Re-Defining the Harsh / Mild Environmental Threshold for EQ

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What is the Harsh / Mild Threshold for EQ?

- The values for a set of environmental conditions above which a device or material may be considered subject to an environment that could significantly affect the device's performance or material properties.
- Rooms with **accident** conditions (one or a combination of more than one) above these threshold values are considered "Harsh."
- By default, all other areas are considered "mild." There may still be environments that need to be considered.

Why Re-Define the EQ Threshold?

- Reduce EQ Program Scope including:
  - Upgrade and / or replacement of current EQ equipment to maintain EQ qualified status would not be required.
  - EQ required installation, maintenance, procurement, and design / modification activities would not be required.
  - Potential for reducing the number of EQ Files.
  - Potential for reduction in personnel radiation doses and contaminated disposal costs.
  - Reduce obsolescence issues.

Why Re-Define the EQ Threshold?

- It is a **utility decision** and usually requires a 10CFR50.59 evaluation, a short technical report, some procedure changes, and possibly a HELB re-analysis.
- Save money and other resources that can be applied to other plant needs.

Original EQ Program Development

- The EQ Programs were developed using prescriptive, regulatory-drive, deterministic methodologies:
  - Identify your Licensing Basis
  - Define your Design Basis
  - Identify your Design Basis Accidents (LOCA, MSLB, HELB, Rod Drop, Fuel Handling, etc.)
  - Determine / Calculate your environmental conditions
  - Identify the safety related, electrical equipment required to function in a a harsh environment.
  - Document the Qualification of the Equipment.
  - Implement the configuration, maintenance and procurement requirements.

Original EQ Program Development

- Most US EQ programs were developed in the 1980 to 1984 time frame.
- Most EQ Programs were developed in parallel with the development and issuance of the various regulatory and industry documents for EQ.
- Most EQ Programs were developed under significant time constraints and submittal deadlines.
- Most utilities relied on their architect-engineers to develop their EQ Programs and they may have used a bounding approach to meet multiple plant needs and deadlines.

Original EQ Program Development

- There was limited or expensive computer power (mainframe vs. desktop program like GOTHIC) that resulted in higher, bounding environments.
- High Energy Line Break (HELB) computer modeling software was not as sophisticated as it is today (e.g., COPDA, COPRA, CONTEMPT, etc. vs. GOTHIC).
- Most HELB models utilized a downstream bounding approach that negated much of the benefit of re-defining the EQ threshold.

Original EQ Program Development

- Two major EQ Program development activities were not performed by many utilities and their Architect-Engineering partner:
  - Rigorous basis for the Harsh / Mild Definition.
  - Detailed functional evaluation of each piece of equipment to determine its exact function for each accident and whether it performed that function in a harsh environment.

EQ Harsh / Mild Regulation

- 10CFR50.49, the primary EQ regulation, defines a **harsh** environment as "significantly more severe" then a mild environment.
- A **mild** environment is not defined.
- Only **significant** degradation mechanisms are considered.
- Harsh and Mild refer to **accident** environments and ***not*** **normal or abnormal** operational environments. Abnormal operational occurences (AOOs) are part of the normal environments.

Harsh / Mild Environments

- All plant locations or EQ Zones, for EQ purposes, are defined as:
  - Harsh environments (areas in which safety related electrical equipment must be considered by the EQ Program) or
  - Mild environments (areas in which safety related electrical equipment equipment need not be considered by the EQ Program)
  - Even if a location is designated “Mild” for EQ, the plant must still meet General Design Criteria 4.

EQ Harsh / Mild Regulation

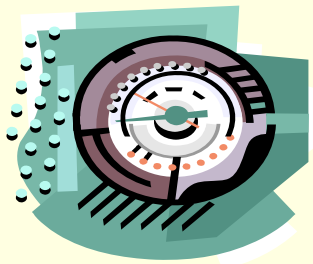
- US Plants must meet General Design Criteria No. 4 which reads,
  - "*Criterion 4--Environmental and dynamic effects design bases*. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents ...."

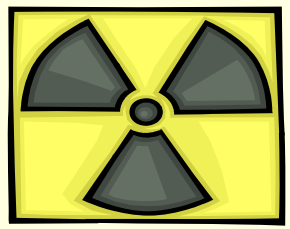
Typical Utility Approach

- The U.S. NRC has not formally endorsed a specific position or specific values, but rather has focused on ***ensuring a basis is provided for the values selected***.
- Many utilities purposely leave definition as “significantly more severe” to permit latitude.
- Some utilities use a “margin” approach, i.e., 104ºF / 40ºC + 15ºF / 8.3ºC, normal radiation + 10% dose.
- Other utilities formally identify threshold with specific values, i.e., 122ºF / 50ºC, 140ºF / 60ºC, 1.0E03 rad, 1.0E04 rad, etc.

Current EQ Harsh / Mild Threshold From One US Plant

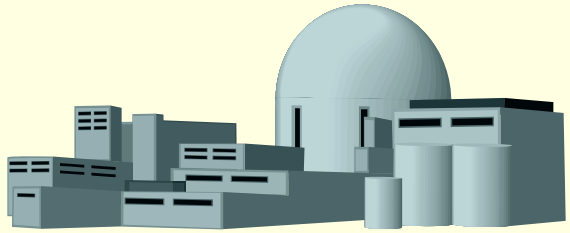
- **Temperature**: 110ºF
- **Pressure**: 16.1 psia
- **Radiation**:
  - 1.0E03 rad
  - 1.0E03 rad to 1.0E04 rad (with analysis)
- **Humidity**: 90%
- Some plants use a combination of parameters

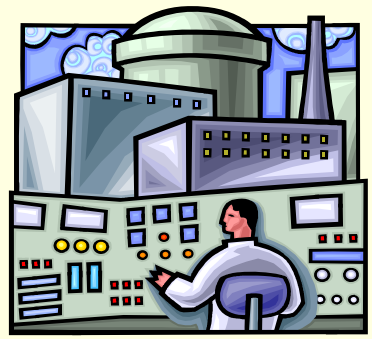




EQ Harsh and Mild Plant Locations

- Harsh Locations:
  - Primary Containment
  - Drywell / Wetwell
  - Auxiliary Building (PWR)
  - Reactor Building (BWR)
  - Intermediate Building
- Mild Locations:
  - Control Room
  - Turbine Building
  - Switch Yard





New Harsh / Mild Threshold Definitions

- Temperature: 140ºF
- Pressure: 16.7 psia (2 psig)
- Radiation: 1.0E05 rad minimum TID
- Humidity: 100%

Basis for New Plant Harsh / Mild Threshold Definitions

- Existing Utility positions based on extensive surveys.
- Vendor, Utility-sponsored and NRC testing.
- Material property research from Underwriters Laboratories (UL) and other sources.
- Materials information and data consolidation
  - Scientech EQDB, EPRI Reports, System 1000 Database, various contractor databases.

Temperature Threshold

- Should be based on the maximum Anticipated Operational Occurrence (AOO) temperature for the plant.
- AOOs are part of the normal environment and are part of the plant design basis.
- Loss of HVAC is an AOO.
- Typical Loss of HVAC event temperatures range from 135°F to 150°F from 3-8 hours.
- Most HVAC systems have temperature control ranges from 40°F to 140°F.

Pressure Threshold

- Utility positions range from 1.0 psig to 5.0 psig.
- Concrete walls, ceilings and floors have a structural limit of 3.0 – 4.0 psig.
- Approximately 2.0 psig required to push grease from bearings.

Radiation Threshold

- Most materials have no measurable change in properties at 1.0E05 rad (NP-1558, NP-2129, NP-4172, System 1000, etc.).
  - Exceptions include Teflon and CMOS and some other electronic components.
- Materials with lower thresholds can be controlled through the design and procurement processes.

Humidity Threshold

- Data exists that shows that even sensitive devices can function in high humidity (up to 100%) or steam environments with sealing:
  - Nutherm testing on unsealed Rosemount transmitters.
  - Utility testing on unsealed NAMCo limit switches.
  - Utility testing of commercial ASCo Red Hat series Solenoid valves to PWR LOCA conditions.

Cost Benefits to Re-Defining EQ Harsh - Mild Threshold

- EPRI Report TR-104063 from 1994 provided EQ cost benefits in a license renewal period. Replacement costs (**in 1994 $$).**
- For example, the following table illustrates the savings for only 30 SOVs, transmitters, and limit switches.
- The result is that $191,125 (**in 1994 dollars $$$**) could be saved if these components did not require replacement **one** time. Many components are replaced multiple times throughout a plant life.
- Savings of more than $500,000 can easily be realized when the total number of components is reviewed and License Renewal is considered.

Cost Benefits to Re-Defining EQ Harsh - Mild Threshold

Device	Cost ($) from EPRI Report	Example No. of Devices to be replaced	Total Savings ($)
SOV	3,725	15	55,875
Transmitter	19,450	5	97,250
Limit Switch	3,800	10	38,000
			191,125

Cost Benefits to Re-Defining EQ Harsh - Mild Threshold

- A European plant backfitting EQ has estimated that by re-defining their harsh – mild threshold, they will be able to remove 283 devices from the EQ program. The total savings are projected to be over $5,000,000 (**in 2005 dollars**) over the life of the plant.
- A preliminary review of one Asian plant similarly backfitting EQ indicates even larger savings by reducing the EQ Master Equipment List by more than 400 - 500 devices.