WESTINGHOUSE CLASS 3

EQDP-ESE-5
Rev. 3 3/82

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.

Resistance Temperature Detectors: RCS Bypass Manifold

APPROVED: _____
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## SECTION 1 - SPECIFICATIONS

### 1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: (Ref. 1.3 Auxiliary Devices with approximately 1 milliamp current))

1.1.2 Frequency: N/A

1.1.3 Load: N/A

1.1.4 Electromagnetic Interference: None

1.1.5 Other: Resistance 410 Ω at 525°F

1.2 Installation Requirements: Westinghouse Drawing 2650C29 Rev. 1 | 3

1.3 Auxiliary Devices: R/E or R/I Converter and the RTD requires an interface connection which will be subject to the same condition as the RTD. The qualification of these interface connections is not an objective of this program

1.4 Preventative Maintenance Schedule: None

1.5 Design Life: 40 years

1.6 Operating Cycles (Expected number of cycles during design life, including test): Continuous duty

1.7 Performance Requirements for[b]: $T_H$ and $T_C$ for $\Delta T$, Tavg

| | Parameter | Normal Conditions | Abnormal Conditions | Containment Test Conditions | DBE Conditions(a) FLB/LOCA | DBE Conditions(a) SLB | DBE Conditions(a) Seismic | Post DBE Conditions(a) FLB/LOCA | Post DBE Conditions(a) SLB | Post DBE Conditions(a) Seismic |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.7.1 | Time requirement | Continuous | Included under normal | Test duration | N/A | < 5 mins | Event duration | N/A | N/A | Continuous |
| 1.7.2 | Performance requirement | (c) | | No damage | | As normal | As normal | | | As normal |

1.8 Environmental Conditions for Same Function[b]

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.8.1 | Temperature(°F) | Fluid 700<br>Minimum 122<br>Maximum 140<br>Rise 90 | | Ambient | | Fig. 1 | Ambient | | | Ambient |
| 1.8.2 | Pressure (psig) | -0.1 to .3 (cable)<br>3125 max. (tip) | | 70 | | Fig. 1 | 0 | | | 0 |
| 1.8.3 | Humidity (percent RH) | 95 | | Ambient | | 100 | Ambient | | | Ambient |
| 1.8.4 | Radiation (R) | $3x10^7$ $_\gamma$ (tip)[d]<br>$8x10^6$ $_\gamma$ (cable)[d] | | | None | $10^7$ $_\gamma$ (tip)[e]<br>$<10^4$ $_\gamma$ (cable)<br>$<10^5$ $_\beta$ (cable) | None | | | None |
| 1.8.5 | Chemicals | None | | None | | Fig. 1 | None | | | None |
| 1.8.6 | Vibration | See Section 2.10 | | None | | None | None | | | None |
| 1.8.7 | Acceleration (g) | None | | None | | None | See Sec. 2.10.3.3 | | | None |

Notes: a: DBE is the Design Basis Event.

b: Margin is not included in the parameters of this section.

c: + 0.2°F repeatability, (+ 2.0°F environmental allowance and + 0.2°F drift allowance) first order time response 2.5 seconds w/well for step change of at least 20°F with a water flow of 7 ft/sec.

d: 20 year life assumed for dose calculation. Radioactive fluid defines normal rating dose.

e: contained accident

1.9 Qualified Life: The qualified life is greater than 20 years based on an ambient temperature of 50°C (122°F) and a 50°C temperature rise due to the Reactor Coolant System temperature. The qualified life would be 20 years based on an ambient temperature of 60°C (140°F) and a temperature rise of 50°C. In both cases the qualified life is limited by the expected radiation during the twenty year life and the Design Basis Event (DBE). Also see Table 1. 3

1.10 Remarks: None

## SECTION 2 - QUALIFICATION BY TEST

2.0 TEST PLAN

2.1 Equipment Description: RdF reactor coolant bypass manifold mounted resistance temperature detector

2.2 Number Tested: Lot test performed on three (3) units

2.3 Mounting: Per Section 1.2

2.4 Connections: 4-wire cable to R/E converter

2.5 Aging Simulation Procedure:

Sequential simulation of thermal, radiation and vibration mechanisms as part of the overall test sequence.

2.6 Service Conditions to be Simulated by Test[1]

| | | Normal | Abnormal | Containment Test | Seismic | HELB | Post-HELB |
|---|---|---|---|---|---|---|---|
| 2.6.1 | Temp. (°F) | Ambient | Included under normal | Covered by HELB | Ambient | Fig. 3 | N/A |
| 2.6.2 | Pressure (psig) | 0 | | | 0 | Fig. 3 | Fig. 3 |
| 2.6.3 | Humidity (percent RH) | Ambient | | | Ambient | 100 | 100 |
| 2.6.4 | Radiation (R) | $4 \times 10^7$ $_\gamma$ (tip) $8 \times 10^6$ $_\gamma$ (cable) | | | None | Included under normal | Included under normal |
| 2.6.5 | Chemicals | None | | | None | Fig. 3 | Fig. 3 |
| 2.6.6 | Vibration | See Section 2.10.3.2 | | | None | None | None |
| 2.6.7 | Acceleration (g) | None | | | See Section 2.10.3.3 | None | None |

## 2.7 Measured Variables

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

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

| | | Required | Not Required |
|---|---|---|---|
| 2.7.5 | Category V - Electrical Characteristics | | |
| 2.7.5.1 | Insulation Resistance | | A,B,C |
| 2.7.5.2 | Output Voltage | | A,B,C |
| 2.7.5.3 | Output Current | | A,B,C |
| 2.7.5.4 | Output Power | | A,B,C |
| 2.7.5.5 | Response Time | | A,B,C |
| 2.7.5.6 | Frequency Characteristics | | A,B,C |
| 2.7.5.7 | Simulated Load | | A,B,C |
| 2.7.6 | Category VI - Mechanical Characteristics | | |
| 2.7.6.1 | Thrust | | A,B,C |
| 2.7.6.2 | Torque | | A,B,C |
| 2.7.6.3 | Time | | A,B,C |
| 2.7.6.4 | Load Profile | | A,B,C |
| 2.7.7 | Category VII - Auxiliary Equipment (List Function and Required Measurements) | | |
| 2.7.7.1 | R/E Converter Voltage (RTD analog out) | A,B,C | |

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A: HELB Test

B: Seismic Test

C: Radiation Test

## 2.8 Test Sequence Preferred

This section identifies the test sequences as specified in IEEE-323-1974

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 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 which constitutes the qualification program for this equipment. A justification for anything other than the preferred sequence is provided. The normal operating test condition referred to is a static calibration check at 32°F, 525°F and 625°F. Time response testing has been successfully performed via type testing on a sample model of this RTD. Performance under abnormal operating conditions is covered under Sections 2.8.2 and 2.8.6. Westinghouse has identified no mechanisms that would cause a degradation in time response and not affect RTD calibration. Therefore, the calibration data taken during the test is adequate to monitor the performance of the RTD for both conditions. Since the probe materials are not sensitive to thermal degradation, time response testing has been excluded from the test sequence. 3

Test Sequence (from Section 2.8):

2.8.1 Inspection
2.8.2 Operation-Normal Condition (Static Calibration)
2.8.4 Thermal Aging, Thermal Cycling

2.8.2 Static Calibration
2.8.4 Radiation, Normal and Post-Accident
2.8.2 Static Calibration
2.8.4 Environmental Vibration Induced Aging
2.8.5 Operating Basis Earthquake, Safe Shutdown Earthquakes
2.8.2 Static Calibration
2.8.6 High Energy Line Break Simulation
2.8.7 Post HELB Simulation
2.8.2 Static Calibration
2.8.8 Inspection

## 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 RCS bypass manifold resistance temperature detectors to complete their safety related functions described in EQDP Section 1.7 while exposed to the applicable environments defined in EQDP Section 1.8.

### 2.10.2 Equipment Tested

Three RdF RCS bypass manifold mounted fast response resistance temperature detectors were subjected to the test environments of the sequence shown in Section 2.9.

### 2.10.3 Test Summary

#### 2.10.3.1 Normal Environment Testing

Operation of the RCS bypass manifold RTD's under normal conditions is reflected by the numerous

three temperature static calibrations performed between each phase of the test sequence reported in Reference 1.

2.10.3.2 Simulated Aging

The test units were pre-conditioned to a simulated twenty year aged condition prior to subjecting them to the design basis seismic event and high energy line break simulation. The aged condition was achieved by separate phases of accelerated thermal aging, thermal cycling, radiation exposure to a total integrated gamma dose equivalent to a twenty-year normal dose plus the design basis accident dose, and accelerated flow induced and pipe vibration simulation. Through all the pre-conditioning phases, the amplified RTD outputs were monitored to verify continuous operation.

2.10.3.3 Seismic Tests

The single design basis event capable of producing an adverse environment at the equipment location is a seismic event. The seismic testing reported in Reference 1 was completed on aged equipment employing multi-axis, single-frequency inputs in accordance with Reg. Guide 1.100 (IEEE 344-1975). The generic required input motion (RIM) (Figure 2) contains significant margin with respect to any single plant application referencing this program(1). The RIM curve is enveloped by the test. Each plant should compare to assure that a 10 percent margin exists based on their actual plant location.

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2.10.3.4 High Energy Line Break/Post HELB Simulation

The RCS bypass manifold RTD's were subjected to the HELB simulation temperature profile of Figure 3. Following the 420°F temperature peak, the temperature gradually declines to 250°F and is held at saturated steam conditions for 15 days, simulating a four-month period of post HELB operation. This post-accident aging simulation was performed but not required for this application.

2.10.4 Conclusion

The qualification of the RCS bypass manifold is demonstrated by the completion of the simulated aging and design basis event condition testing described herein and reported in Reference 1.

2.11 The generic tests completed by Westinghouse 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. Black, J.P., Skeers, D.M.,Rens, T.E., "Equipment Qualification Report, Resistance Temperature Detectors - RCS Bypass (Seismic and Environmental Testing)" WCAP-8687, Supplement 2-E05A (Proprietary), WCAP-8587, Supplement 2-E05A (Non-Proprietary).

# SECTION 3 QUALIFICATION BY EXPERIENCE

3 Westinghouse does not employ operating experience in support of the qualification program for the RCS Bypass RTD's.

## SECTION 4 QUALIFICATION BY ANALYSIS

Analysis is employed for the RCS Bypass RTD's to support the use of the pressure tight metal hose as discussed in Reference 1.

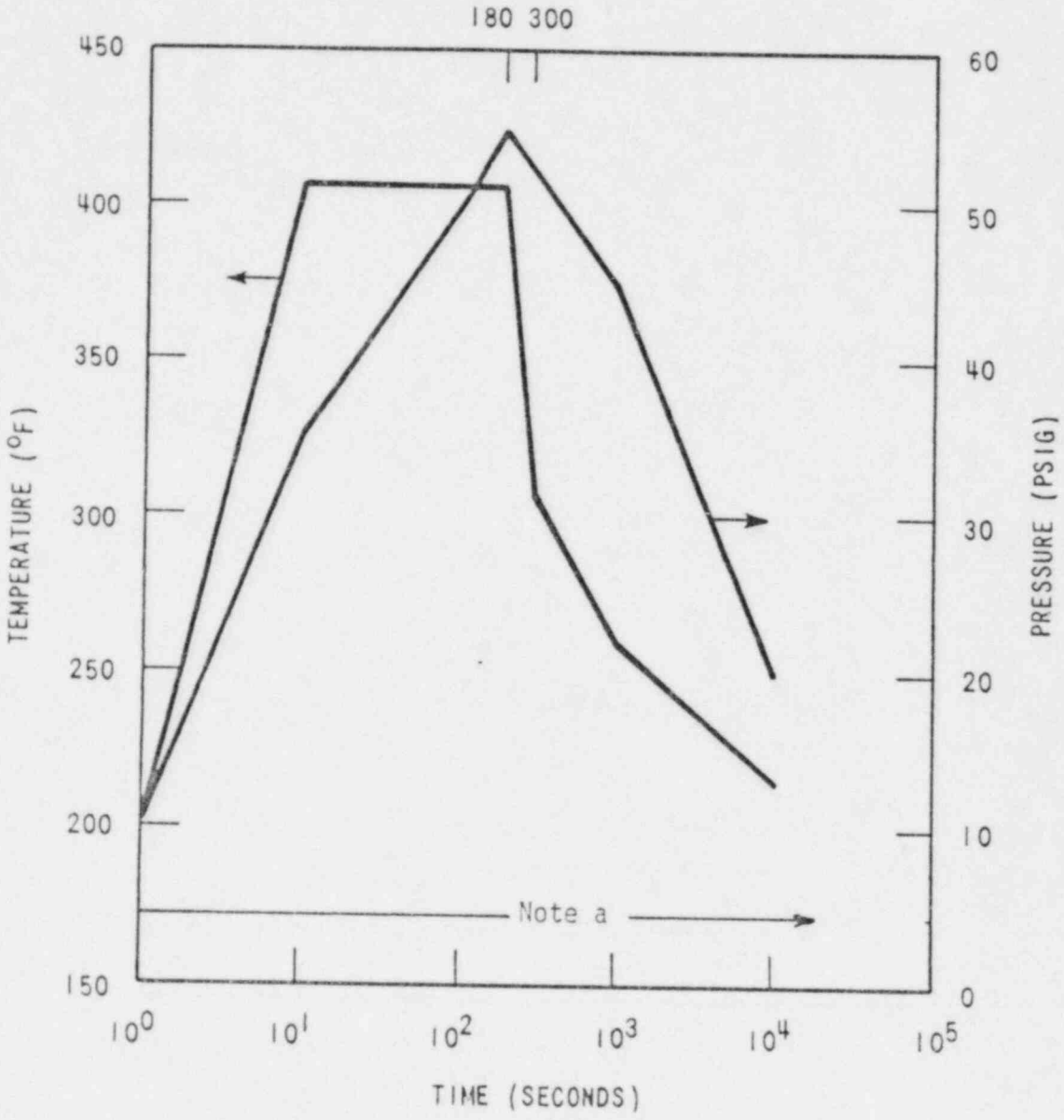
TABLE 1

ACTUAL QUALIFICATION TEST CONDITIONS

| EQUIPMENT (1) SYSTEM/CATEGORY | LOCATION STRUCTURE/AREA | MANUFACTURER TYPE/MODEL | ABNORMAL/ACCIDENT ENVIRONMENTAL EXTREMES PARAMETER | SPECIFIED (2) | QUALIFIED (3) | OPERABILITY REQ | OPERABILITY DEM | ACCURACY(°F) REQ | ACCURACY(°F) DEM | QUAL LIFE | QUAL METHOD | QUAL REF | QUAL PROGRAM STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RCS temperature narrow range RTD's/ RPS/ Category a | Containment Bldg./inside missile shield | RdF 21204 | Temperature | | 420°F | Trip | Trip | ±2.0°F | ±2.0 °F | 20 yrs. | Seq. Test | ESE-5 | Completed |
| | | | Pressure | | 75 psig | <5 min. | >5 min. | (4) | (4) | (5) | | | |
| | | | Rel. humidity | | 100 | | | | | | | | |
| | | | Radiation | | (Tip) $4.16 \times 10^7$ (γ) (Cable; $8.64 \times 10^6$ R(γ) | | | | | | | | |
| | | | Chemistry | | 2750 ppm $H_3BO_3$ NaOh to 10.7 pH | | | | | | | | |

NOTES:

1. For definition of the equipment category, refer to NUREG-0588 "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Appendix E Section 2.
2. Plant specific environmental parameters are to be inserted by the applicant.
3. The values listed represent the design conditions plus margin. For completed programs, the values listed were met in the test. Any variations from the values listed were in a conservative direction or were not considered significant.
4. The accuracies are changes in the RTD due to severe environments. The calebration accuracy is ± 0.2°F and the drift allowance in ± 0.2°F. These errors do not include the channel inaccuracies or process errors. Response times and seismic accuracies are contained in the equipment EQDP.
5. Qualified life assumed a normal temperature of 50°C.




Note a: Initial 24 hour containment spray solution of 2500 ppm boron with 0.24% NaOH

Figure 1. Containment Environmental Design Conditions - Main Steam Line Break and Feedline Break

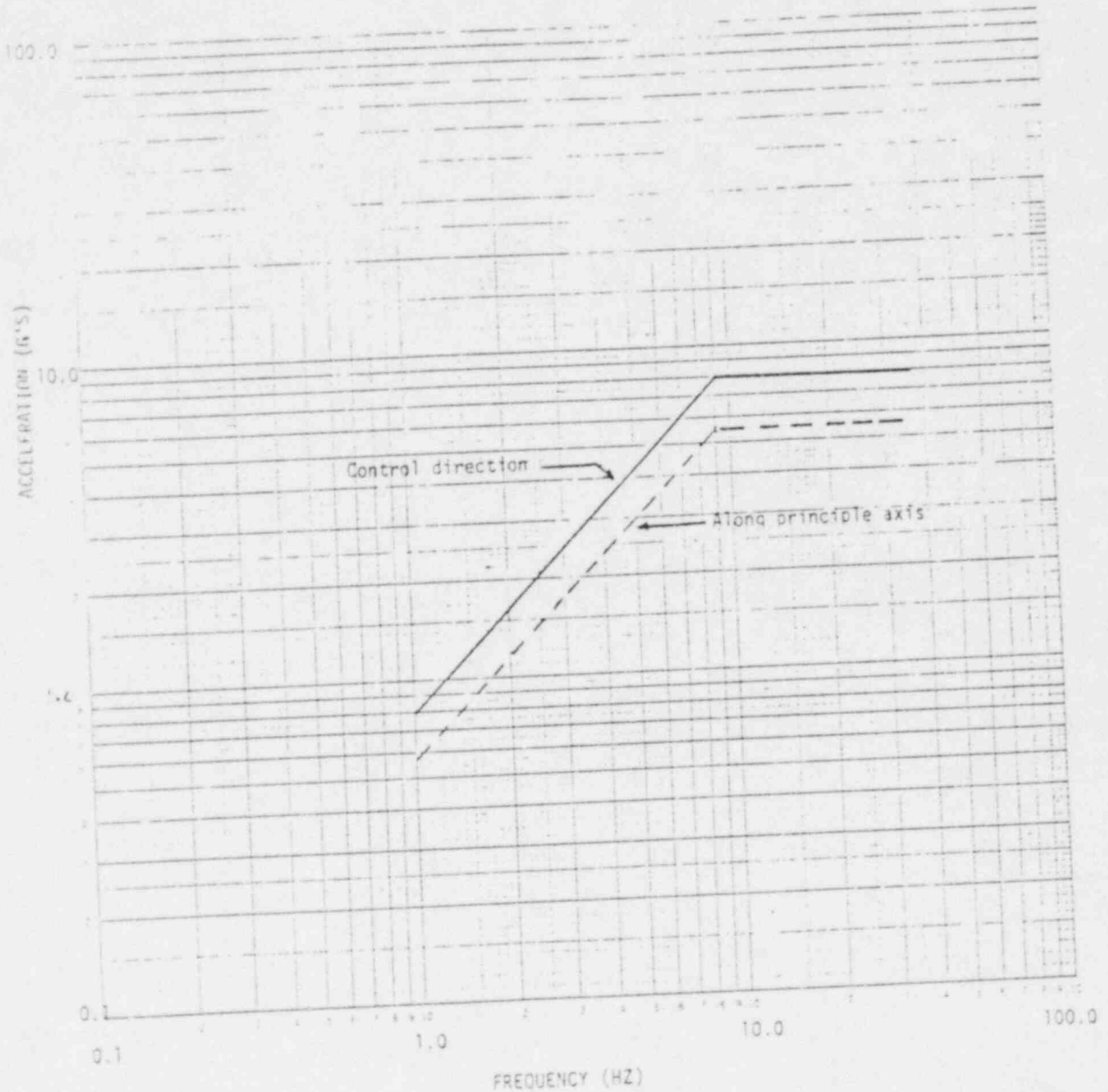



Figure 2. Safe Shutdown Earthquake Required Input Motion

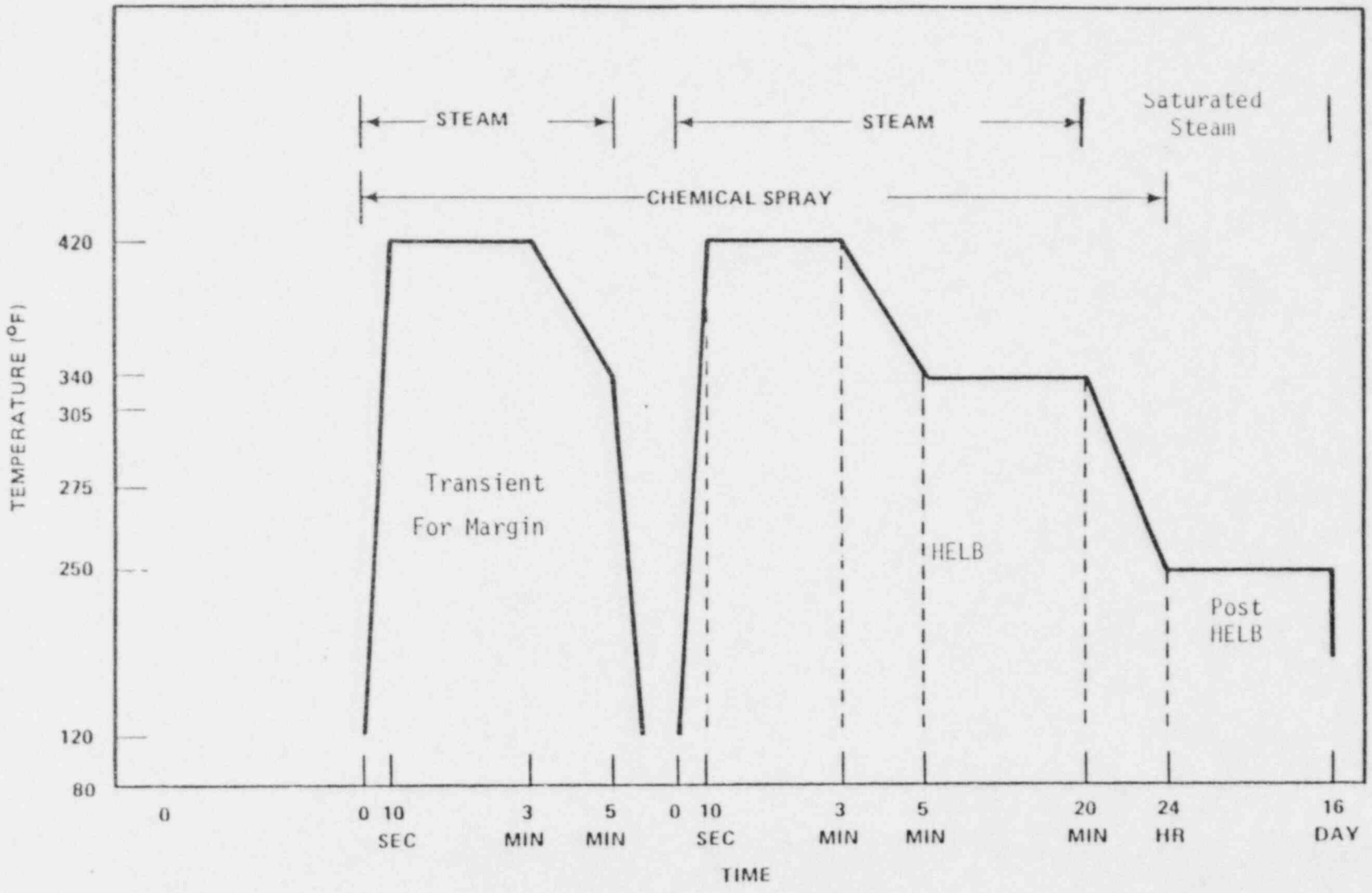



Figure 3. Test Envelope for In-Containment