead of oil is used to minimize the impact of a seal failure.

The qualification of the lubricant is insured by adhering to the recommend maintenance and inspection program and demonstrating the capability of the lubricant during the adverse conditions of radiation exposure and LOCA.

The deletion of the actuator from thermal aging is justified by the above discussion.

c) Contact Blocks Switch Materials: Contact blocks and switches were not thermally aged. Justification for this position is contained in Section 3.2.2 of Limitorque Report B0058. The

Vibration

IT is possible that the actuators will experience pipe induced Vibration. Low Level Vibration was done during the Seismic testing of the actuators. This will be addressed in SQRT documentation.

Interface

For the proper operation of the Values it is important that the actuators be sized properly for the Associated Values. The compatibility of the actuator will be proven by the Pre-operational Start-up Tests performed at site.

Conclusion

The internal wiring qualification is addressed in EQ-CL025.

Based on our analysis it is concluded that the Limitorque actuators Listed in Tab D are qualified For a 40 year plant life. No maintenance and Surveillance are Required For Environmental qualification.

SARGENT LUNDY ENGINEERS CHICAGO

Calcs. For #56		Calc. No. CQD-006418
		Rev. 06 Date 6-7-85
X Safety-Related	Non-Safety-Related	Page C7 of C9

Client	Prepared by	Date
Project	Reviewed by	Date
Proj. No. 4536-32 Equip. No.	Approved by	Date

B. Environmental Parameters

The snubbers are located in all CPS-1 Harsh zones, except zone H-28, the environmental parameters for both normal service conditions and accident conditions are shown as follows. These values are taken from the worst case as considered in the CPS-FSAR Table 3.11-5.

	Normal	Accident
Temperature (°F)	150	330 *
Pressure (PSIG)	2	30 +
Humidity (%)	100	steam
Radiation (rads)	5×10^7	2×10^8

* 330°F for 3 hrs, ramp down to 310°F in 3 hrs, ramp down to 250°F in 18 hrs, ramp down to 100°F in 99 days.

\+ 30 PSIG for 40 sec., ramp down to 15 PSIG in 5 sec., at 15 PSIG for 1 hr., ramp down to 5 PSIG, ramp down to 0 PSIG till 100 days.

To qualify the snubbers, it is necessary to establish the compatibility of their non-metallic materials within the above boundary limits.

C. Non-metallic components

As per Reference 1, page 1, the only non-metallic component in the Snubbers is lubricant. This lubricant is used to prevent the increase in breakaway friction force in the Snubbers as the Snubbers have to perform their safety-related function.

REV. 06 | HOWEVER IT IS EMPHASIZED THAT LUBRICANTS IN THE SNUBBERS DO NOT PERFORM ANY SAFETY RELATED

Form GQ 3.08.1 Rev. 2

FUNCTION. THE LUBRICANTS USED FOR THE SNUBBERS ARE NRRG-159 GREASE AND NRRG 335 GREASE. BOTH GREASES ARE MANUFACTURED BY CHEVRON USA. INC (REF. 2). GREASE IS USED IN THE SNUBBERS AS A LIGHT LUBRICANT TO DECREASE THE BREAKAWAY FRICTION. MOREOVER IT HAS BEEN CONFIRMED BY TEST THAT THE SNUBBERS WILL FUNCTION WITHOUT LUBRICATION (REF. 3). PACIFIC SCIENTIFIC MAINTENANCE MANUAL PS141 INDICATES THAT NO MAINTENANCE IS IMPOSED ON THE SNUBBERS (SEE TELEPHONE MEMO IN TAB 6). THEREFORE THE FUNCTION OF LUBRICANTS IN THE SNUBBERS IS INSIGNIFICANT

D. MATERIAL ANALYSIS (LUBRICANT):

ALTHOUGH THE LUBRICANTS DO NOT PERFORM THE SAFETY RELATED FUNCTION, YET THE FOLLOWING MATERIAL ANALYSIS FOR THE LUBRICANT IS PERFORMED.

TEMPERATURE: AS PER REF. 2, THE SNUBBERS HAS BEEN TESTED UP TO 392°F AND PER REFERENCE 4 (PAGES 8 & 9), THE SNUBBERS HAS BEEN TESTED IN ALL STEAM CHAMBER AT 330°F FOR 3 HOURS. THE TEMPERATURE VALUES ENVELOPE BOTH OUR NORMAL AND ACCIDENT CONDITIONS. THE EVAPORATION OF LUBRICANT IS INSIGNIFICANT.

PRESSURE: PRESSURE IS NOT APPLICABLE TO LUBRICANT.

HUMIDITY: AS PER REF. 4, THE SNUBBERS WITH LUBRICANT WERE TESTED IN ALL STEAM CHAMBER FOR 3 HOURS AND AT 100% HUMIDITY FOR OVER 2 DAYS. HUMIDITY DID NOT AFFECT THE PERFORMANCE OF THE SNUBBERS.

RADIATION: PER REF. 2, THE LUBRICANTS WILL NOT DEGRADE THE SHOCK ARRESTOR PERFORMANCE AT RADIATION EXPOSURE OF 3×10^8 RADS. THIS VALUE ENVELOPES THE PLANT'S T.I.D OF 2×10^8 RADS.

THE LUBRICANTS ARE ABLE TO SUSTAIN THE ABOVE ENVIRONMENT. THE LUBRICANTS ARE ENVIRONMENTALLY QUALIFIED FOR USE IN THE SNUBBERS IN ALL ZONES, EXCEPT ZONE H-28 EVEN Though THEY DO NOT PERFORM ANY SAFETY RELATED FUNCTION.

SUBMERGENCE:

A FEW SNUBBERS IN THE PLANT ARE LOCATED WITHIN THE ZONE OF INFLUENCE OF POOL SWELL. THIS MOMENTARY PHENOMENON, MAY TYPICALLY LAST FOR A PERIOD OF 5 SECONDS AS REFERENCED IN CPS-FSAR, ART. A.3.8.3.1, PAGE A.3.8-13 AND FIGURE A3.9-26.
PACIFIC SCIENTIFIC HAS INFORMED US THAT SNUBBERS SIMILAR TO THOSE INCLUDED IN THIS PACKAGE WERE SUBJECTED TO WATER INGRESS DURING THE TMI ACCIDENT AND PERFORMED SATISFACTORILY (SEE TAB G FOR REF. TELEPHONE MEMOS FROM S. AKHTAR TO PACIFIC SCIENTIFIC). WE CAN THEREFORE CONCLUDE THAT IN THE UNLIKELY EVENT OF POOL SWELL ASSOCIATED WITH A DBA, THE SNUBBERS WILL PERFORM THEIR SAFETY FUNCTION.

IV CONCLUSION:

BASED ON THE ABOVE ANALYSIS, IT CAN BE CONCLUDED THAT THE LUBRICANTS CAN SUSTAIN THE ENVIRONMENTAL PARAMETERS OF TEMPERATURE, HUMIDITY, RADIATION, SPRAY AND SUBMERGENCE. THE SNUBBERS ARE THUS ENVIRONMENTALLY QUALIFIED FOR 40 YEARS OF NORMAL SERVICE CONDITIONS PLUS 100 DAYS OF ACCIDENT CONDITIONS FOR ALL ZONES IN CPS-1 EXCEPT H-28, PROVIDED THAT THE MAINTENANCE SCHEDULE (TAB G) ... . IS IMPLEMENTED.

Re 07

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For #15

X Safety-Related | Non-Safety-Related

Calc. No. CQD-015366
Rev. 05 Date 11/21/85
Page C9.1 C9.1 of C16 C9.2

Client IP6
Project Clinton I
Proj. No. 4536.32 Equip. No.

Prepared by	Date
Reviewed by	Date
Approved by	Date

SCRAM VALVES (AIR ACTUATED)

The HCU Scram and backup Scram Valves and associated solenoids are spring loaded. The mechanical spring action is designed to assure the solenoids and valves move to the position to scram the drive if power is lost. This evaluation was performed in Reference 11 (page 1 of 11, included in Tab G). Therefore, harsh environment qualification for these valves is not a requirement. However, these valves are under IPC mechanical environmental qualification program. Buna-N material associated with these solenoid valves have not been tested to obtain aging information. Because Reference 4, Page 6 of this qualification package indicates that Buna-N parts used in these valves have at least a seven year shelf and in-service life. Our recommendation for replacement, considering the shelf life of Buna-N is every 3 years.

AGING (TEMPERATURE)

As per the arrhenius equation the lower the activation energy the shorter the life span. Therefore, material with the lowest activation energy is considered to be the weakest link. The activation energy for the weakest link material in the HCU's other than the solenoids is 1.42ev (ethylene propylene). Therefore, regression line for ethylene propylene is used to determine the qualified life of all the non-metallics materials excluding Buna-N.

Slope = 16518.69201
Intercept = -33.37225114

The regression line calculation is performed using the equation:

$Ln(L) = m(1/T) + C$ where m = slope
C = intercept
T = Temp. in deg K
L = life in hours

For maximum temperature of 104 deg F (40 deg C)
(Plant maximum temperature in Zone H-26 is 104 deg F)
T= 104 deg F = 40 deg C = 313 deg K

Expected Life

$Ln(L) = 16518.69201/313 - 33.37225114$
$L = \exp(19.403985)$
$L = 2.6733 E 8$ hours
$L = 30495.96$ years >> 40 years

The qualified life of the weakest link material excluding Buna-N is much grater than 40 years. All Buna-N components, considering shelf life of Buna-N, will be replaced every 3 years.

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For #75

Calc. No. CQD-015366

Rev. 05 Date 11/21/85

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☒ Safety-Related ☐ Non-Safety-Related

Client ILLINOIS POWER CO.	Prepared by / Date
Project CLINTON UNIT 1	Reviewed by / Date
Proj. No. 4535-32 Equip. No.	Approved by / Date

The Buna-N seals are normally rated at 200 degree F, but on the following basis their use on normally energized solenoids with 248 degree F ambient is acceptable.

Thermal degradation analysis of the organic material, Buna-N, from a purely analytical approach, using Wyle Laboratories Data Bank, factoring the temperature rise expected as 30 degree C (since the solenoid is continuously energized) along with the maximum service temperature 104 degree F. The projected life for Buna-N is higher than 7 years. Additionally, the location of Buna-N seals in the pilot solenoid valve assembly are such that the seals will not see the maximum coil temperature due to the heat sink created by the metal parts and the surroundings (See Tab F-3, page 2 & 4 of the qualification package). Parker O- Ring Handbook, Parker Hannefin Corporation (Pages A3-2, A3-35) indicates that Buna-N is suitable for service over a temperature range of -65 degree F to 275 degree F. Effects of radiation on materials and components by J. K. Kircher and R. E. Bowman (Page 157) indicates Buna-N is suitable as seals and gaskets below 300 degree F and other applications with a range up to 280 degree F. These reference documents therefore confirm that Buna-N can be used for a maximum temperature of 275 degree F which is above our application of 248 degree F. Furthermore, we have conservatively recommended that the Buna-N seals be replaced every 3 years instead of the calculated life of 7 years.