MIT Research Reactor

Edward S. Lau
Assistant Director of Reactor Operations
MIT Nuclear Reactor Laboratory

Replacement of Emergency Batteries for the MIT Research Reactor

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Discussion Topics

- 60 lead-acid (Pb-acid) batteries that provided emergency backup power were reaching their end of life
- New type of battery cell: Valve-Regulated Lead-Acid (VRLA) Absorbent Glass Mat (AGM)
- License Amendment Request (LAR)
- Implementation

Previous Pb-Acid Battery Bank

Previous Pb-Acid Battery Bank

- Each of the 60 cells contained Pb plates flooded with 30% sulfuric acid
- Each cell produced 2 Volts DC & was capable of outputting 298 amps for one hour, ending at 1.75 V_{DC} per cell
- For an eight-hour duration discharge, each cell was capable of 72 amps output (so ~576 A-h), ending at 1.75 V_{DC} per cell
- Design life was 20 years
- Routinely required specific gravity measurements using a hydrometer. Other routinely monitored parameters included bank voltage and pilot cell voltage.
- Battery discharge test performed once every two years

New VRLA AGM Batteries (half bank)

New VRLA AGM Batteries

- Each of the 60 cells contains Pb plates sandwiched between glass mats that have absorbed sulfuric acid
- Each cell is sealed; specific gravity measurement is not required (and not possible)
- Each cell produces 2 Volts DC, and is capable of outputting 454 amps for one hour, ending at 1.75 V_{DC} per cell
- For eight-hour duration discharge, each cell is capable of 105 amps output (so 840 A-h), ending at 1.75 V_{DC} per cell
- Design life is 20 years
- Routinely requires voltage, negative terminal temperature, and cell connector resistance measurements
- Battery discharge test performed once every two years

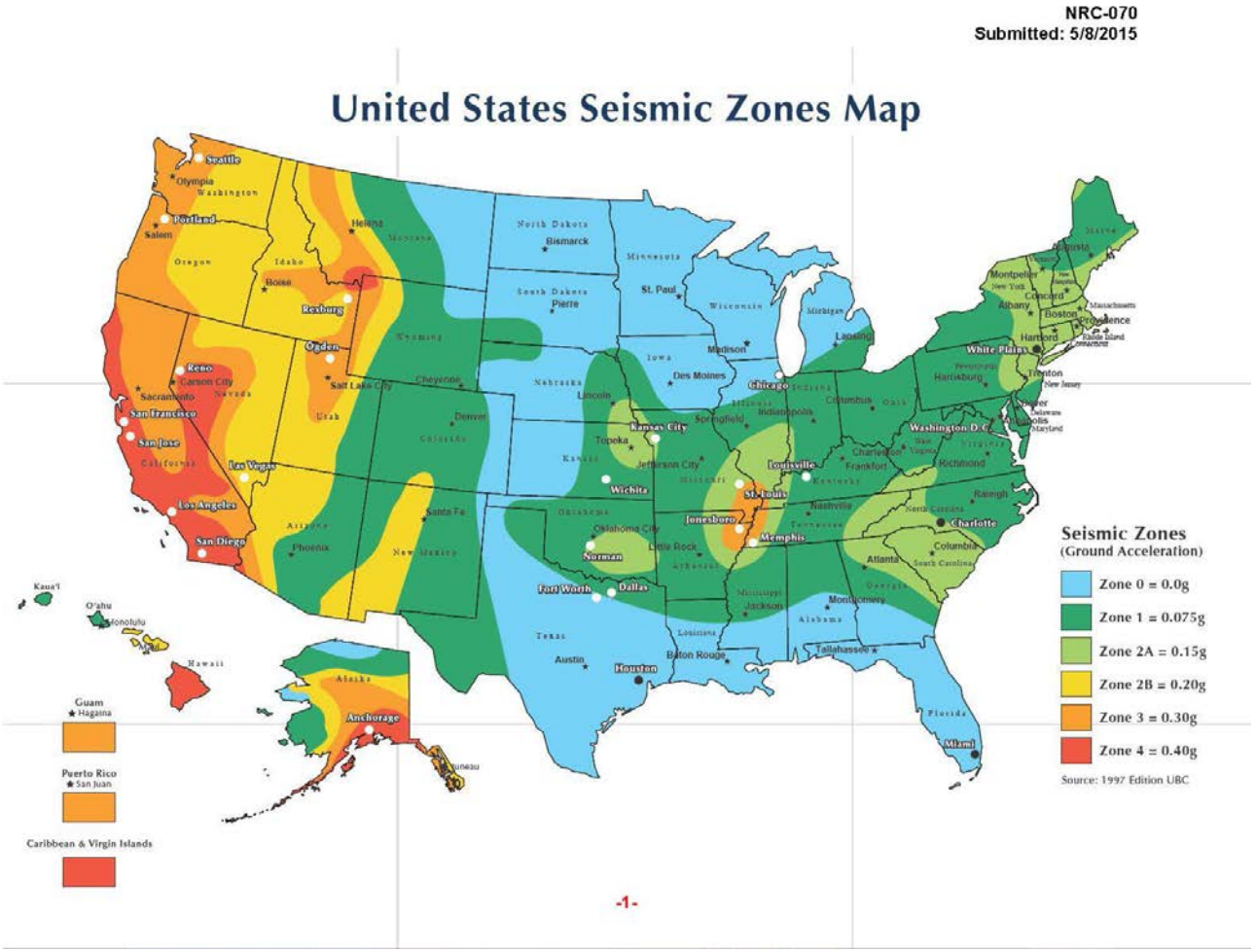
NRC Interaction

- The MIT Reactor Safeguards Committee reviewed and approved a draft LAR on 29 January 2021
- Several videoconferences between Dec. 2020 and early March 2021, including a Phase 0 public meeting with the NRC technical review team on 5 Feb. 2021
- LAR formally submitted on 2 March 2021
- NRC Request for Additional Information (RAI) on 18 March
- MIT Response to the RAI submitted on 24 March
- After several rounds of telephone & email correspondence, MIT Response to RAI supplemented by MIT on 17 May
- NRC sent LAR Approval on 31 August 2021, with 180 days for implementation

NRC's RAI Item Highlights

- Reliability
  - Expected service life and its technical basis
    - Following manufacturer's recommendations on maintenance
    - Following IEEE Standard 1188 recommendations
  - The batteries will operate in an area which is ventilated and at a controlled room temperature
  - Longest off-site electrical power loss in the past 20 years (in 2003) lasted ~3 hours
  - Similar batteries in application at MIT Co-Generation Plant since 2016 with no failures
  - Replacement criteria

Seismic Qualification



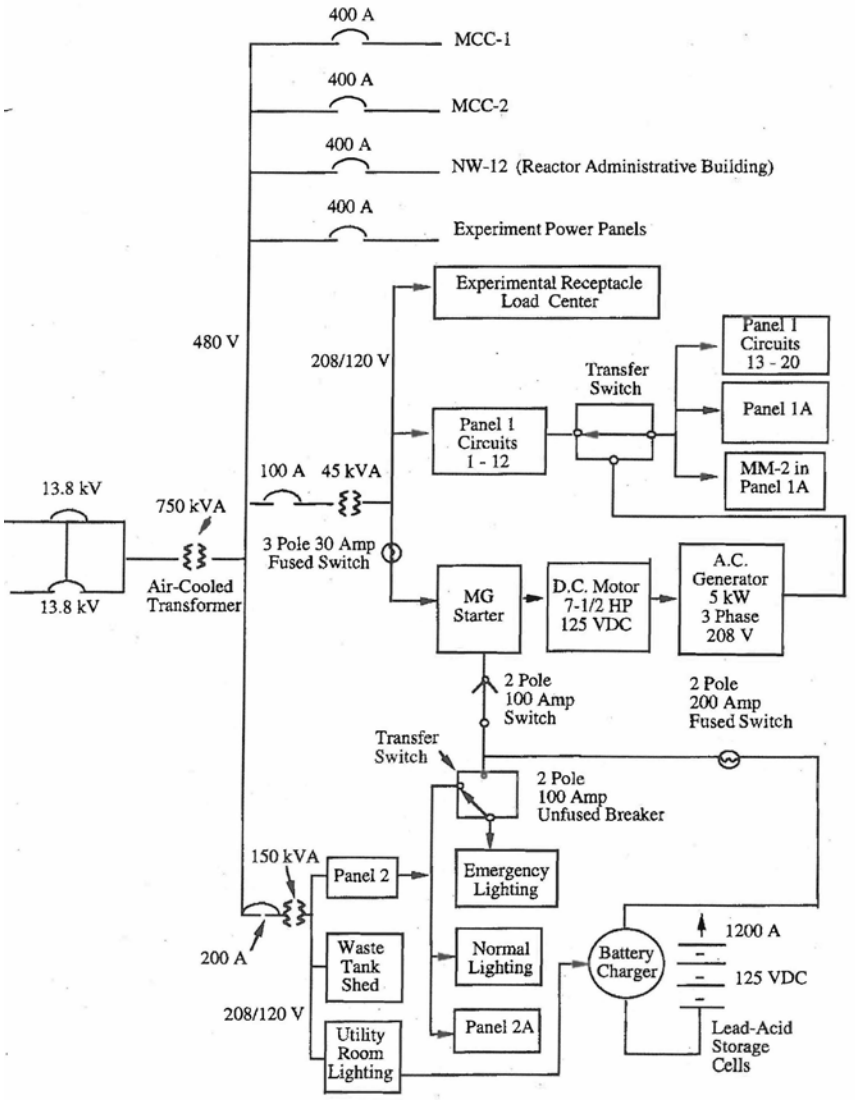
NRC's RAI Item Highlights

- ## Sizing – Batteries & Charger
  - Manufacturer sizing methodology adheres to IEEE 485 & 1184
  - Demonstrate all expected loads on the batteries, including both momentary and continuous (duty cycle diagram)
  - The batteries must operate a set of equipment listed in an MITR Technical Specification for a minimum of one hour
- ## Ventilation
  - For temperature (77º F, 25º C) and hydrogen control per IEEE 1187
  - Ceiling exhaust fan – continuous operation
  - Room doors fitted with large vents to promote circulation
  - Battery bank occupies less than 1% of the room's volume

NRC's RAI Item Highlights

- Electrical Protection of the Batteries
  - Battery protection adheres to IEEE 1187
  - Battery bank connects to emergency power system through a 200-amp disconnect switch, a 100-amp switch at the motor-generator set, and a 100-amp circuit breaker for the DC emergency lighting
  - Short circuit evaluation – maximum current of 6038 amps
  - A state-of-the-art battery charger controls charging current
    - Float current monitoring
    - Temperature-compensated charging minimizes chance of thermal runaway
    - Ground fault detection
    - AC input circuit breaker trips at 18.75 amps; DC output protection trips at 50 amps
  - State-of-the-art battery monitoring unit provides instantaneous indication of vital battery parameters such as cell voltages, internal resistance, and negative terminal temperatures

Electrical Power Distribution Diagram



NRC's RAI Item Highlights

- Surveillance, Maintenance, Testing
  - Follow manufacturer's operating manual
  - For areas that the manufacturer's manual does not address, follow IEEE 1188
  - Distinction between types of test
    - Performance Test – checks battery capacity
    - Service Test – checks capability of emergency power distribution system
    - Modified Performance Test – combination of both
      (MITR Emergency Battery Discharge Test falls into this category, per IEEE 1188)
  - Periodic surveillance beyond what manufacture directs, including more frequent visual inspection and review of battery monitoring data
  - Hydrogen measurements are not needed for MITR's application

Removal of Previous Batteries

Packaging the Removed Batteries onto Pallets for Transport

Transport of Removed Batteries to Truck for Recycling / Disposal

Installation of New Battery Systems

- In progress!
- Questions & Answers