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LOFT TECHNICAL REPORT LTR 1310-22
JUNE 7, 1978

MASTER

ELECTRICAL, INSTRUMENTATION AND CONTROL
CODES AND STANDARDS

A. N. Kranning

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

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LOFT PROGRAM**
MASTER

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ABSTRACT		

During recent years numerous documents in the form of codes and standards have been developed and published to provide design, fabrication and construction rules and criteria applicable to instrumentation, control and power distribution facilities for nuclear power plants.

The contents of this LTR were prepared by NUS Corporation under Subcontract K5108 and provide a consolidated index and listing of the documents selected for their application to procurement of materials and design of modifications and new construction at the LOFT facility. These codes and standards should be applied together with the National Electrical Code, the ID Engineering Standards and LOFT Specifications to all LOFT instrument and electrical design activities.

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SUBJECT	ANSI STANDARDS	IEEE STANDARDS	NRC REG. GUIDES	RDT STANDARDS
<u>BATTERIES</u>				
Maintenance, Testing, and Replacement of Large Stationary Type Lead Storage Batteries	N41.15 (1976)	450 (1975)	1.89, 1.129	
Installation Design and Installation of Large Lead Storage Batteries	N41.24 (1976)	484 (1975)	1.89, 1.128	
<u>CABLES</u>				
Class 1E Electric Cables, Field Splices and Connections	N41.10 (1975)	383 (1974)	1.131	
High Temperature Cable for Nuclear Detectors				F3-39T (8-71)
Foil Shielded Instrumentation Cable				C17-9T (6-74)
Stranded Hookup Wire	C7. Series			
Design and Installation of Cable Systems in Power Generating Stations	*	422 (1977)		
Classifying Electrical Insulating Materials Exposed to Neutron and Gamma Radiation	*	278 (1967)		
* No equivalent IEEE or ANSI Standard to date.				

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<u>CIRCUIT BREAKERS</u>				
Low-Voltage AC Power Circuit Breakers	C37.13 (1973)	20 (1973)	1.89	
Low-Voltage AC Power Circuit Protectors	C37.29 (1974)	508 (1974)	1.89	
Trip Devices for AC and General-Purpose DC Low Voltage Power Circuit Breakers	C37.17 (1972)	*	1.89	
<u>CONNECTORS</u>				
Thermocouple Connectors & Thermocouple Connector Panels				C7-15T (1-72)
High Temperature Electrical Connectors and Hermetic Seals				C17-1T (3-70)
Signal Connectors for Nuclear Instruments	N3.3 (1968) Reaffirmed as N544 (1973)	*		
High Voltage Connectors for Nuclear Instruments	N42.4 (1971)	*		
Class 1E Electric Cables, Field Splices and Connections	N41.10 (1975)	383 (1974)	1.131	
* No equivalent IEEE Standard to date.				

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Power Supply Cord Sets, Wire Connectors, Soldering Lugs, and Fuses	C33. Series	*		
Precision Coaxial Connectors	C16.43 (1972)	287 (1968)		
<u>CONSTRUCTION</u>				
General OSHA 19-10 & 19-26				
Rigging				
Design and Installation of Cable Systems in Power Generating Station	*	422 (1977)		F8-6T
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations	N45.2.4(1972)	336 (1971)		
Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants during the Construction Phase	N45.2.2(1972)	*		
Protective Coatings (Paints) for Nuclear Industry	N512 (1974)	*		
* No equivalent IEEE or ANSI Standard to date.				

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<u>DOCUMENTS</u>				
Operation and Maintenance Manuals				F4-20T (10-71)
Identification of Documents Related to Class 1E Equipment and Systems for Nuclear Power Generating Power Generating Stations	N41.28 (1976)	494 (1974)		
Preparation of System Design Descriptions				F1-2T (3-72)
<u>ELECTROMAGNETIC INTERFERENCE PROTECTION</u>				
Foil Shielded Instrumentation Cable				C17-9T (6-74)
Instrumentation and Control Equipment Grounding and Shielding Practices				C1-1T (1-73)
Recommended Practice for Measurement of Shielding Effectiveness of High-Performance Enclosures	*	299 (1969)		
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<u>FIRE PROTECTION</u>				
Fire Protection Guidelines for Nuclear Power Plants	N18.10 (1976)	*	1.120	
Installation of Oil Burning Equipment NFPA-31	Draft			
<u>GENERATORS</u>				
Diesel-Generator Units Applied as Standby Power Supplies	N41.13 (Draft)	387 (1972)	1.6, 1.9, 1.89, 1.108	
Emergency and Standby Power Systems	*	446 (1974)	1.61, 1.81, 1.9, 1.93	
* No equivalent IEEE or ANSI Standard to date.				

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<u>GROUNDING</u>				
Instrumentation and Control Equipment Grounding and Shielding Practices				C1-1T (1-73)
Neutral Grounding Devices	*	32 (1972)		
AC Substation Grounding	*	80 (1976)		
Measuring Ground Resistance and Potential Gradients in the Earth	*	81 (1962)		
Grounding of Industrial and Commercial Power Systems	C114.1 (1973)	142 (1972)		
<u>INDUSTRIAL CONTROL</u>				
Test Code for Industrial Control (600 Volt or Less)	*	74 (1958) (reaffirmed in 1974)		
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<u>INDUSTRIAL POWER SYSTEMS</u>				
General Requirements	C1 (1978)	*		
Electric Power Distribution	*	141 (1976)	1.41, 1.75	
Grounding of Industrial and Commercial Power Systems	C114.1 (1973)	142 (1972)		
Protection and Coordination	*	242 (1975)		
Emergency and Standby Power Systems	*	446 (1974)		
Availability of Electrical Power Sources			1.93	
<u>INSTALLATION</u>				
General OSHA 19-10 & 19-26	C1 and C2	*		F8-6T
Rigging				
Design and Installation of Cable Systems in Power Generating Stations	*	422 (1977)		
Installation Design and Installation of Large Lead Storage Batteries	N41.24 (1976)	484 (1975)	1.89, 1.128	
Installation, Inspection, and Testing Requirements for Instrumentation and Electrical Equipment during Construction of Nuclear Power Generating Stations	N45.2.4(1972)	336 (1971)	1.30	
Transducer and Transmitter Installation	N678 (Draft)	*		
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<u>MOTORS</u>				
Polyphase Induction Motors and Generators	*	112A (1964)		
Induction Motor Protection	C37.92 (1972)	288 (1969)	1.106	
Continuous-Duty Class 1E Motors	*	334 (1974)		
AC Motor Protection	C37.96 (1975)	588 (1976)	1.106	
Induction Motor Letter Symbols	*	58 (1976)		
Fire Pump Installation NFPA-20				
<u>NUCLEAR DETECTORS</u>				
Fission Type Neutron Detector Assembly				C15-5T (12-71)
Gamma Compensated Ionization Chamber Assembly (Fixed Electrical Compensation)				C15-7T (8-73)
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<u>NUCLEAR STATION EQUIPMENT</u>				
Class 1E Electric Equipment	N41.5 (1971)	323 (1974)	1.73, 1.89	E5-2T (5-72)
Continuous-Duty Class 1E Motors	N41.9 (Draft)	334 (1974)	1.40, 1.89	
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during Construction	N45.2.4 (1972)	336 (1971)	1.30	
Class 1E Electric Valve Operators	N41.6 (Draft)	382 (1972)	1.89, 1.106	
Class 1E Electric Cables, Field Splices, and Connections	N41.10 (1975)	383 (1974)	1.89, 1.131	
Diesel-Generator Units Applied as Standby Power Supplies	N41.13 (Draft)	387 (1972)	1.9, 1.89, 1.118	
1E Control Switchboards	N41.17 (Draft)	420 (1973)	1.89	
Classifying Electrical Insulating Materials Exposed to Neutron and Gamma Radiation	*	278 (1967)		
Seismic Qualification of Class 1E Equipment	N41.7 (Draft)	344 (1975)	1.89, 1.100	F9-2T (1-74)
Electric Penetration Assemblies in Containment Structures	N45.3 (1973)	317 (1976)	1.63, 1.89	P3-1T (12-71)
Physical Independence of Electric Systems			1.75	
Temperature Limits in the Rating of Electrical Equipment	*	1 (1969)		
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<u>NUCLEAR STATION EQUIPMENT (Cont.)</u>				
Measuring and Test Equipment Used in the Construction and Maintenance of Nuclear Power Generating Station	*	498 (1975)		
Nuclear Safety Criteria for the Design of Pressurized Water Reactor Plants	N18.2 (1973) N18.2a (1973)	*		
Nuclear Safety Criteria for the Design of Boiling Water Reactor Plants	N212 (1974)	*		
General Instrumentation				C17-4T(5-73)
<u>NUCLEAR POWER SYSTEMS</u>				
Class 1E Power Systems	N41.12 (1975)	308 (1974)	1.32, 1.118	
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during Construction	N45.2.4 (1972)	336 (1971)	1.30	
Diesel-Generator Units Applied as Standby Power Supplies	N41.13 (Draft)	387 (1972)	1.9, 1.89, 1.93, 1.108	
Criteria for Separation of Class 1E Equipment and Circuits	N41.14 (1974)	384 (1974)	1.75	
Design and Installation of Cable Systems in Power Generating Stations	*	422 (1977)		
Generating Station Electric Power Systems	*	505 (1976)		
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<u>NUCLEAR PROTECTION SYSTEMS</u>				
Protection System Logic				C16-2T (5-73)
PPS Buffers				C16-3T (10-71)
Protection System Comparators				C16-4T (5-73)
Design Bases for Systems that Perform Protection Functions	N18.8 (Draft)	*		
Application of the Single Failure Criterion for Nuclear Power Generating Station Protection Systems	N41.2 (1972)	379 (1972)	1.53	
Criteria for Protection Systems for Nuclear Power Generating Stations	N42.7 (1972)	279 (1971)	1.47, 1.53	
Periodic Testing of Protection Systems	N41.3 (Draft)	338 (1975)	1.22, 1.53	
Manual Initiation of Protection Actions			1.62	
Physical Independence of Electric Systems	N14.14 (Draft)	384 (1974)	1.75	
Instrument Setpoints			1.105	
Supplementary Criteria and Requirements for RDT Reactor Plant Protection Systems				C16-1T (12-69)
Protection System Logic				C16-2T (6-73)
General Instrumentation				C17-4T (5-73)
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<u>PENETRATION ASSEMBLIES</u> Electric Penetration Assemblies in Containment Structures	N45.3 (1973)	317 (1976)	1.11, 1.63	P3-1T (12-71)
<u>POWER DISTRIBUTION</u> Electric Power Distribution	*	141 (1976)	1.41, 1.75	
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<u>POWER SYSTEM RELAYING</u>				
Guide for Protective Relay Applications	C37.93 (1976)	305 (1976)		
Protection and Coordination	*	242 (1975)		
Induction Motor Protection	C37.92 (1972)	288 (1969)	1.106	
Protective Relay Applications to Power Transformers	C37.91 (1972)	273 (1967)		
Relays and Relay Systems Associated with Electric Power Apparatus	C37.90 (1971)	313 (1971)	1.89	
<u>PROCESS INSTRUMENTATION</u>				
General Instrumentation Temperature Measurement Thermocouples	C96.1 (1964)	*		C16-2T (6-73)
Differential Pressure Transmitter, Pneumatic or Electrical Output Signal				C6-2T (8-75)
Specifications for Type K Thermocouples for Nuclear Applications	N142 (1974)	*		
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<u>PROCESS INSTRUMENTATION (Cont)</u>				
Thermocouple Materials				C7 - 7T (11-74)
Thermocouple Assemblies, Magnesium-Oxide Insulated, Stainless Steel Sheathed				C7-16T (11-76)
Platinum Resistance Thermometers				C7-17T (4-75)
Thermocouple Signal Transmitter				C10-1T (11-71)
Instrument Setpoints			1.105	
Instrument Piping and Tubing	N677 (Draft)	*		
Transducer and Transmitter Installation General Instrumentation	N678 (Draft)	*		C17-4T (5-73)
<u>PROCESS RADIATION MONITORING</u>				
Effluent Radioactivity Monitoring Instrumentation	N13.10 (1974)	*		
General Instrumentation				C17-4T (5-73)
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<u>PROCUREMENT</u>				
Procurement of Items and Services for Nuclear Power Plants, QA Requirements for Control of	N45.2.13(1976)	*	1.123	
Packaging, Packing and Marking of Components for Shipment and Storage	N45.2.2(1972)	*	1.38	F7-2T (9-75) F7-3T (6-75)
<u>QUALITY ASSURANCE</u>				
Quality Assurance Program Requirements	N45.2 (1971) N45.2.11(1974)	* *	1.28	F2-2 (8-73)
Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants	N45.2.2 (1972)	*	1.38	F7-2T (9-75) F7-3T (6-75)
Requirements for Inspection of Dimensional Characteristics				F3-15T (8-73)
Quality Verification Program Requirements				F2-4T (12-74)
Acceptance Sampling Plans				F2-7T (9-75)
* No equivalent IEEE Standard to date.				

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<u>QUALITY ASSURANCE (Cont.)</u>				
Quality Assurance Requirements Control of Procurement of Items and Services for Nuclear Power Plants	N45.2.13(1976)	*	1.123	
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations	N45.2.4(1972)	336 (1971)	1.30	
Reliability Assurance				F2-9T (6-74)
* No equivalent IEEE Standard to date.				

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<u>QUALIFICATION</u>				
Qualifying 1E Equipment for Nuclear Power Generating Station	N41.5 (1971)	323 (1974)	1.29, 1.89 Accepts IEEE 323	
Type Tests of Continuous-Duty Class 1E Motors for Nuclear Power Generating Stations	*	334 (1974)	1.40, 1.89	
Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations	N41.7 (Draft)	344 (1975)	1.100	F9-2T (1-74)
Type Test of Class I Electric Valve Operators for Nuclear Power Generating Stations	N41.6 (1972)	382 (1972)	1.89, 1.106	
Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations	N41.10 (1975)	383 (1974)	1.89, 1.131	
<u>RELAYS</u>				
Relays and Relay Systems Associated with Electric Power Apparatus	C37.90 (1971)	313 (1971)	1.89	
* No equivalent ANSI Standard to date.				

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<u>RELIABILITY</u>				
Reliability Analysis of Nuclear Protection Systems	N41.4 (1976)	352 (1975)		
Application of the Single-Failure Criterion to Nuclear Protection Systems	N41.2 (Draft)	379 (1972)	1.53	
Requirements for Reliability Analysis in Design and Operation of Safety Systems Reliability Assurance	*	577 (1976)		F2-9T (6-74)
<u>SAFETY</u>				
National Electrical Safety Code	C2 (1977)	*		
Safety in AC Substation Grounding	*	80 (1976)		
<u>SEISMIC</u>				
Seismic Qualification of Class 1E Equipment	N41.7 (Draft)	344 (1975)	1.29, 1.89 1.100	F9-2T (1-74)
Instrumentation for Earthquakes	N18.5 (1974)	*	1.12	
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<u>SIGNAL CONDITIONING</u>				
Preamplifier/Discriminator				C10-3T (12-75)
Protection System Logic				C16-2T (5-73)
PPS Buffers				C16-3T (10-71)
Protection System Comparator				C16-4T (5-73)
Wide-Range (10 Decade) Neutron Flux Monitoring Channel				C15-2T (2-71)
Logarithmic Mean Square (MSV) System (Intermediate Range)				C15-6T (7-71)
Direct Current Power Range Neutron Flux Monitoring System				C15-8T (7-71)
Current Pulse Preamplifiers for Use with Fission Counters				C15-3T (10-74)
<u>SPLICING</u>				
Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations	N41.10 (1975)	383 (1974)	1.89, 1.131	
Power Cable Joints	*	404 (1976)		
* No equivalent ANSI Standard to date.				

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<u>SYMBOLS</u>				
Graphic Symbols for Logic Diagrams (Two-State Devices)	Y32.14 (1973)	91 (1973)		
Reference Designations for Electrical and Electronic Parts and Equipments	Y32.16 (1975)	200 (1975)		
Letter Symbols for Semiconductor Devices	*	255 (1963)		
Standard for Metric Practice	*	268 (1976)		
Graphic Symbols for Electrical and Electronics Diagrams	Y32.2 (1975)	315 (1975)		
<u>SURGE PROTECTION (LIGHTNING)</u>				
Surge Arresters for AC Power Circuits	C62.1 (1975)	28 (1974)		
Neutral Grounding Devices	*	32 (1972)		
* No equivalent ANSI Standard to date.				

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<u>SWITCHGEAR</u>				
Low-Voltage AC Power Circuit Breakers used in Enclosures	C37.13 (1973)	20 (1973)	1.89	P2-5T (10-75)
Switchgear Assemblies including Metal-Enclosed Bus	C37.20 (1969)	27 (1974)	1.89	
Automatic Circuit Reclosures for Alternating Current Systems	C37.60 (1974)	437 (1974)	1.89	
Low-Voltage AC Power Circuit Protectors used in Enclosures	C37.29 (1974)	508 (1974)	1.89	
<u>TERMS</u>				
Dictionary of Electrical and Electronic Terms	C42.100 (1972)	100 (1972)		
Definition of Semiconductor Terms	*	216 (1960)		
Definition of Terms for Solid State Devices - Thermoelectric Devices	*	221 (1962)		
Definition of Terms for Integrated Circuits	*	274 (1966)		
Definition of Terms Used in IEEE Nuclear Power Generating Stations Standards	*	380 (1975)		
* No equivalent ANSI Standard to date.				

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Definitions for Power Switchgear	C37.100 (1972)	*		
<u>TESTING</u>				
Periodic Testing of Electric Power and Protection Systems	N41.3 (Draft)	338 (1975)	1.22, 1.118	
Calibration Program Requirements				F3-2T (2-73)
Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations	N45.2.4(1972)	336 (1971)	1.30	
Test Code for Industrial Control (600 Volt or Less)	*	74 (1958) (reaffirmed in 1974)		
Maintenance, Testing, and Replacement of Large Stationary Type Lead Storage Batteries	N41.15 (1976)	450 (1975)	1.89, 1.129	
Also see "Qualification" section, page 18.				
* No equivalent IEEE or ANSI Standard to date.				

ELECTRICAL,
INSTRUMENTATION AND CONTROL
CODES AND STANDARDS

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SUBJECT	ANSI STANDARDS	IEEE STANDARDS	NRC REG. GUIDES	RDT STANDARDS
<u>TRANSFORMERS</u>				
General Requirements for Distribution, Power, and Regulating Transformers	C57.12.00 (1973)	462 (1973)	1.89	
Protective Relay Application to Power Transformers	C37.91 (1972)	273 (1967)	1.89	
Distribution, Power, Regulating Transformers and Shunt Reactors	C57.12.90 (1973)	262 (1973) 262A (1974)	1.89	
Electronics Power Transformers	*	295 (1969)		
* No equivalent ANSI Standard to date.				