WCAP 8587

"Equipment Qualification Data Packages"

Supplement 1

EQDP-AE-3

Chempump Canned Motor Pump

Revision 3

## Instruction Sheet

The following instruction information and checklist is being furnished to help insert Revision 3 into WCAP 8587 Supplement 1 EQDP-AE-3 Class 3 (Non-Proprietary). Discard the old sheet and insert the new sheet as listed below. Revised information is indicated by a bar and number 3 on the outside margin of the page. Retain this sheet in the front of your WCAP.

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Rev. 1
June, 1981

# EQUIPMENT QUALIFICATION DATA PACKAGE

This document contains information, relative to the qualification of the equipment identified below, in accordance with the methodology of WCAP 8587. The Specification section (Section 1) defines the assumed limits for the equipment qualification and constitute interface requirements to the user.

Chempump Canned Motor Pump (Outside Containment)

APPROVED: _____
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## SECTION 1 - SPECIFICATIONS

1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: 190 to 575 VAC ±10% operating; +10%,-20% starting

1.1.2 Frequency: 50 or 60 Hz +5%; 3 phase.

1.1.3 Load: 0.5 to 25 Hp.

1.1.4 Electromagnetic Interference: None.

1.1.5 Other: Motors have Class H insulation system.

1.2 Installation Requirements: As specified in the instruction manual provided with the equipment.

1.3 Auxiliary Devices: None required for safeguard operation.

1.4 Preventative Maintenance Schedule: Normal preventative maintenance must be performed in accordance with the instruction manual provided with the equipment.

1.5 Design Life: 40 years.

1.6 Operating Cycles (Expected number of cycles during design life, including test): Boric Acid Transfer Pump motors, 43,800; Boron Inject ecirculation Pump Motors, 14,600.

1.7 Performance Requirements for[b]: Boric Acid Transfer (212, 312, 412, 3XL, 4XL)

| | Parameter | Normal Conditions | Abnormal Conditions | Containment Test Conditions | DBE Conditions(a) FLB/SLB | DBE Conditions(a) LOCA | DBE Conditions(a) Seismic | Post DBE Conditions(a) FLB/SLB | Post DBE Conditions(a) LOCA | Post DBE Conditions(a) Seismic |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.7.1 | Time requirement | 87,600 hrs. | 12 hrs. | N/A | N/A | N/A | Event Duration | Same as Normal | Same as Normal | Continuous |
| 1.7.2 | Performance requirement | 6 Hrs/Day Full Speed | | | | | Same as Normal | Same as Normal | Same as Normal | Same as Normal |
| 1.8 Environmental Conditions for Same Function[b] | | | | | | | | | | |
| 1.8.1 | Temperature($^{o}$F) | 40-120$^{o}$F[c] | | | | | Same as Normal | | | Same as Normal |
| 1.8.2 | Pressure (psig) | 0 | 0 | | | | 0 | | | 0 |
| 1.8.3 | Humidity (% RH) | N/A since motor is sealed unit | | | | | | | | |
| 1.8.4 | Radiation (R) | $\leq$400 | Same as Normal | | | | Same as Normal | | | Same as Normal |
| 1.8.5 | Chemicals | None | None | | | | None | | | None |
| 1.8.6 | Vibration (in.)[d] | 0.002 | Same as Normal | | | | Same as Normal | | | Same as Normal |
| 1.8.7 | Acceleration (g) | None | None | | | | Figure 1 | | | Figure 1 |

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: Maximum water temperature environment 175$^{o}$F.
d: Bearing housing vibration filtered to running speed.

1.7 Performance Requirements for[b]: Boron Injection Recirculation (212, 312, 412, 3XL, 4XL)

| | Parameter | Normal Conditions | Abnormal Conditions | Containment Test Conditions | OBE Conditions(a) FLB/SLB | OBE Conditions(a) LOCA | Post OBE Conditions(a) Seismic | Post OBE Conditions(a) FLB/SLB | Post OBE Conditions(a) LOCA | Post OBE Conditions(a) Seismic |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.7.1 | Time requirement | 350,400 hrs. | 12 hrs. | N/A | N/A | N/A | Event Duration | Same as Normal | Same as Normal | Continuous |
| 1.7.2 | Performance requirement | Continuous Full Speed | | | | | Same as Normal | Same as Normal | Same as Normal | Same as Normal |
| 1.8 | Environmental Conditions for Same Function[b] | | | | | | | | | |
| 1.8.1 | Temperature($^{o}$F) | 40-120$^{o}$F[c] | | | | | Same as Normal | | | Same as Normal |
| 1.8.2 | Pressure (psig) | 0 | 0 | | | | 0 | | | 0 |
| 1.8.3 | Humidity (% RH) | N/A since motor is sealed unit | | | | | | | | |
| 1.8.4 | Radiation (R) | ≤400 | Same as Normal | | | | Same as Normal | | | Same as Normal |
| 1.8.5 | Chemicals | None | None | | | | None | | | None |
| 1.8.6 | Vibration (in.)[d] | 0.002 | Same as Normal | | | | Same as Normal | | | Same as Normal |
| 1.8.7 | Acceleration (g) | None | None | | | | Figure 1 | | | Figure 1 |

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: Maximum water temperature environment 175$^{o}$F.
d: Bearing housing vibration filtered to running speed.

1.9 Qualified Life: The demonstrated qualified life is 40 years, based on 6 hours/day operation of the Boric Acid Transfer (BAT) pump and 24 hours/day for the Boron Injection Recirculation (BIR) pump.

1.10 Remarks: Canned motors are hermetically sealed and protected from the outside environment.

## SECTION 2 - QUALIFICATION BY TEST

2.0 TEST PLAN

2.1 Equipment Description: Motorettes (random wound), Teflon and Nomex insulated leads. Lead connectors with Nomex insulated leads and Vespel and Kalrez seals.

2.2 Number Tested: Motorettes (28); Teflon leads (10), Vespel and Kalrez, seals (12 each), lead connectors with Nomex insulated leads (12), graphite bearings (16).

2.3 Mounting: Motorettes and motor lead connectors were bolted to a common support plate. The actual mounting configuration to be used in the field in accordance with the instruction manual is represented in the seismic analysis performed for the pump. 3

2.4 Connections: Motorette leads terminated at binding posts mounted on the base plate.

2.5 Aging Simulation Procedure: The motorettes were subjected to thermal, radiation, and vibration aging. The Teflon insulated leads were subjected to thermal aging only. Nomex insulated leads, Vespel and Kalrez seals, and motor lead connectors were subjected to thermal, mechanical and radiation aging (Reference 1).

2.6 Service Conditions to be Simulated by Test[1]

| | | Normal | Abnormal | Containment Test | Seismic | HELB | Post-HELB |
|---|---|---|---|---|---|---|---|
| 2.6.1 | Temp. ($^{o}$F) | Ambient | Included Under Normal | N/A | Included Under Normal | N/A | N/A |
| 2.6.2 | Pressure (psig) | 0 | 0 | | 0 | N/A | N/A |
| 2.6.3 | Humidity (% RH) | N/A | N/A | | N/A | N/A | N/A |
| 2.6.4 | Radiation (R) | $10^{4}$(a) | Included Under Normal | | N/A | N/A | N/A |
| 2.6.5 | Chemicals | None | None | | None | N/A | N/A |
| 2.6.6 | Vibration (b) | 0.008 In. @ 60 Hz for 1 Hr. | Included Under Normal | | Included Under Normal | N/A | N/A |
| 2.6.7 | Acceleration (g) | None | None | | Figure 1 | N/A | N/A |

(a) Requirement is less than $10^{4}$; however, radiation testing was extended to $2 \times 10^{8}$ Rads for some components.

(b) Equipment is qualified for inservice vibration by experience, however, in addition this test was performed as suggested by IEEE-117-1974.

2.7 Measured Variables

This section identifies the parameters required to be measured during the test sequence(s).

| | | Required | Not Required |
|---|---|---|---|
| 2.7.1 | Category I - Environment | | |
| 2.7.1.1 | Temperature | A | BCD |
| 2.7.1.2 | Pressure | | ABCD |
| 2.7.1.3 | Moisture | | ABCD |
| 2.7.1.4 | Composition | | ABCD |
| 2.7.1.5 | Seismic Acceleration | D | ABC |
| 2.7.1.6 | Time | ABCD | |
| 2.7.2 | Category II - Input Electrical Characteristics | | |
| 2.7.2.1 | Voltage | | ABCD |
| 2.7.2.2 | Current | | ABCD |
| 2.7.2.3 | Frequency | | ABCD |
| 2.7.2.4 | Power | | ABCD |
| 2.7.2.5 | Other | | ABCD |
| 2.7.3 | Category III - Fluid Characteristics | | |
| 2.7.3.1 | Chemical Composition | | ABCD |
| 2.7.3.2 | Flow Rate | | ABCD |
| 2.7.3.3 | Spray | | ABCD |
| 2.7.3.4 | Temperature | | ABCD |
| 2.7.4 | Category IV - Radiological Features | | |
| 2.7.4.1 | Energy Type | B | ACD |
| 2.7.4.2 | Energy Level | B | ACD |
| 2.7.4.3 | Dose Rate | B | ACD |
| 2.7.4.4 | Integrated Dose | B | ACD |

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| | | Required | Not Required |
|---|---|---|---|
| 2.7.5 | Category V - Electrical Characteristics | | |
| 2.7.5.1 | Insulation Resistance | ABCD | |
| 2.7.5.2 | Output Voltage | ABCD | |
| 2.7.5.3 | Output Current | ABCD | |
| 2.7.5.4 | Output Power | ABCD | |
| 2.7.5.5 | Response Time | ABCD | |
| 2.7.5.6 | Frequency Characteristics | ABCD | |
| 2.7.5.7 | Simulated Load | ABCD | |
| 2.7.6 | Category VI - Mechanical Characteristics | | |
| 2.7.6.1 | Thrust | ABCD | |
| 2.7.6.2 | Torque | ABCD | |
| 2.7.6.3 | Time | ABCD | |
| 2.7.6.4 | Load Profile | ABCD | |
| 2.7.7 | Category VII - Auxiliary Equipment | | |

None required for safeguard operation.

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A - Thermal Aging
B - Radiation Aging
C - Vibration Aging
D - Seismic

2.8 Test Sequence Preferred

This section identifies the preferred test sequences as specified in IEEE-323-74

2.8.1 Inspection of Test Item
2.8.2 Operation (Normal Condition)
2.8.3 Operation (Performance Specifications Extremes, Section 1)
2.8.4 Simulated Aging
2.8.5 Seismic Vibration
2.8.6 Operation (Simulated High Energy Line Break Conditions)
2.8.7 Operation (Simulated Post HELB Conditions)
2.8.8 Inspection

2.9 Test Sequence Actual

This section identifies the actual test sequence(s) employed which when used in conjunction with these seismic analyses constitutes the overall qualification program for this equipment. The separate subsections indicate the separate test sequences completed on the same components.

| Step | Notes |
|---|---|

2.9.1 Functional motor tests are performed by the manufacturer for each pump. Data taken during hydraulic runout tests or individual tests determine the following:

2.9.1.1 Running current at shutoff
2.9.1.2 Phase balance (at design point)
2.9.1.3 Winding resistance
2.9.1.4 High potential
2.9.1.5 Vibration
2.9.1.6 Overall efficiency at design point
2.9.1.7 Power factor at design point

In addition, the first motor for each pump application is sujected to the following tests:

2.9.1.8 Full load heat run
2.9.1.9 Percent Slip
2.9.1.10 Locked rotor current
2.9.1.11 Pullout torque
2.9.1.12 Starting torque
2.9.1.13 Efficiency at design point, shutoff, and runout
2.9.1.14 Power factor at design point, shutoff, and runout
2.9.1.15 Power factor at design point, shutoff, and runout
2.9.1.16 Minimum starting voltage

2.9.2 Motorettes, Motor Lead Connectors, Nomex Insulated Leads, Vespel and Kalrez Seals Test Sequence

2.8.1 Canned Motor Pump is located outside of the
2.8.4 containment building and does not require
2.8.5 HELB simulation.
2.8.8

2.9.3 Teflon Insulated Lead Test Sequence

2.8.1 Canned Motor Pump is located outside of the
2.8.4 containment building and does not require HELB
2.8.8 simulation.

## 2.10 Type Test Data

### 2.10.1 Objective

The objective of this test program is to demonstrate, employing the recommended practices of Reg. Guide 1.89 (IEEE-323-1974) and Reg. Guide 1.100 (IEEE 344-1975), the capability of the canned pump motor to complete its safety-related function described in EQDP Section 1.7 while exposed to the applicable environments defined in EQDP Section 1.8. This objective is accomplished through test of critical components and evaluation of less critical components with well known material properties and performance characteristics.

### 2.10.2 Equipment Tested

Twenty-eight motorettes, twelve motor lead connectors, ten Teflon and twelve Nomex insulated leads, and twelve Vespel and Kalrez seals were tested.

### 2.10.3 Test Summary

#### 2.10.3.1 Motorette and Motor Lead Connectors

Active canned pump motors used in Westinghouse plants are located outside of the reactor containment and will not be exposed to the adverse environmental conditions that may arise from a design base HELB. In addition, the canned pump motors are hermetically sealed isolating the motor environment from the external environment with the exception of temperature. Consequently, environment testing is only required to demonstrate equipment capability under normal and abnormal temperature extremes.

2.10.3.1.1 Aging and Radiation Testing

Prior to testing, the twenty-eight motorettes and motor lead connectors were subjected to a voltage screening test to verify the integrity of the electrical insulation.

The motorettes and motor lead connectors were baked in an oven to accelerate thermal aging equivalent to 40 years of normal plant operation at an equivalent temperature of 180°C. The motorette and motor lead connector electrical insulation integrity was again confirmed by the voltage check.

Subsequent to thermal aging, the motorettes and motor lead connectors were irradiated to an accumulated gamma dose of 2 x $10^8$ Rads which is significantly greater than that expected from 40 years of normal and one year post accident operation. The insulation integrity was again confirmed.

2.10.3.1.2 Vibration Aging

The motor is qualified by experience and engineering judgement for the expected inservice vibration. However, in addition the motorettes and motor lead connectors were subjected to the vibration, or mechanical stress, test described in the qualification report, Reference 1. All motorettes and connectors passed the electrical insulation voltage tests after vibration.

2.10.3.1.3 Seismic Testing

The twenty-eight motorettes and motor lead connectors were seismically tested using a multi-axis multi-frequency input in accordance with Reg. Guide 1.100(1). The test response spectrum was significantly greater than the required response spectrum envelope generated from many Westinghouse plants, Figure 1. The post-seismic voltage test verified the integrity of the motorette and connector lead electrical insulation.

2.10.3.2 Teflon Insulated Leads

Ten (10) teflon insulated leads were thermally aged to an equivalent service life of 40 years at 180°C. No changes or damage were evident from a visual examination.

2.10.3.3 Graphite Bearings

Sixteen (16) graphite bearings were aged to the equivalent of 5 years of service life and exposed to 2 x $10^8$ R of gamma radiation. No significant changes were noted. 3

2.10.4 Conclusion

The qualified life of the canned pump motor is defined in Section 1.9. The results of aging and seismic testing, and seismic analysis combined with an assessment of components with known characteristics, ensure that the motor will meet the qualification criteria recommended by Reg. Guides 1.89 and 1.100.

2.11 Section 2 Notes

(1) The successfully completed motorette , motor lead connectors, Nomex insulated leads and Vespel and Kalrez seal seismic tests employ parameters designed to envelope a number of plant applications. Margin is a plant specific parameter and will be established by the applicant.

2.12 References

(1) Marinkovich, Philip S., "Equipment Qualification Test Report for the Chempump Canned Pump Motor," WCAP-8687 Supplement 2-A03A (Proprietary): WCAP-8587, Supplement 2-A03A (Non-Proprietary), March 1981.

## SECTION 3 - QUALIFICATION BY EXPERIENCE

Westinghouse does not employ operating experience in support of the qualification program for the Chempump canned motors with the exception of gaskets and inservice vibration.

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## SECTION 4 - QUALIFICATION BY ANALYSIS

4.1 Analysis is employed to qualify the motor for operation during and after the seismic event. A static seismic analysis is applicable since the canned motor has no natural frequencies below 33 Hz. The analysis considers the effect of pressure loads, operating loads, attached piping loads, and seismic loads on the pump assembly. The natural frequency of the rotor and pump assembly is calculated. Deflection is calculated for the impeller and rotor. Stress in the mounting bolts, cradle bolts, bearing loads and loads in the cradle spot welds are calculated. A plant specific seismic analysis is completed for each application and maintained by Westinghouse. 3