

# Qualification of DRS Digital Equipment for Lungmen NPS

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*Institute of Nuclear Energy Research (INER)*

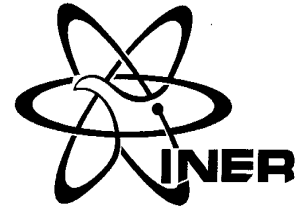
*Taiwan, ROC*

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# Content

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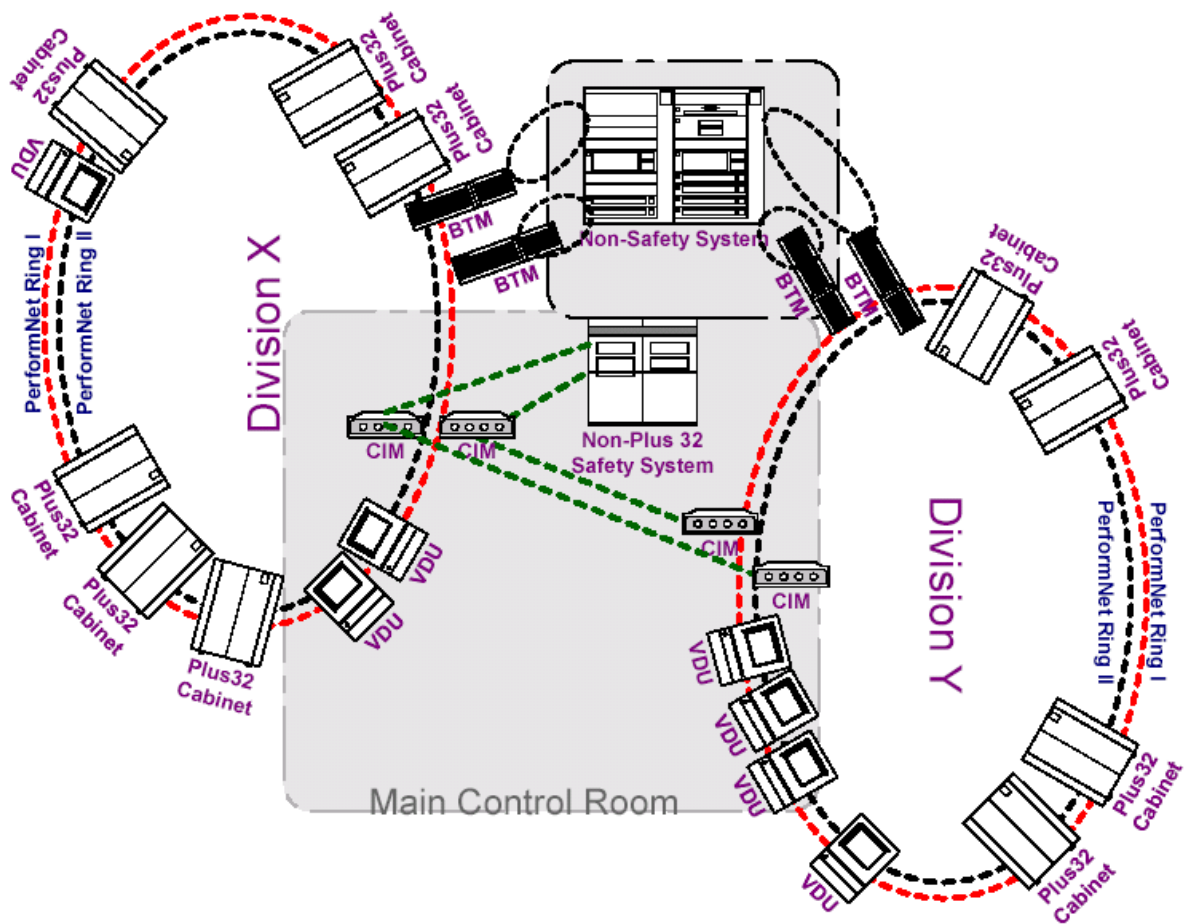
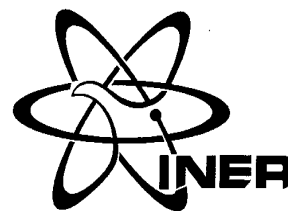
- Background
- DRS Plus32 Control System
- EMC Test
- Environmental Test
- Seismic Test



# Background

- INER (Institute of Nuclear Energy research)
  - Established Commercial Grade Item Dedication (CGID) program in 1993
  - Constructed a bi-axial shake table in 1994
  - Installed a harsh environment test lab in 2000
  - Participate in several Class 1E equipment Dedication projects
  - Support TPC (Taiwan Power Company) Lungmen project
- TPC Lungmen NPS
  - Two 1300MW GE ABWR Unit (awarded in 1996)
- DRS
  - Previous known as Eaton
  - DRS Plus32 digital control system is used in Lungmen ESF System

# DRS Plus32 Control System

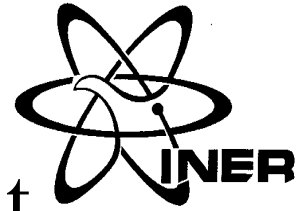




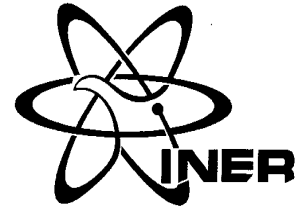
# Qualification Methodology

## Established in DRS Digital Equipment

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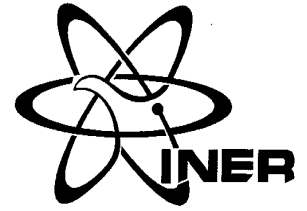
- Employ a combination of type testing and analysis
- Type testing
  - Environmental (IEEE Standard 323)
  - Seismic (IEEE Standard 344)
  - Electromagnetic Compatibility (EMC)
- In mild environment
- SV&V and its qualification are not included



# Qualification Plan

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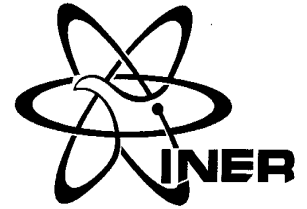
- Functional Performance Test Procedure
- EMC Qualification Test Procedure
- Environmental Qualification Test Procedure
- Seismic Qualification Test Procedure
- Equipment Qualification Test Matrix
- Development of Aging Justification
- Seismic Qualification Test Procedure-VDU

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# General Test Sequence

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1. Receiving Inspection (Burn-in)
2. Baseline
3. Environmental (Aging Test ,Radiation)
4. Functional Test
5. Seismic Test: 5 OBE test & 1 SSE test  
(IEEE Standard 344)
6. Design Basis Event Test
7. Post Test Functional Inspection



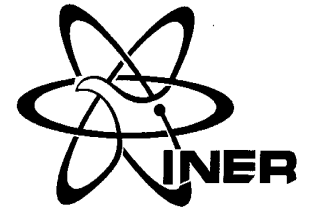
# EMC Test Reference

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- GE Documents
  - EQ, Standard Equipment Requirements.
  - EMC Qualification Test Criteria.
  - Safety Related Control Panels, Standard Equipment Requirements
- EPRI-TR-102323 R1, Guidelines for Electromagnetic Interference Testing In Power Plant.
- IEEE-C37.90.2-1995, IEEE-100-1988, IEEE-380-1972/83
- U.S. MILITARY
  - MIL-STD-461D-1993, MIL-STD-462D-1993
- REGULATION AND REGULATORY GUIDANCE
  - NUREG/CR-6431, NUREG/CR-5941, RG 1.180
- IEC 801-2, IEC 801-4, IEC 801-5

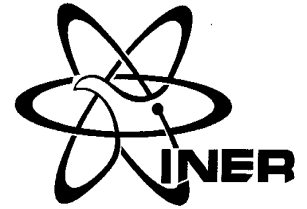


# EMC Testing by GE Specification

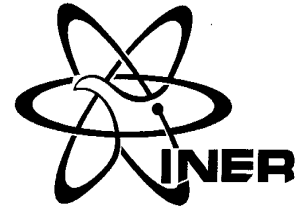


Section	EMC	Test	Test Levels Requirements	GE Table
8.1	Fast Transient/Burst	IEC 801-4	Severity Level X: +/- 3 kV for all lines (recommends modified wave shape)	1
8.2	Surge Immunity	IEC 801-5	Severity Level X: +/- 3 kV for all lines (recommends modified wave shape)	1
8.3	Radiated Susceptibility, Electric Field	RS-103	10 V/m (10 kHz to 1 GHz)	1
8.4	Radiated Emissions, Electric Field	RE-102	80 dBuV/m (10 kHz to 1MHz) to 60 dBuV/m (1GHz)	2
8.5	Conducted Susceptibility, Electric Fields, Power Leads	CS-101	Requirements are: 136 dBuV (30 Hz to 50 kHz)	1
8.6	Conducted Susceptibility, Electric Fields, Bulk Cables	CS-114	103 dBuA (50 kHz to 400MHz)	1
8.7	Conducted Emissions, Power Leads	CE-102	112 dBuV (50 kHz) to 94 dBuV (100kHz) to 74 dBuV (10 – 400 MHz)	2

# EMC Testing Imposed by DRS itself

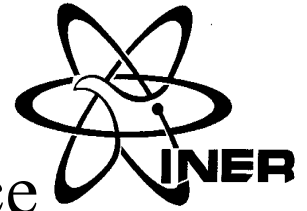


<b>Section</b>	<b>EMC</b>	<b>Test</b>	<b>Test Levels Requirements</b>
9.1	Conducted Susceptibility Damped Sinusoidal Transients	CS-116	Cables and Power Leads: 10 kHz to 100 MHz
9.2	Conducted Susceptibility, Bulk Cable Injection Impulse	CS-115	Power Leads and Signal Leads to pass MIL-STD-461D of 5 Amps into 50 ohm load for duration of 30 nanosecond
9.3	Radiated Immunity, Horizontal and Vertically Polarized Fields	ANSI / IEEE C37.90.2	Un-modulated waveform with an electric strength of 35 from 25 MHz to 1 GHz, and keying specification of 27, 120, and 450 MHz at 10 V/m



# Environmental Qualification Reference

- GE Documents
  - EQ, Standard Equipment Requirements.
  - Safety Related Control Panels, Standard Equipment Requirements
- EPRI Report NP-2129 Project 1707-3, "Radiation Effects on Organic Materials in Nuclear Power Plants".
- IEEE-100-1988, IEEE-101-1987, IEEE-323-1974/83 ,IEEE-380-1972/83 ,IEEE-381-1977, IEEE-384-1981, IEEE-420-1982, IEEE-603-1991, IEEE-1050-1989
- REGULATION AND REGULATORY GUIDANCE
  - R.G. 1.89 Environmental Qualification Of Electrical Equipment Important to Safety for Nuclear Power Plant
  - 10CFR 50.49, "Environmental Qualification Of Electrical Equipment Important to Safety for Nuclear Power Plant" of 10CFR 50

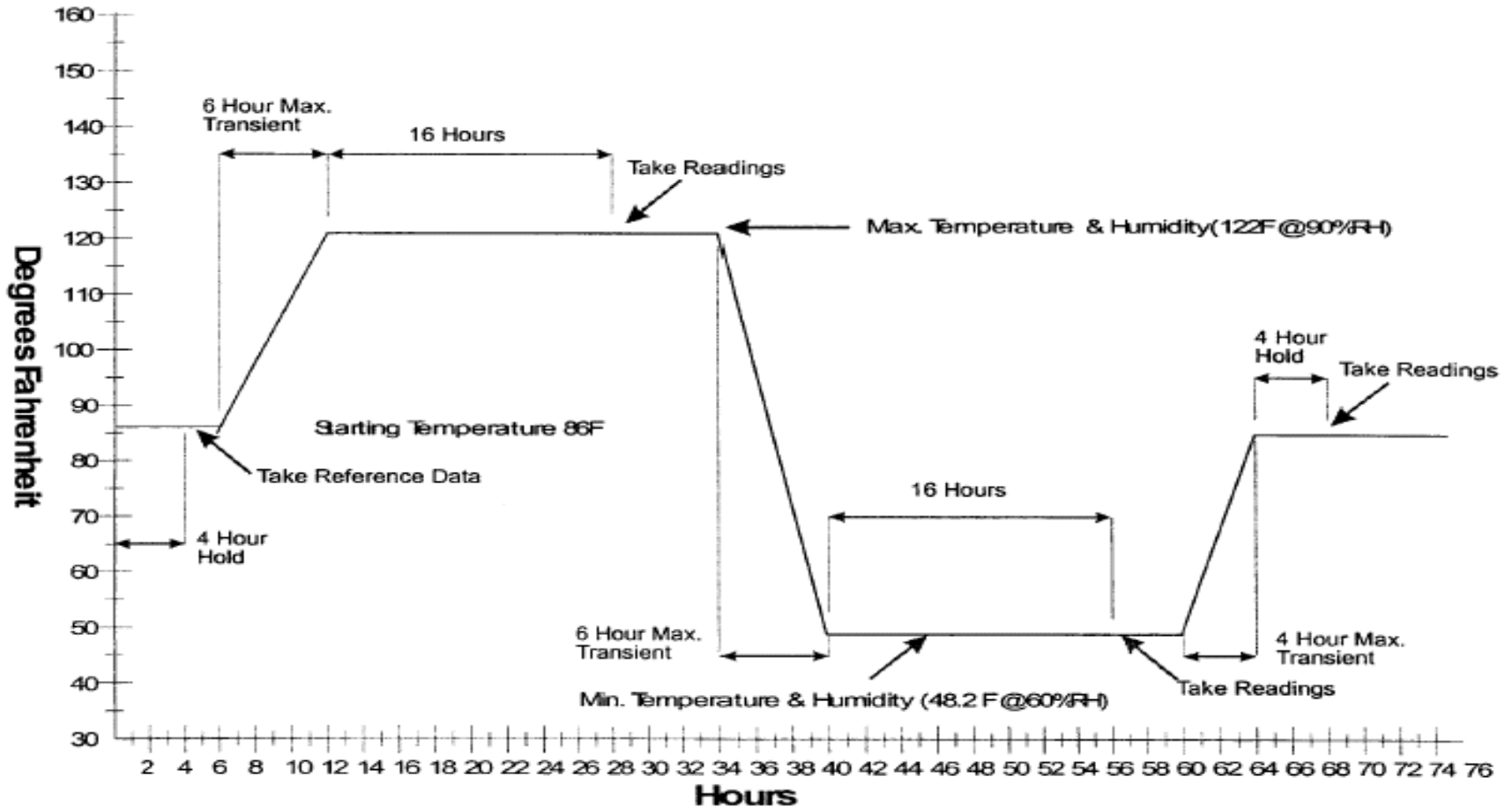
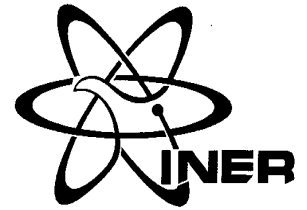


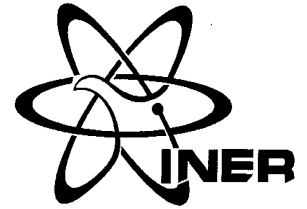
## Environmental Qualification Test Sequence

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1. Receiving inspection
2. Install inside a large test chamber
3. Wiring
4. Function test
5. Install a minimum of 20 thermocouples to the unit under test
6. Program the Test Chamber at the beginning of this 76 hour environmental qualification program in accordance with figure shown below
7. Post test functional inspection

# Environmental Qualification Profile





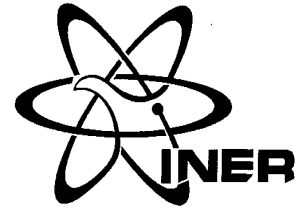
# Seismic Qualification Reference

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  - Safety Related Control Panels, Standard Equipment Requirements
- EPRI Report NP-2129 Project 1707-3, "Radiation Effects on Organic Materials in Nuclear Power Plants".
- IEEE-100-1988, IEEE-101-1987, IEEE-323-1974/83 , **IEEE-344-1987**, IEEE-380-1972/83 ,IEEE-381-1977, IEEE-420-1982, IEEE-500-1984, IEEE-603-1991,
- REGULATION AND REGULATORY GUIDANCE
  - R.G. 1.29 Seismic Design Classification
  - R.G. 1.29 to Safety for Nuclear Power Plant
  - 10CFR 50.49, "Environmental Qualification Of Electrical Equipment Important to Safety for Nuclear Power Plant" of 10CFR 50



# Seismic Qualification Test Sequence

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1. Receiving Inspection
2. Install on a shake Table
3. Wiring
4. Function Test
5. Seismic Test: 5 OBE test & 1 SSE test  
(IEEE Standard 344)
6. Post Test Functional Inspection