LOCA TESTING

Spray Fluid Chemical Composition

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LOCA Testing- Spray Fluid Chemistry

- Overview
- Spray Fluid pH and Chemistry Requirements
- IEEE 323 Requirements
  - 1974
  - 1983
  - 2003
- Spray Fluid pH and Chemistry Requirements Compliance
- IEEE 323 Guidance to address pH and Chemistry during and following testing

LOCA Testing Requirements

- Temperature Transient
- Pressure Transient
- Chemical Spray
  - Initial Spray
  - Final Spray
- Submergence

LOCA Testing – pH and Chemistry AP1000 Plant Requirements

- LOCA Spray Fluid Chemistry Requirements is based on Plant Design Requirements
  - Chemical Spray
    - Initial Spray (1 hour – boric acid ppm B/pH)
    - Final Spray (> 1 hour to 24 hours –TSP ppm B/pH)
  - Submergence (> 24 hours – Mission Time; TSP ppm B/pH)

LOCA Testing – pH and Chemistry AP1000 Plant Requirements

AP1000 Post-Accident Submergence Fluid Chemistry				
	Duration	**Boric Acid**	**TSP**	**pH_T**
Initial Fluid	1 hour	2700 ppm B	0	4.5
Final Fluid	23 hours	2428 ppm B	7.53 g/l	7.80 – 7.85

AP1000 Post-Accident Submergence Fluid Chemistry				
	Duration	**Boric Acid**	**TSP**	**pH_T**
Initial Fluid	1 hour	2700 ppm B	0	4.5
Final Fluid	23 hours	2428 ppm B	7.53 g/l	7.80 – 7.85
Final Fluid	Up to 1 year	2428 ppm B	7.53 g/l	7.80 – 7.85

IEEE 323 Requirements

- IEEE 323 – 1974
- IEEE 323 – 1983
- IEEE 323 - 2003/R2008

IEEE 323 – 1974 Requirements

(2) Exposure to Steam and Chemicals

(a) Steam Exposure

Time	Temperature (°F)	Temperature (°C)	Pressure (lb_f/in^2, gauge)	Pressure (kPa)
0 to 10 seconds	120 to 300	48.9 to 148.9	0 to 70	0 to 482.6
10 seconds to 10 hours	300	148.9	70	482.6
10 hours to 4 days	210	98.9	40	275.8
4 days to 1 year	167	75.0	5	34.5

(b) Spray Exposure. Continuously spray vertically downward for first 24 hours with a solution of the following composition at a rate of 0.15 (gal/min)/ft^2 (6.1 (ml/min)/m^2) of area of the test chamber projected on to a horizontal plane.

0.28 molar H_3BO_3 (3000 parts per million boron)
0.064 molar $Na_2S_2O_3$
NaOH to make a pH of 10.5 at 77°F (about 0.59 percent)
Dissolve chemicals, on a one-liter basis, in the following order:

(i) 600 ml potable water
(ii) H_3BO_3
(iii) NaOH
(iv) $Na_2S_2O_3$
(v) Add remainder of water to volume of one liter
(vi) Add NaOH to make a pH of 10.5 at 77°F, as required for the initial spray solution.

*The values given in this table may vary from plant to plant and may or may not contain adequate margin.

†Conservative calculation of radiation dose to containment atmosphere resulting from beta and gamma radiation emitters released from the primary system and at a location within the primary containment.

- IEEE 323 Notes: All the conditions are representative and need modifications to assure their suitability to any specific equipment application

IEEE 323 – 1983 Requirements

- **Section 6.1.5.2** The curves of Figs 1 and 2, Section 7, illustrate typical forms for the specification of some environmental parameters for a postulated high energy line break (HELB), loss of coolant accident (LOCA), and the post-LOCA events. The chemical composition and duration of in-containment spray, if applicable, shall also be specified.

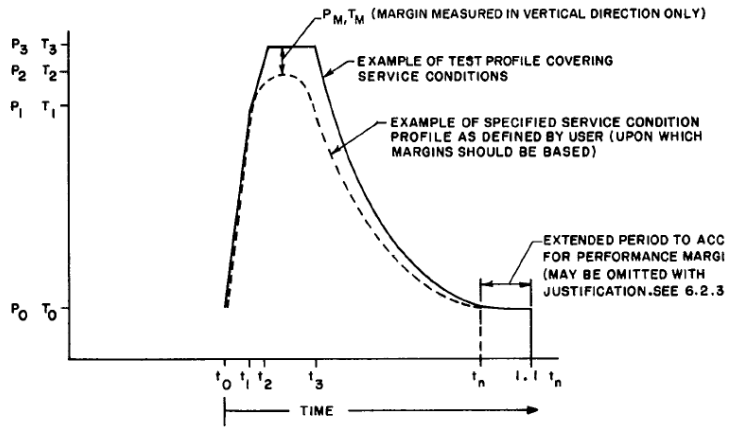

Fig 1
Typical LOCA/HELB Temperature and Pressure Illustrating Application of Time, Temperature, and Pressure Margins

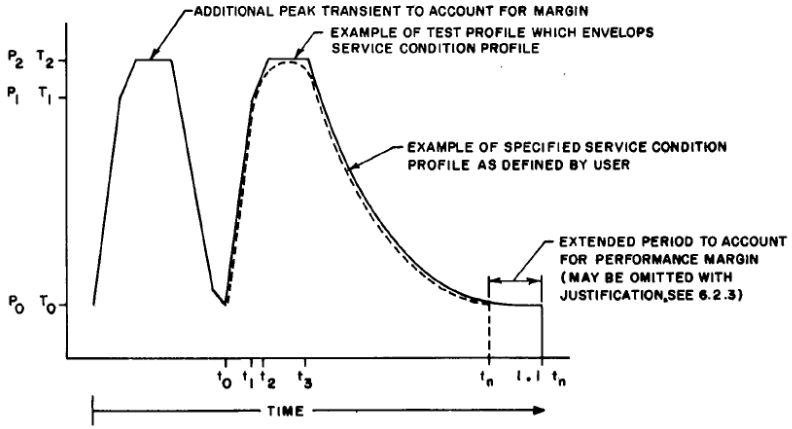

Fig 2
Typical LOCA/HELB Temperature and Pressure Illustrating Additional Peak Transient to Account for Margin

IEEE 323 – 2003 Requirements

6.1.5 Service conditions

6.1.5.1 Normal and abnormal service conditions

- The service conditions for the equipment shall be specified. These conditions shall include the nominal values
- and their expected durations, as well as extreme values and their expected durations. Examples include,
- but are not limited to, the following:
- a) Ambient pressure and temperature
- b) Relative humidity
- c) Radiation environment
- d) Seismic operating basis earthquake (OBE) and non seismic vibration
- e) Operating cycles
- f) Electrical loading and signals
- g) **Condensation, chemical spray, and submergence**
- h) EMI/RFI and power surges

6.1.5.2 Design basis event conditions

- The postulated design basis event conditions including specified high-energy line break, loss-of-coolant accident, main steam line break, and/or safe shutdown seismic events, during or after which the equipment is required to perform its safety function(s), shall be specified. Equipment shall be qualified for the duration of its operational performance requirement for each applicable design basis event condition, including any required post design basis event operability period.

LOCA Testing – pH and Chemistry Compliance During Testing

- During LOCA Testing,
  - Spray fluid chemical composition is measured initially before start of testing (initial and subsequent spray fluid).
  - Spray fluid chemical composition is typically not measured and/or adjusted during testing

pH and Chemistry Compliance During Testing-Continued

- Actual Test Conditions,
  - Recent review of actual spray fluid chemical composition has indicated the following:
    - Spray chemical composition varied from initial start to first hour
    - Spray chemical composition varied after the first hour to 24 hours
    - Chemical composition variation was minor to significant
    - Chemical composition variation was dependent on the test facility
      - LOCA/Steam plant configuration
      - Spray fluid flow conditions
      - Spray fluid temperature

pH and Chemistry Requirement/Compliance Discussions

- What are acceptable measures of spray fluid chemistry for the duration of testing?
  - pH
  - Boric Acid ppM
  - % variation from initial specified value of pH and Boric Acid
  - No confirmation of fluid spray chemistry needed
  - Meet specified requirements within acceptable range

pH and Chemistry Requirements/ Compliance Discussions

- IEEE 323 Guidance to address Spray Fluid Chemistry?
  - Steam plant design
  - Spray fluid temperature
  - Spray fluid flow conditions

LOCA Testing – pH and Chemistry

Questions