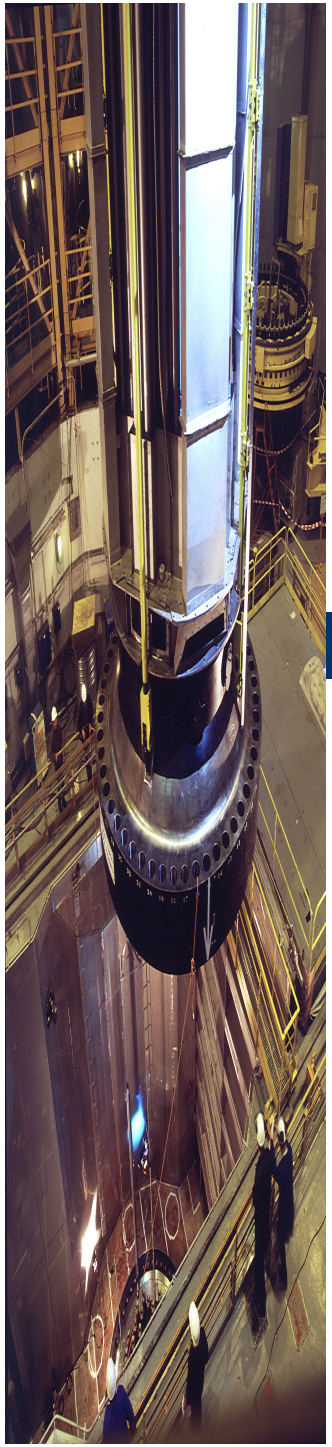


U.S. EQ STANDARDS AND REGULATIONS

Paul Shemanski
Office of New Reactors
U. S. Nuclear Regulatory Commission

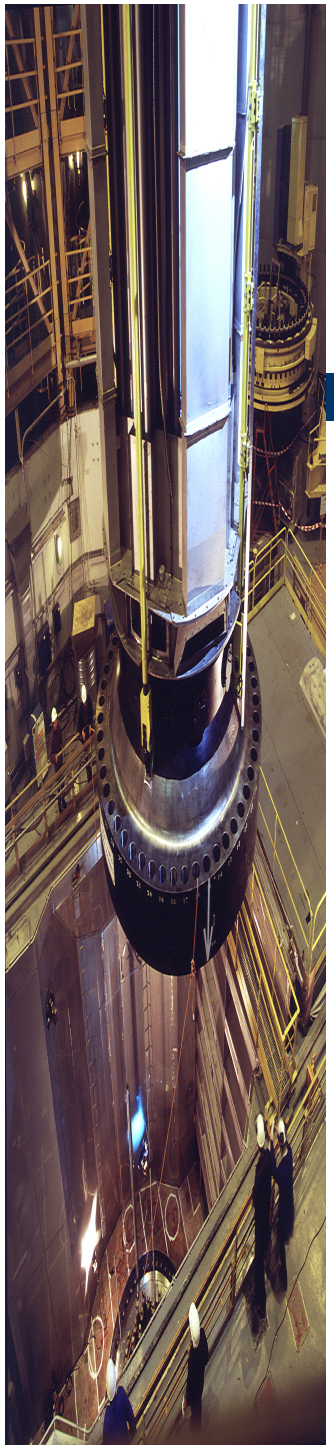
At

The 1st SINO-US Symposium of Nuclear Equipment Qualification

Chengdu, China

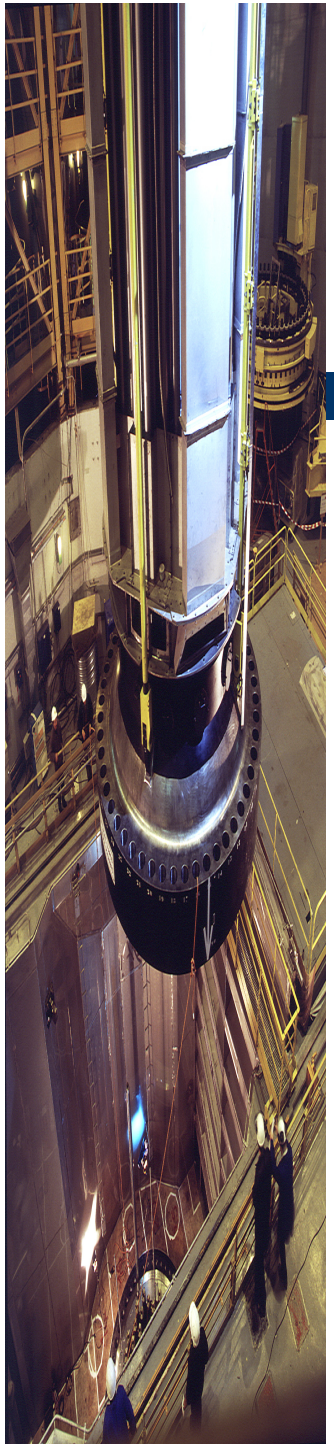
3 - 5 November 2008

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



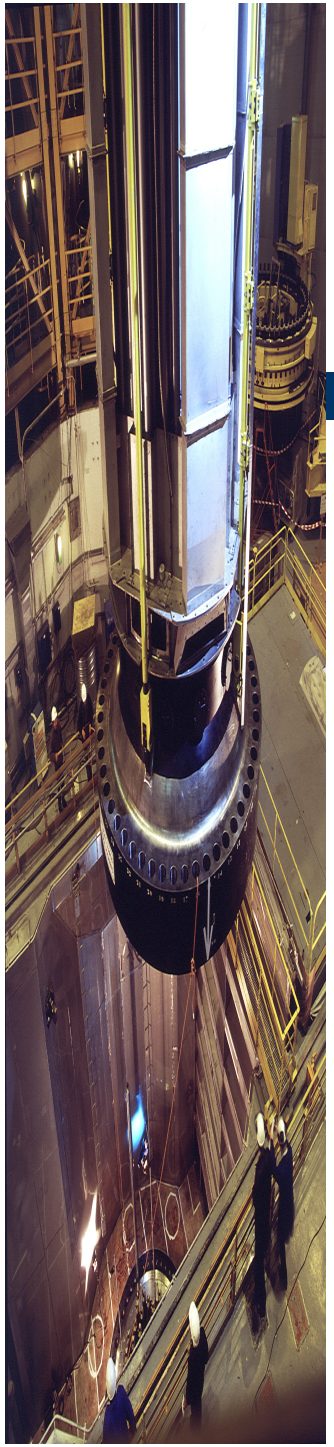
Agenda

- Definition of Qualification
- Typical Service Conditions
- Historical Evolution
- Regulations and Standards
- How U.S. Standards Are Developed and Enforced
- Participants in the EQ Process
- Scope of EQ Equipment
- Activities Essential to the EQ Process
- Contents of Electrical EQ Program
- Qualification Testing
- Treatment of Equipment Aging



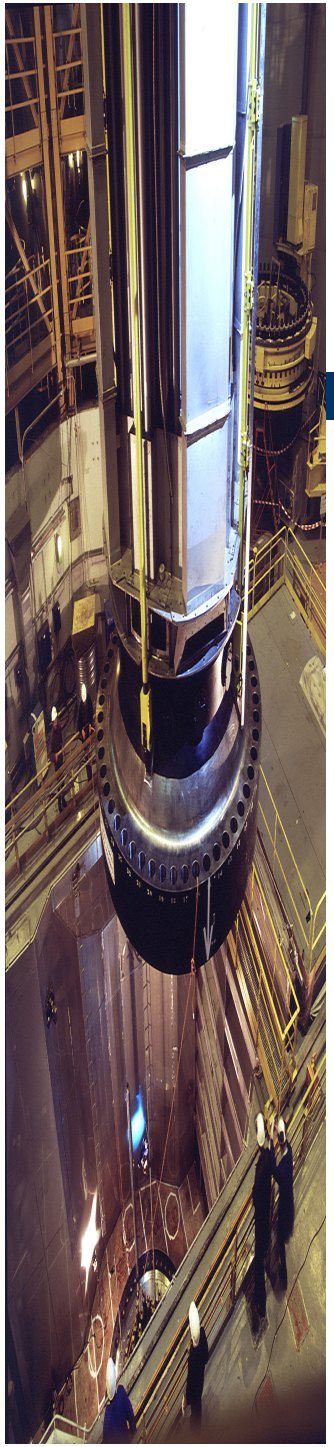
Definition of Qualification (What is EQ?)

- Generation and maintenance of evidence to assure that the equipment has the inherent capability to operate on demand to meet its performance requirements under applicable service conditions.
- This concept applies to both electrical an mechanical equipment.



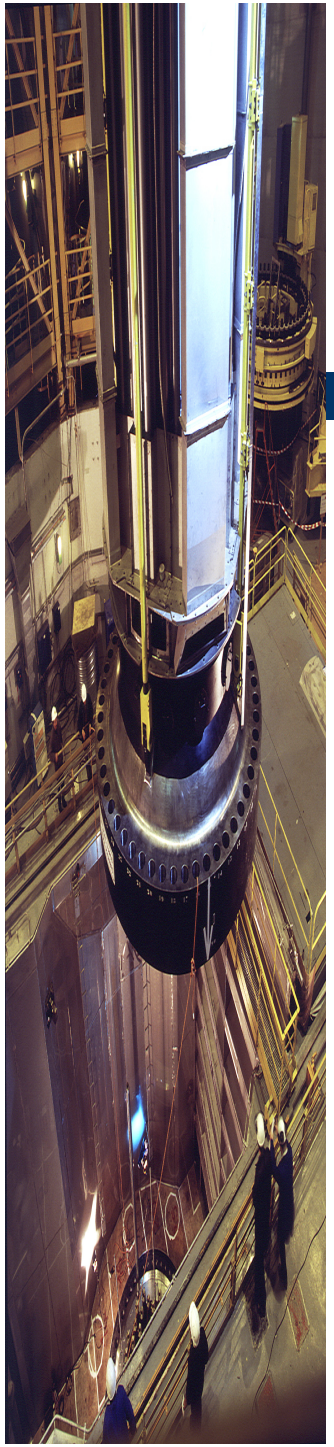
Typical Service Conditions

- Environmental Conditions:
  - Temperature
  - Pressure
  - Humidity
  - Radiation
  - Vibration
  - Synergistic Effects
- Test Conditions
  - Start-up
  - Maintenance
  - Testing
- Postulated Design Basis Event Conditions
  - Loss-of-Coolant-Accident
  - Main-Steam-Line-Break
  - High-Energy-Line-Break Outside Containment



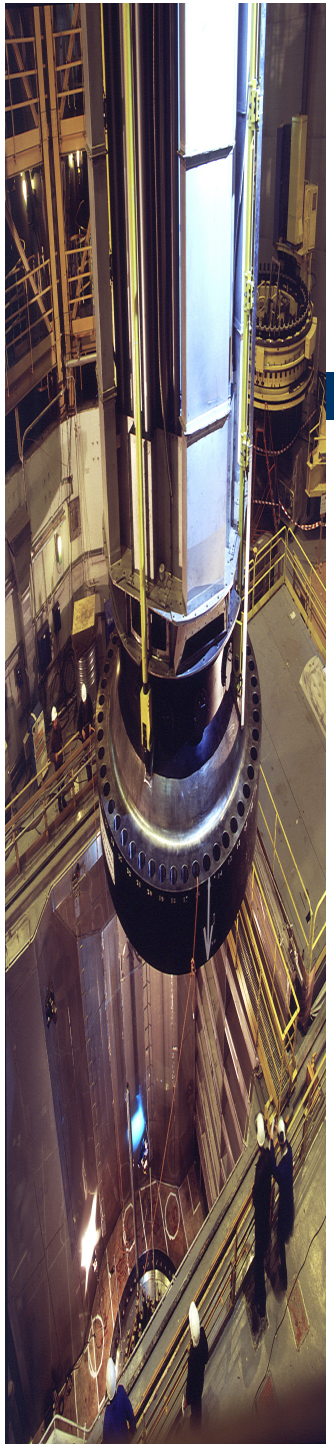
Historical Evolution

- General Design Criterion 4
- Inspection and Enforcement Bulletin No. 79-01B
- NUREG-0588, Staff Position on EQ
- 10 CFR 50.49, NRC Equipment Qualification Rule
- Regulatory Guide 1.89, Environmental Qualification of Electric Equipment
- IEEE Standards 323-1971 and 1974, Standard for Qualifying Class 1E Equipment



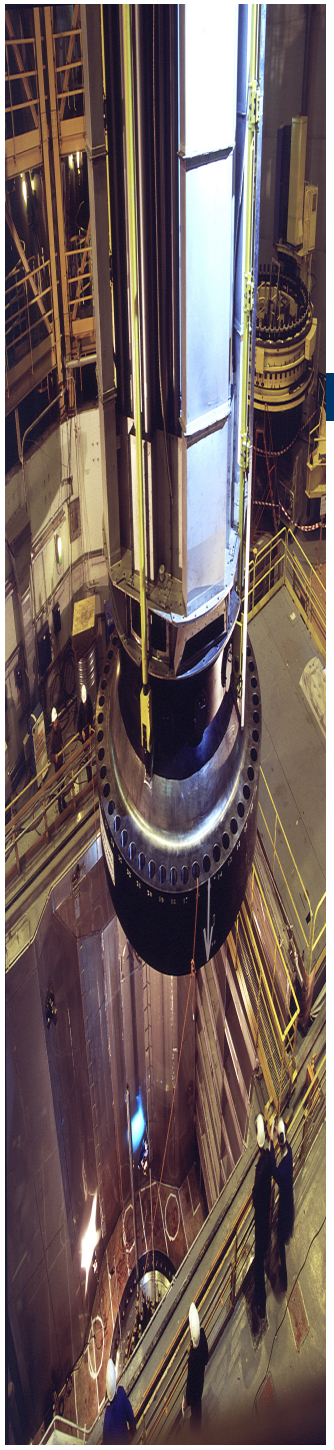
Regulations

- Regulations
  - 10 CFR 50.49, Equipment Qualification Rule
  - 10 CFR 50 Appendix A, Quality Standards and Records
  - 10 CFR 50 Appendix B, Quality Assurance Criteria



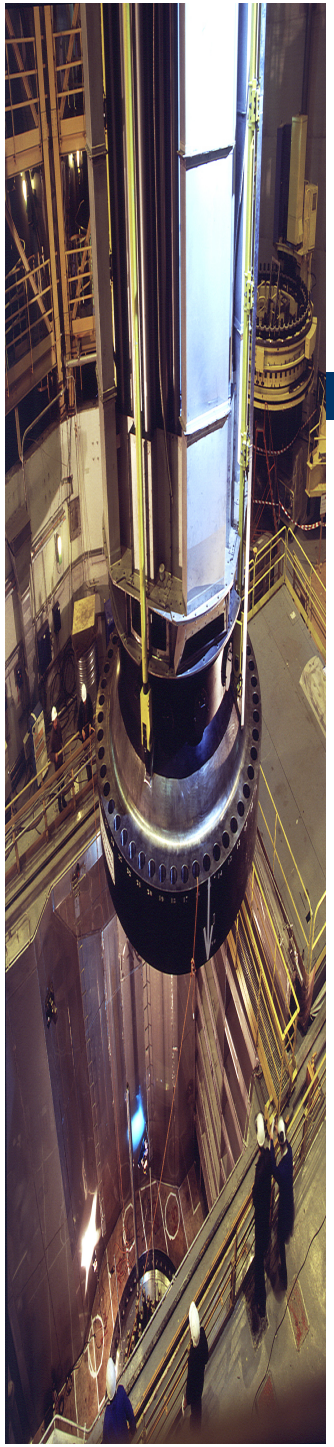
Regulatory Guidelines

- Regulatory Guidelines
  - Regulatory Guide 1.89, Environmental Qualification of Equipment Important to Safety
  - Regulatory Guide 1.100, Seismic Qualification of Electric and Mechanical Equipment
  - Standard Review Plan 3.10, Seismic & Dynamic Qualification of Electric and Mechanical Equipment
  - Standard Review Plan 3.11, Environmental Qualification of Electric and Mechanical Equipment



Industry Standards

- Industry Standards
  - IEEE 323-1974, Qualification of Class 1E Equipment
  - IEEE 344-1987, Seismic Qualification of Class 1E Equipment



How U.S. EQ Standards Are Developed and Enforced

- IEEE Standards are developed within the IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association Standards Board.
- Standards are developed though a consensus development program.
- Standards are endorsed by the U.S. Nuclear Regulatory Commission (NRC) through regulatory guides for implementation.
- Standards are mandatory requirements if they are invoked in NRC regulations or cited in the licensing basis of a nuclear power plant. Enforcement action can be taken by NRC if violations are identified.

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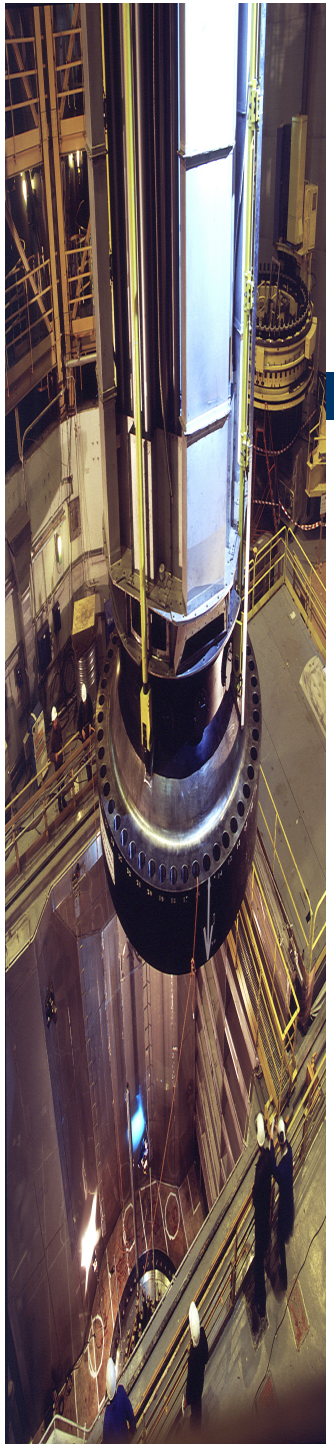
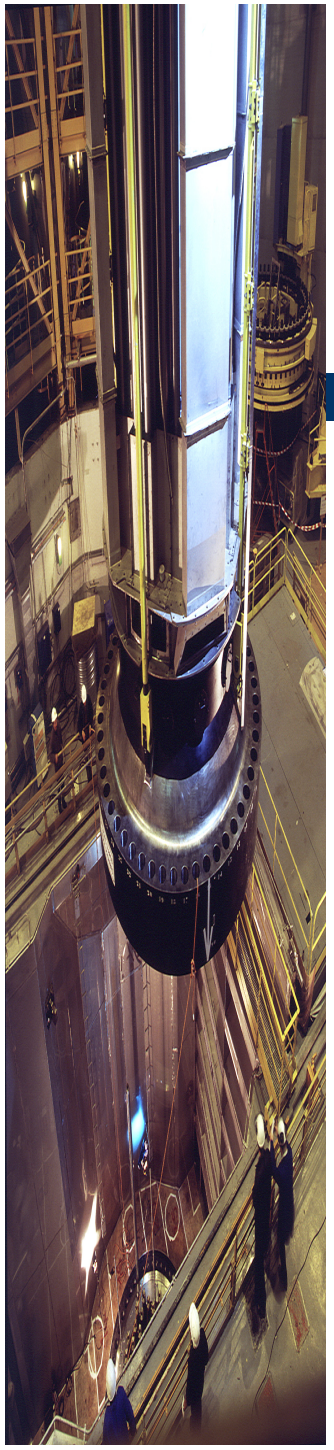


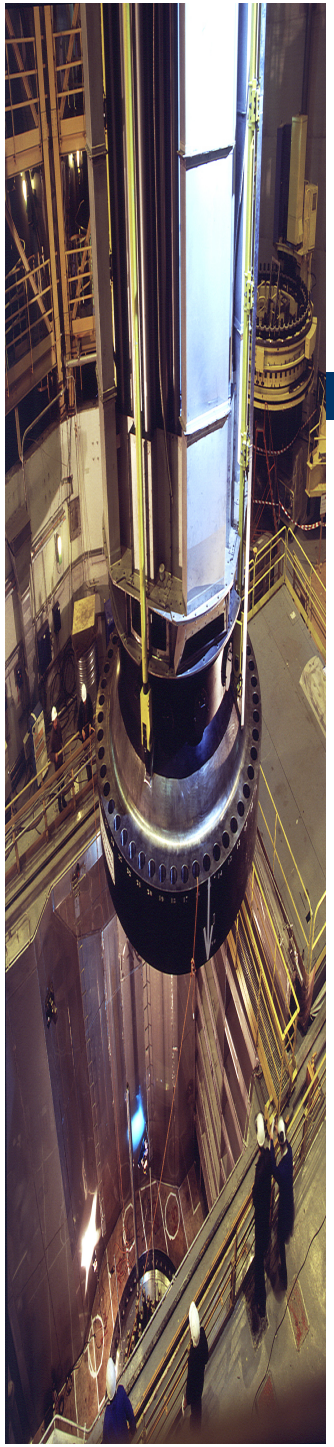
Participants in the Qualification Process

- Government Regulators: Nuclear Regulatory Commission
- Professional Associations: The Institute of Electrical and Electronic Engineers and their Standards Committees, American Nuclear Society and the American Society of Mechanical Engineers
- Nuclear Equipment Vendors and their suppliers
- Qualification testers such as Wyle Laboratories
- Nuclear Utility Plant Operators



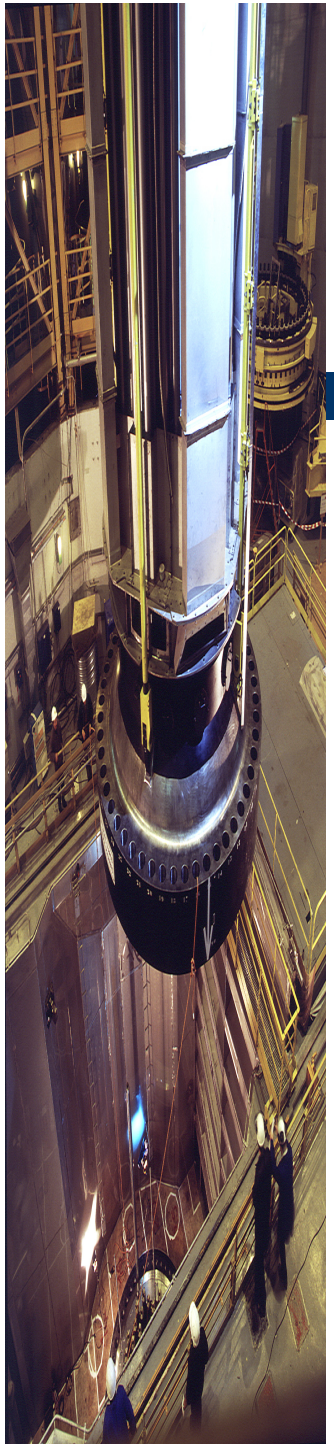
Scope of EQ Equipment

- All components needed for:
  - Emergency reactor shutdown
  - Containment isolation
  - Reactor Core Cooling
  - Containment and Reactor Heat Removal
  - Prevent significant release of radioactive material to the environment
- Develop and maintain an EQ equipment qualification master list and supporting documentation available for NRC audit
  - Class 1E equipment in harsh environment
  - Certain non-safety related equipment
  - Certain post-accident monitoring equipment



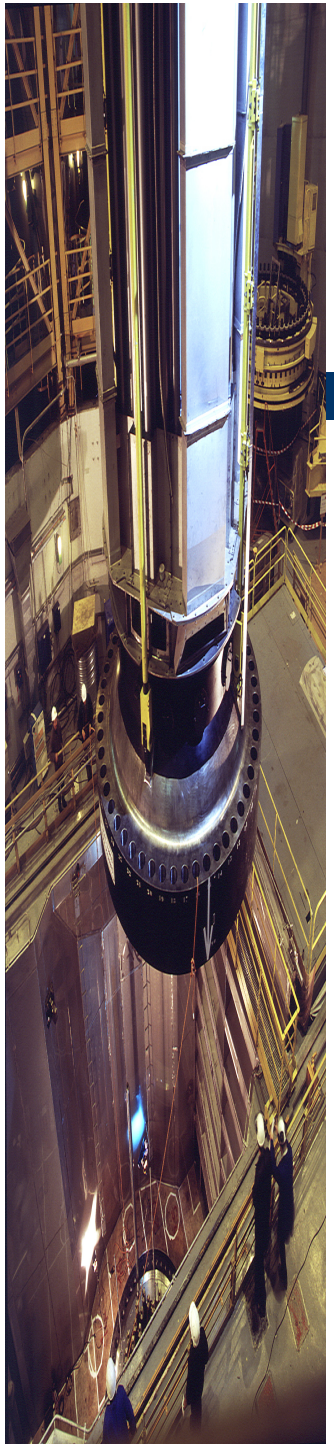
Activities Essential to EQ

- Accident Analysis
- Safety Classification
- Plant Design and Configuration Control
- Procurement
- Maintenance
- Quality Assurance
- Operating Experience



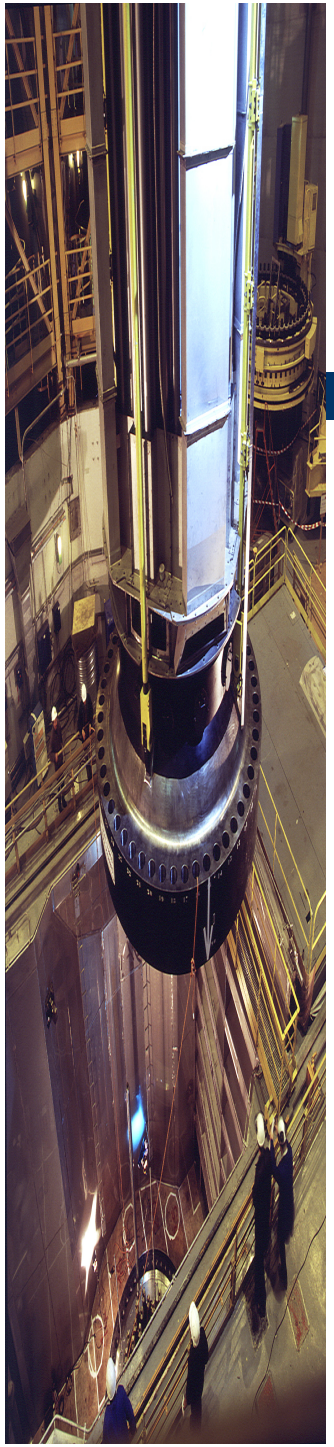
Contents of Electrical EQ Program

- Regulatory Basis
- Program Scope
- Responsibilities
- Procedural Controls
  - Requirements for evaluating new equipment
  - Measures for controlling EQ Program
  - Procurement Procedures
  - Measures to identify and control design changes
  - Maintenance procedures to control qualified life
  - Procedures for evaluating qualification test results
  - Measures for review of EQ operating experience



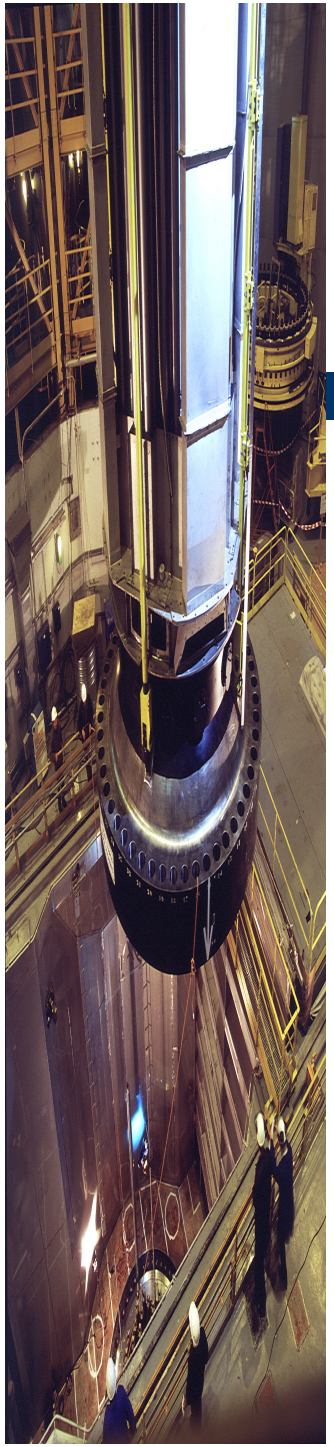
Qualification Testing

- Qualification requirements
- Qualification methods
- Test chamber environmental qualification
- Performance characteristics demonstrating operability
- Chemical or demineralized spray
- Radiation sources



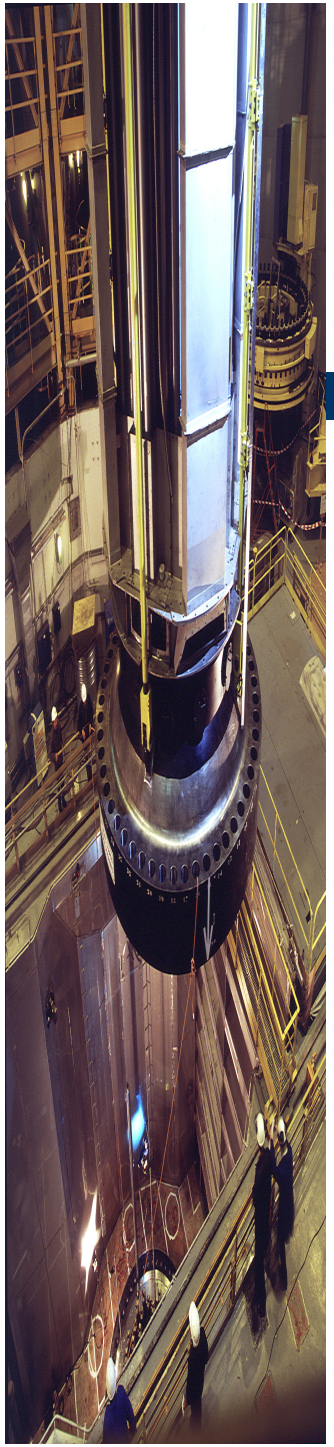
Treatment of Equipment Aging

- 10 CFR 50.49 (EQ Rule) and IEEE 323-1974 approaches should be supplemented with the following for equipment aging:
  - Synergistic effects of aging stressors
  - Operating effects of temperature on qualified life
  - Periodic surveillance and testing program



Equipment in Mild Environment

- Requirements are specified in the design/purchase specifications and a qualified life is not required if there are no significant aging mechanisms.



Conclusions

- Environmental qualification of equipment prior to their installation provides reasonable assurance that they would be resilient against common cause failures due to operational environment and design basis events.
- EQ nuclear power plant operating experience has shown that “doing it right the first time" is essential to a trouble-free equipment qualification program for the life of the plant.