FAILURE DATA HANDBOOK -FOR NUCLEAR POWER FACILITIES-

A Guide for the Design, Construction, and Maintenance
of Nuclear Power Plants
from a Reliability Improvement Standpoint

VOLUME II FAILURE CATEGORY IDENTIFICATION AND GLOSSARY

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Liquid Metal Engineering Center

Operated for

the U.S. Atomic Energy Commission by *Atomics International*

A Division of North American Rockwell Corporation

Contract: AT(04-3)-700

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B Steele
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FOREWORD

Under the sponsorship of the AEC Division of Reactor Development Technology, a category identification and sorting codes system has been developed within the ground rule that they shall be compatible with equipment and events for any of its reactor types or component testing facilities. A system evolved for standardizing identification of each bit of data with respect to: source, system, particular components or parts, design characteristics, environment, failure cause, mode, and effect; and failure detection method.

Category tables for digital recording and sorting, and for tabular publication of failure data, are displayed in Part I. Categories, as selected, are intended to be applicable to failure classification of all systems and components. Considerable expansion of the proposed classification systems will probably be required to accommodate future activities of each program.

A one-card digital Engineering Accounting Machine (EAM) card format (presented on the following page) is used for setting up equipment for the MIRACODE microfilm storage and retrieval, and digital computer program.

Part II is a glossary of engineering terms whose definitions are based on commonly accepted usage.

EAM CARD FORMAT

1.		41.	Safety or Programmatic Significance
2.	Report Number	42.	
3.		43.	
4.	Type of Report	44.	
5.		45.	Facility Identification
6.	Month and Day	46.	
7.		47.	
8.		48.	
9.	Year	49.	
10.		50.	ID No. of the Subsystem/Component
11.		51.	
12.		52.	
13.	System/Subsystem	53.	
14.		54.	Number of Previous Failures of
15.		55.	This Component
16.		56.	Quantity of Identical Components
17.		57.	at Facility
18.		58.	
19.		59.	Vendor
20.		60.	
21.	Component/Part Identification	61.	Time Since Last Inspection or
22.	Environmental Classification	62.	Maintenance - Days
23.	xxx xxx xxx xxx	63.	
24.		64.	Total Operating Time on
25.		65.	Component/Part - Days
26.		66.	
27.		67.	
28.		68.	Component Repair - Man Days
29.		69.	
30.	Cause of Failure	70.	
31.		71.	Repair Time - Days
32.	Mode of Failure	72.	
33.		73.	Additional Time Generator or
34.		74.	Rig is Off - Days
35.	Effect of Failure	75.	Facility Operation Condition
36.		76.	Temperature Peak (Local)
37.	Method of Failure Detection	77.	Power Peak
38.	Corrective Action - Performed	78.	Method of Shutdown
39.	Corrective Action -	79.	Card Identification
	Recommended for Future	80.	
40.	Sequence Order of Failure if a		
	Cascading Series (i. e., 1st,		
	2nd, 3rd, etc.) in same event		

PART 1
SYSTEM/COMPONENT AND FAILURE CATEGORY IDENTIFICATION

I. TYPE OF REPORT

A. DESCRIPTION

Unusual or unplanned occurrences (those significantly affecting planned program cost or schedule) are reported as incidents, investigated, and assessed by LMEC management and technical personnel to minimize or prevent "repeated losses" from such occurrences. Concern is also given to the more numerous noncritical malfunctions and problems which are frequent sources of plant (or system) outages, or which result in downgraded performance.

An Incident is defined as any unusual or unplanned occurrence affecting or potentially affecting (a near miss) the performance, reliability, or safety of a reactor or test facility, which may be classed as having programmatic significance with respect to schedule delay, cost of corrective action, or as having personnel safety significance.

Malfunctions are defined as normal failures or degradations occurring during plant operation for which a corrective-action procedure has been prepared or planned but which occurrences do not fall either under the category of routine scheduled maintenance or the definition of an incident. Malfunctions are separated into two classes:

- 1) Major Malfunction – An occurrence which under more severe (but normal) environmental or operational level conditions, or different scheduling conditions, would have been classed as an incident (i. e., occurring at low-power operation or discovered during scheduled maintenance or routine tests but having no present safety or programmatic significance).
- 2) Minor Malfunction – An occurrence which under expected operating conditions would have no safety or programmatic significance.

Problems include operational defects or nonconsistent performances which adversely affect operation or maintenance, but which the operator or maintenance personnel should make the design engineers aware of so that improvements will be made in future facilities, modifications, or existing procedures.

B. CLASSIFICATION CODE (Column 4)

	<u>4</u>
Incident (contruction/fabrication/modification)	1
Incident (transport)	2
Incident (operation)	3
Malfunction (major)	4
Malfunction (minor)	5
Problem	6
Maintenance (routine)	7
Maintenance (associated with Incident, Malfunction, and Problem Report)	8

II. SYSTEM/SUBSYSTEM

A. DESCRIPTION

In an effort to avoid duplication of AEC facilities system category classification for failure reporting and analysis, Holmes and Narver, Phillips Petroleum, and LMEC agreed to adapt, with modification to improve logic sorting and compatibility with the components codes, the AEC Classification of Construction Accounts as summarized in TID-7025 (Volume 1) and TID-7025 (Supplement 1). The AEC classification was derived from the Federal Power Commission's Uniform System of Accounts, which applies to government records on all types of power generation and transmission facilities. In adapting the AEC code, the first digit of the AEC code (the number 2) has been dropped, since this digit indicates a nuclear power plant which is the only type of facility considered in this classification of equipment. The remaining digits provide a classification code based on functional systems found in all types of nuclear power plants. As many as six digits may be used to identify a system. As shown, the first digit in the system code identifies a major functional group. Additional digits provide functional classifications within each major functional group. The system is arranged to provide the possibility of computer sorting to the subsystem depth of interest or only to the major functioning system group, if desired. A basic problem with this classification system is the attempt to numerically separate instrumentation and control systems from the related system category. The separation is workable even though awkward.

This category, as well as several of the auxiliary systems, is far from being completely developed in this issue. Much development will occur as the need arises.

1 - STRUCTURES & IMPROVEMENTS

2 - REACTOR PLANT/TEST FACILITY

3 - TURBINE-GENERATOR UNITS & CONDENSER

4 - ACCESSORY ELECTRICAL EQUIPMENT

5 - MISCELLANEOUS EQUIPMENT

SYSTEM/SUBSYSTEM ORGANIZATION

LMEC-Memo-69-7, Vol II

C. CLASSIFICATION CODE (Columns 11 to 16)

	11	12	13	14	15	16
<u>STRUCTURES AND IMPROVEMENTS</u>	1					
GROUND AND WATERFRONT IMPROVEMENTS	1	1				
Excavation and Backfill	1	1	1			
Bearing Piles and Retaining Walls	1	1	2			
Substructure	1	1	3			
Superstructure	1	1	4			
BACKUP SAFEGUARD SYSTEM STRUCTURE (Other Than Reactor Containment)	1	2				
Excavation and Backfill	1	2	1			
Bearing Piles and Retaining Walls	1	2	2			
Substructure	1	2	3			
Superstructure	1	2	4			
Structural supports	1	2	4	1		
Floors	1	2	4	2		
Walls	1	2	4	3		
Roof	1	2	4	4		
Emergency Cooling System	1	2	5			
Spray cooling system	1	2	5	1		
Pressure suppression system	1	2	5	2		
Ice cooling system	1	2	5	3		
Building Services	1	2	6			
Plumbing and draining system	1	2	6	1		
Plumbing	1	2	6	1	1	
Drainage	1	2	6	1	2	
Sump pump	1	2	6	1	2	1
Heating system (closed)	1	2	6	2		
Ventilation system	1	2	6	3		
Fans	1	2	6	3	1	
Inlet	1	2	6	3	1	1
Outlet	1	2	6	3	1	2
Duct work	1	2	6	3	2	
Service water	1	2	6	3	3	
Piping and valves	1	2	6	3	4	
Purge system (emergency, cleanup)	1	2	6	4		
Fans	1	2	6	4	1	
Valves	1	2	6	4	2	
Air filters and coils	1	2	6	4	3	
Duct work	1	2	6	4	4	
Scrubbers	1	2	6	4	5	
Sprinkler system	1	2	6	4	6	
Elevators	1	2	6	5		
Lighting and services	1	2	6	6		
Fire protection	1	2	6	7		

	11	12	13	14	15	16
TURBINE BUILDING	1	3				
Excavation and Backfill	1	3	1			
Bearing Piles and Retaining Walls	1	3	2			
Substructure	1	3	3			
Superstructure	1	3	4			
Structural supports	1	3	4	1		
Floors	1	3	4	2		
Walls	1	3	4	3		
Roof	1	3	4	4		
Building Services	1	3	6			
Plumbing and draining system	1	3	6	1		
Plumbing	1	3	6	1	1	
Drainage	1	3	6	1	2	
Sump pump	1	3	6	1	2	1
Heating system (closed)	1	3	6	2		
Ventilation system	1	3	6	3		
Fans	1	3	6	3	1	
Inlet	1	3	6	3	1	1
Outlet	1	3	6	3	1	2
Duct work	1	3	6	3	2	
Service water	1	3	6	3	3	
Piping and valves	1	3	6	3	4	
Purge system (emergency cleanup)	1	3	6	4		
Fans	1	3	6	4	1	
Valves	1	3	6	4	2	
Air filters and coils	1	3	6	4	3	
Duct work	1	3	6	4	4	
Scrubbers	1	3	6	4	5	
Sprinkler system	1	3	6	4	6	
Elevators	1	3	6	5		
Lighting and services	1	3	6	6		
Fire protection	1	3	6	7		
FUEL HANDLING BUILDING	1	4				
Excavation and Backfill	1	4	1			
Bearing Piles and Retaining Walls	1	4	2			
Substructure	1	4	3			
Superstructure	1	4	4			
Structural supports	1	4	4	1		
Floors	1	4	4	2		
Walls	1	4	4	3		
Roof	1	4	4	4		
Building Services	1	4	6			
Plumbing and draining system	1	4	6	1		
Plumbing	1	4	6	1	1	
Drainage	1	4	6	1	2	
Sump pump	1	4	6	1	2	1

FUEL HANDLING BUILDING (Cont)

	11	12	13	14	15	16
Heating system (closed)	1	4	6	2		
Ventilation system	1	4	6	3		
Fans	1	4	6	3	1	
Inlet	1	4	6	3	1	1
Outlet	1	4	6	3	1	2
Duct work	1	4	6	3	2	
Service water	1	4	6	3	3	
Piping and valves	1	4	6	3	4	
Purge system (emergency cleanup)	1	4	6	4		
Fans	1	4	6	4	1	
Valves	1	4	6	4	2	
Air filters and coils	1	4	6	4	3	
Duct work	1	4	6	4	4	
Scrubbers	1	4	6	4	5	
Sprinkler system	1	4	6	4	6	
Elevators	1	4	6	5		
Lighting and services	1	4	6	6		
Fire protection	1	4	6	7		

RADIOACTIVE WASTE BUILDING

	1	5				
Excavation and Backfill	1	5	1			
Bearing Piles and Retaining Walls	1	5	2			
Substructure	1	5	3			
Superstructure	1	5	4			
Structural supports	1	5	4	1		
Floors	1	5	4	2		
Walls	1	5	4	3		
Roof	1	5	4	4		
Building Services	1	5	6			
Plumbing and draining system	1	5	6	1		
Plumbing	1	5	6	1	1	
Drainage	1	5	6	1	2	
Sump pump	1	5	6	1	2	1
Heating system (closed)	1	5	6	2		
Ventilation system	1	5	6	3		
Fans	1	5	6	3	1	
Inlet	1	5	6	3	1	1
Outlet	1	5	6	3	1	2
Duct work	1	5	6	3	2	
Service water	1	5	6	3	3	
Piping and valves	1	5	6	3	4	
Purge system (emergency cleanup)	1	5	6	4		
Fans	1	5	6	4	1	
Valves	1	5	6	4	2	
Air filters and coils	1	5	6	4	3	
Duct work	1	5	6	4	4	
Scrubbers	1	5	6	4	5	
Sprinkler system	1	5	6	4	6	

	11	12	13	14	15	16
RADIOACTIVE WASTE BUILDING (Cont)						
Elevators	1	5	6	5		
Lighting and services	1	5	6	6		
Fire protection	1	5	6	7		
TEST FACILITY BUILDING						
Excavation and Backfill	1	6	1			
Bearing Piles and Retaining Walls	1	6	2			
Substructure	1	6	3			
Superstructure	1	6	4			
Structural supports	1	6	4	1		
Floors	1	6	4	2		
Walls	1	6	4	3		
Roof	1	6	4	4		
Building Services	1	6	6			
Plumbing and draining system	1	6	6	1		
Plumbing	1	6	6	1	1	
Draining	1	6	6	1	2	
Sump pump	1	6	6	1	2	1
Heating system (closed)	1	6	6	2		
Ventilation system	1	6	6	3		
Fans	1	6	6	3	1	
Inlet	1	6	6	3	1	1
Outlet	1	6	6	3	1	2
Duct work	1	6	6	3	2	
Service water	1	6	6	3	3	
Piping and valves	1	6	6	3	4	
Purge system (emergency cleanup)	1	6	6	4		
Fans	1	6	6	4	1	
Valves	1	6	6	4	2	
Air filters and coils	1	6	6	4	3	
Duct work	1	6	6	4	4	
Scrubbers	1	6	6	4	5	
Sprinkler system	1	6	6	4	6	
Elevators	1	6	6	5		
Lighting and services	1	6	6	6		
Fire protection	1	6	6	7		
CONTROL BUILDING						
Excavation and Backfill	1	7	1			
Bearing Piles and Retaining Walls	1	7	2			
Substructure	1	7	3			
Superstructure	1	7	4			
Structural supports	1	7	4	1		
Floors	1	7	4	2		
Walls	1	7	4	3		
Roof	1	7	4	4		

CONTROL BUILDING (Cont)

	11	12	13	14	15	16
Building Services	1	7	6			
Plumbing and draining system	1	7	6	1		
Plumbing	1	7	6	1	1	
Drainage	1	7	6	1	2	
Sump pump	1	7	6	1	2	1
Heating system (closed)	1	7	6	2		
Ventilation system	1	7	6	3		
Fans	1	7	6	3	1	
Inlet	1	7	6	3	1	1
Outlet	1	7	6	3	1	2
Duct work	1	7	6	3	2	
Service water	1	7	6	3	3	
Piping and valves	1	7	6	3	4	
Purge system (emergency cleanup)	1	7	6	4		
Fans	1	7	6	4	1	
Valves	1	7	6	4	2	
Air filters and coils	1	7	6	4	3	
Duct work	1	7	6	4	4	
Scrubbers	1	7	6	4	5	
Sprinkler system	1	7	6	4	6	
Elevators	1	7	6	5		
Lighting and services	1	7	6	6		
Fire protection	1	7	6	7		

STACKS

	1	8				
Excavation and Backfill	1	8	1			
Bearing and Retaining Walls	1	8	2			
Substructure	1	8	3			
Superstructure	1	8	4			
Structural supports	1	8	4	1		
Floors	1	8	4	2		
Walls	1	8	4	3		
Roof	1	8	4	4		
Building Services	1	8	6			
Plumbing and draining system	1	8	6	1		
Plumbing	1	8	6	1	1	
Draining	1	8	6	1	2	
Sump pump	1	8	6	1	2	1
Heating system (closed)	1	8	6	2		
Ventilation system	1	8	6	3		
Fans	1	8	6	3	1	
Inlet	1	8	6	3	1	1
Outlet	1	8	6	3	1	2
Duct work	1	8	6	3	2	
Service water	1	8	6	3	3	
Piping and valves	1	8	6	3	4	
Purge system (emergency cleanup)	1	8	6	4		

	11	12	13	14	15	16
STACKS (Cont)						
Fans	1	8	6	4	1	
Valves	1	8	6	4	2	
Air filters and coils	1	8	6	4	3	
Duct work	1	8	6	4	4	
Scrubbers	1	8	6	4	5	
Sprinkler systems	1	8	6	4	6	
Elevators	1	8	6	5		
Lighting and services	1	8	6	6		
Fire protection	1	8	6	7		
REACTOR CONTAINMENT STRUCTURE AND BUILDING						
	1	9				
Excavation and Backfill	1	9	1			
Bearing Piles and Retaining Walls	1	9	2			
Substructure	1	9	3			
Vaults and galleries	1	9	3	1		
Seals	1	9	3	1	1	
Access parts or plugs	1	9	3	1	2	
Ventilation and cooling systems	1	9	3	1	3	
Air	1	9	3	1	3	1
CO ₂	1	9	3	1	3	2
Helium	1	9	3	1	3	3
Nitrogen	1	9	3	1	3	4
Superstructure	1	9	4			
Structural supports	1	9	4	1		
Containment shell	1	9	4	2		
Shell	1	9	4	2	1	
Inner lining	1	9	4	2	1	1
Primary shell, concrete	1	9	4	2	1	2
Primary shell, steel	1	9	4	2	1	3
Stairs and walkways	1	9	4	2	1	4
Air lock	1	9	4	2	2	
Process penetrations	1	9	4	2	3	
Electrical power	1	9	4	2	3	1
Signal cable	1	9	4	2	3	2
Pneumatic	1	9	4	2	3	3
Piping - Heat transfer coolant	1	9	4	2	3	4
Inert gas piping	1	9	4	2	3	5
Other service piping	1	9	4	2	3	6
Emergency Cooling System	1	9	5			
Spray cooling system	1	9	5	1		
Pressure suppression system	1	9	5	2		
Ice cooling system	1	9	5	3		
Building Services	1	9	6			
Plumbing and draining systems	1	9	6	1		
Plumbing	1	9	6	1	1	
Drainage	1	9	6	1	2	
Sump pump	1	9	6	1	2	1

REACTOR CONTAINMENT STRUCTURE
AND BUILDING (Cont)

	11	12	13	14	15	16
Heating system (closed)	1	9	6	2		
Ventilation system	1	9	6	3		
Fans	1	9	6	3	1	
Inlet	1	9	6	3	1	1
Outlet	1	9	6	3	1	2
Duct work	1	9	6	3	2	
Service water	1	9	6	3	3	
Piping and valves	1	9	6	3	4	
Purge system (emergency cleanup)	1	9	6	4		
Fans	1	9	6	4	1	
Valves	1	9	6	4	2	
Air filters and coils	1	9	6	4	3	
Duct work	1	9	6	4	4	
Scrubbers	1	9	6	4	5	
Sprinkler system	1	9	6	4	6	
Elevators	1	9	6	5		
Lighting and services	1	9	6	6		
Fire protection	1	9	6	7		

REACTOR PLANT/TEST FACILITY

REACTOR EQUIPMENT

	2	1				
Reactor Vessel	2	1	1			
Reactivity Control and Safety Shutdown	2	1	2			
Control and safety element	2	1	2	1		
Motors or engines	2	1	2	2		
Electrical	2	1	2	2	1	
Hydraulic, pneumatic, and steam	2	1	2	2	2	
Transmission and drive shafts	2	1	2	3		
Neutron source	2	1	2	4		
Reactor Shielding	2	1	3			
Reactor Auxiliary Cooling and Heating Systems	2	1	4			
Steam and feedwater emergency shutdown cooling system	2	1	4	1		
Turbine steam bypass	2	1	4	1	1	
Emergency condenser system	2	1	4	1	2	
Emergency fresh water system	2	1	4	1	3	
Steam dump system	2	1	4	1	4	
Decay heat removal	2	1	4	2		
Primary system	2	1	4	2	1	
Secondary system	2	1	4	2	2	
Tertiary	2	1	4	2	3	
Preheating systems	2	1	4	3		
Hot water	2	1	4	3	1	
Steam tracing	2	1	4	3	2	

	11	12	13	14	15	16
REACTOR EQUIPMENT (Cont)						
Gas	2	1	4	3	3	
Electrical	2	1	4	3	4	
Emergency core cooling system	2	1	4	4		
Safety injection system	2	1	4	4	1	
Core spray system	2	1	4	4	2	
Emergency condenser system	2	1	4	4	3	
High pressure coolant injection	2	1	4	4	4	
Low pressure coolant injection	2	1	4	4	5	
Pressure suppression system	2	1	4	5		
Core Components and Supports	2	1	6			
Moderator	2	1	6	1		
Reflector	2	1	6	2		
Fuel element	2	1	6	3		
Vessel internals, removable (excluding fuel, moderator, reflector, and control components)	2	1	6	4		
Reactor Plant Cranes (not fuel handling)	2	1	7			
Cranes (bridge)	2	1	7	1		
Bridge	2	1	7	1	1	
Drive motor	2	1	7	1	1	1
Transmission	2	1	7	1	1	2
Structure	2	1	7	1	1	3
Trolley	2	1	7	1	2	
Drive motor	2	1	7	1	2	1
Transmission	2	1	7	1	2	2
Structure	2	1	7	1	2	3
Hoist	2	1	7	1	3	
Drive motor	2	1	7	1	3	1
Transmission	2	1	7	1	3	2
Hoisting unit	2	1	7	1	3	3
HEAT TRANSFER SYSTEM						
Reactor Coolant System	2	2	1			
Pump, transmission, and motors	2	2	1	1		
Pump and supports	2	2	1	1	1	
Motors or engines	2	2	1	1	2	
Electrical	2	2	1	1	2	1
Internal combustion	2	2	1	1	2	2
Hydraulic, pneumatic, and steam	2	2	1	1	2	3
Pony motors or engines	2	2	1	1	3	
Electrical	2	2	1	1	3	1
Internal combustion	2	2	1	1	3	2
Hydraulic, pneumatic, and steam	2	2	1	1	3	3
Transmission and drive shafts	2	2	1	1	4	
Coolant piping and valves	2	2	1	2		
Piping	2	2	1	2	1	

HEAT TRANSFER SYSTEM (Cont)

	11	12	13	14	15	16
Hot leg	2	2	1	2	1	1
Cold leg	2	2	1	2	1	2
Test section	2	2	1	2	1	3
Valves	2	2	1	2	2	
Valve operators	2	2	1	2	3	
Rupture discs	2	2	1	2	4	
Steam drums and/or external steam separators	2	2	1	3		
Intermediate Cooling System	2	2	2			
Pump, transmission, and motors	2	2	2	1		
Pump and supports	2	2	2	1	1	
Motors and engines	2	2	2	1	2	
Electrical	2	2	2	1	2	1
Internal combustion	2	2	2	1	2	2
Hydraulic, pneumatic, and steam	2	2	2	1	2	3
Pony motors and engines	2	2	2	1	3	
Electric	2	2	2	1	3	1
Internal combustion	2	2	2	1	3	2
Hydraulic, pneumatic, and steam	2	2	2	1	3	3
Transmission and drive shafts	2	2	2	1	4	
Coolant piping and valves	2	2	2	2		
Piping	2	2	2	2	1	
Hot leg	2	2	2	2	1	1
Cold leg	2	2	2	2	1	2
Test section	2	2	2	2	1	3
Valves	2	2	2	2	2	
Valve operators	2	2	2	2	3	
Rupture discs	2	2	2	2	4	
Intermediate heat exchanger and supports	2	2	2	3		
Steam Generators	2	2	3			
Steam generators, superheaters, reheaters, and supports	2	2	3	1		
Steam drums and separators	2	2	3	2		
Coolant Receiving, Makeup, and Treatment (and Intermediate, if any)	2	2	4			
Coolant charge systems	2	2	4	1		
Pressurization and relief system	2	2	4	1	1	
Purification system	2	2	4	2		
Demineralizer system	2	2	4	2	1	
Organic coolant purification system	2	2	4	2	2	
Liquid metals purification	2	2	4	2	3	
Regenerative heat exchanger (economizer)	2	2	4	2	3	1
Pumps and drives	2	2	4	2	3	2
Cold traps/hot traps, filters/strainers	2	2	4	2	3	3
Freeze traps	2	2	4	2	3	4

	11	12	13	14	15	16
HEAT TRANSFER SYSTEM (Cont)						
Plugging meter	2	2	4	2	3	5
Storage tanks	2	2	4	2	3	6
Heaters, electric	2	2	4	2	3	7
Coolers (liquid metal to air)	2	2	4	2	3	8
Piping, valves	2	2	4	2	3	9
Heavy water recovery system	2	2	4	2	4	
Gas recombiners	2	2	4	2	4	1
Chemical treatment, Blowdown, and sampling system	2	2	4	3		
Corrosion control system	2	2	4	3	1	
Sampling and blowdown system	2	2	4	3	2	
Coolant receiving, storage and makeup	2	2	4	4		
Water	2	2	4	4	1	
Organic	2	2	4	4	2	
Liquid metal	2	2	4	4	3	
Gas	2	2	4	4	4	
Coolant preheating system	2	2	4	5		
Inert gas supply and monitoring system	2	2	4	6		
Compressors	2	2	4	6	1	
Cylinder station	2	2	4	6	2	
Surge, vacuum suction, and monitoring tanks	2	2	4	6	3	
Purifiers, filters, driers and traps	2	2	4	6	4	
Cooling system	2	2	4	6	5	
Reactor Moderator Auxiliary System	2	2	5			
Gas system supply and circulation	2	2	5	1		
Cooling and purification system for gas and liquids	2	2	5	2		
Moderator cooling system	2	2	5	3		
Conventional Fossil Fuel Fired Superheaters or Boilers	2	2	7			
Superheaters	2	2	7	1		
Boilers, steam generators	2	2	7	2		
Furnace and equipment	2	2	7	3		
Coolant system	2	2	7	4		
Fuel handling and storage system	2	2	7	5		
Ash handling and storage system	2	2	7	6		
Blowdown equipment	2	2	7	7		
Waste Heat System	2	2	8			
Atmospheric boiler	2	2	8	1		
NUCLEAR FUEL HANDLING AND STORAGE EQUIPMENT						
	2	3				
Cranes and Hoisting Equipment (if special)	2	3	1			
Special Tools and Service Equipment	2	3	2			
Reactor vessel servicing equipment	2	3	2	1		

NUCLEAR FUEL HANDLING AND STORAGE
EQUIPMENT (Cont)

	11	12	13	14	15	16
Fuel assembly, disassembly equipment	2	3	2	2		
Control rod handling (if special equipment)	2	3	2	3		
Television, other viewing and special lighting	2	3	2	4		
Containers and racks	2	3	2	5		
Spent Fuel Storage, Cooling, Cleaning, and Inspection Equipment	2	3	3			
Spent fuel cooling and cleaning	2	3	3	1		
Heat exchangers	2	3	3	1	1	
Pump and drives	2	3	3	1	2	
Filters and strainers	2	3	3	1	3	
Piping	2	3	3	1	4	
Valves	2	3	3	1	5	
Spent fuel washing (sodium coolant)	2	3	3	2		
Cleanup cells	2	3	3	2	1	
Storage tanks	2	3	3	2	2	
Pumps and drives	2	3	3	2	3	
Piping and valves	2	3	3	2	4	
Shipping Casks and Cars	2	3	4			
Fuel Handling Machines (external)	2	3	5			
Liquid metal	2	3	5	1		
Primary carriage	2	3	5	1	1	
Drive motor	2	3	5	1	1	1
Transmission	2	3	5	1	1	2
Support structures	2	3	5	1	1	3
Secondary carriage	2	3	5	1	2	
Drive motor	2	3	5	1	2	1
Transmission	2	3	5	1	2	2
Support structure	2	3	5	1	2	3
Vessel	2	3	5	1	3	
Cooling system	2	3	5	1	4	
Shielding	2	3	5	1	5	
Hoist	2	3	5	1	6	
Drive motor	2	3	5	1	6	1
Transmission	2	3	5	1	6	2
Hoisting unit	2	3	5	1	6	3
Non liquid metal	2	3	5	2		
Fuel Handling Equipment	2	3	6			
Liquid metal internal	2	3	6	1		
Other internal	2	3	6	2		
NUCLEAR FUEL PROCESSING AND FABRICATION EQUIPMENT	2	4				

RADIOACTIVE WASTE TREATMENT AND DISPOSAL

	11	12	13	14	15	16
	2	5				
Liquid Waste	2	5	1			
Acqueous	2	5	1	1		
Tanks and vessels	2	5	1	1	1	
Ion exchangers	2	5	1	1	2	
Filters and separators	2	5	1	1	3	
Condensers and evaporators	2	5	1	1	4	
Heat exchangers and/or heaters	2	5	1	1	5	
Pumps	2	5	1	1	6	
Piping and valves	2	5	1	1	7	
Gaseous Waste	2	5	2			
Tanks and vessels	2	5	2	1		
Exchange towers	2	5	2	2		
Absorbers	2	5	5	2	1	
Scrubbers	2	5	5	2	2	
Filters and separators	2	5	2	3		
Gas coolers/heat exchangers	2	5	2	4		
Compressors, fans, and drives	2	5	2	5		
Pumps, blowers, and drives	2	5	2	6		
Recombiners	2	5	2	7		
Holdup ducts	2	5	2	8		
Piping and valves	2	5	2	9		
Solid Wastes	2	5	3			
Drain and Vent Systems	2	5	4			
Reactor coolant	2	5	4	1		
Tanks and vessels	2	5	4	1	1	
Filters and separators	2	5	4	1	2	
Pumps	2	5	4	1	3	
Heaters	2	5	4	1	4	
Piping and valves	2	5	4	1	5	
Secondary coolant	2	5	4	2		
Tanks and vessels	2	5	4	2	1	
Filters and separators	2	5	4	2	2	
Pumps	2	5	4	2	3	
Heaters	2	5	4	2	4	
Piping and valves	2	5	4	2	5	
INSTRUMENTATION AND CONTROL	2	6				
Reactor Plant Control System	2	6	1			
Reactor	2	6	1	1		
Neutron monitor system	2	6	1	1	1	
Reactor vessel instrumentation	2	6	1	1	2	
Reactor safety and protection system	2	6	1	1	3	
Fuel element failure detection system	2	6	1	1	4	
Reactor manual control system	2	6	1	1	5	
Reactor automatic control system	2	6	1	1	6	
Control rod position indicating system	2	6	1	1	7	

INSTRUMENTATION AND CONTROL (Cont)

	11	12	13	14	15	16
Regulating rod	2	6	1	1	7	1
Safety rod	2	6	1	1	7	2
Reactivity monitoring system	2	6	1	1	8	
Shield	2	6	1	2		
Temperature monitoring	2	6	1	2	1	
Cooling system	2	6	1	2	2	
Reactor auxiliary systems	2	6	1	3		
Poison injection system	2	6	1	3	1	
Safety injection system	2	6	1	3	2	
Emergency shutdown cooling system	2	6	1	3	3	
Decay heat removal system	2	6	1	3	4	
Component cooling system	2	6	1	3	5	
Preheating system	2	6	1	3	6	
Post-incident cooling system	2	6	1	3	7	
Vapor containment or suppression	2	6	1	4		
Leakage monitoring	2	6	1	4	1	
Ventilation and cooling system	2	6	1	4	2	
Heat Transfer System	2	6	2			
Reactor coolant system	2	6	2	1		
Main coolant loop	2	6	2	1	1	
Intermediate coolant system	2	6	2	2		
Intermediate coolant loop	2	6	2	2	1	
Intermediate heat exchanger	2	6	2	2	2	
Steam generators	2	6	2	3		
Evaporators and steam drums	2	6	2	3	1	
Primary side	2	6	2	3	1	1
Secondary side	2	6	2	3	1	2
Superheater	2	6	2	3	2	
Primary side	2	6	2	3	2	1
Secondary side	2	6	2	3	2	2
Coolant supply and treatment	2	6	2	4		
Charge and volume control system	2	6	2	4	1	
Purification system	2	6	2	4	2	
Pressurizing and relief system	2	6	2	4	3	
Corrosion control systems	2	6	2	4	4	
Decontamination system	2	6	2	4	5	
Sampling system	2	6	2	4	6	
Primary makeup system	2	6	2	4	7	
Inert gas systems	2	6	2	4	8	
Drain and vent system control	2	6	2	4	9	
Coolant receiving and storage	2	6	2	5		
Safety and protective system	2	6	2	6		
Service to Fuel Handling and Storage	2	6	3			
Spent fuel storage coolant system	2	6	3	1		
Fuel wash system	2	6	3	2		
Radioactive Waste Treatment and Disposal	2	6	4			
Liquid waste	2	6	4	1		
Gaseous waste	2	6	4	2		

	11	12	13	14	15	16
INSTRUMENTATION AND CONTROL (Cont)						
Solid waste	2	6	4	3		
Radiation Monitoring	2	6	5			
Process	2	6	5	1		
Health physics	2	6	5	2		
Off-site environs	2	6	5	3		
Conventional Fossil-fired Control System	2	6	7			
Fire control system	2	6	7	1		
Blowdown control system	2	6	7	2		
Protective system	2	6	7	3		
Steam, Condensate, and Feedwater Piping and Equipment	2	6	8			
Main steam	2	6	8	1		
Auxiliary steam	2	6	8	2		
Condensate	2	6	8	3		
Feedwater	2	6	8	4		
Drains	2	6	8	5		
Vents	2	6	8	6		
Other	2	6	9			
Na-to-air heat exchanger control system	2	6	9	1		
Air control system	2	6	9	1	1	
Sodium flow control system	2	6	9	1	2	
Television	2	6	9	2		
Data aquisition system	2	6	9	3		
Core display	2	6	9	4		
Communications	2	6	9	5		
Turbine-generator	2	6	9	6		
Turbine side	2	6	9	6	1	
Generator side	2	6	9	6	2	
Cooling water	2	6	9	6	3	
Condenser	2	6	9	7		
Central lubricating	2	6	9	8		
Hydrogen cooling system	2	6	9	9		
FEEDWATER SUPPLY AND TREATMENT SYSTEM						
	2	7				
Raw Water Supply	2	7	1			
Filters, strainers	2	7	1	1		
Pumps and drives	2	7	1	2		
Storage facilities	2	7	1	3		
Makeup Water Treatment	2	7	2			
Evaporators	2	7	2	1		
Demineralizers	2	7	2	2		
Pumps and drives	2	7	2	3		
Storage facilities	2	7	2	4		
Feedwater Purification	2	7	3			
Condensate and demineralized water storage and supply (bypass purification)	2	7	3	1		

FEEDWATER SUPPLY AND TREATMENT
SYSTEM (Cont)

Condensate demineralizing (full flow purification)	2	7	3	2
Chemical treatment facilities	2	7	3	3
Chemical analysis facilities	2	7	3	4
Storage facilities	2	7	3	5

STEAM, CONDENSATE, AND FEEDWATER
PIPING AND EQUIPMENT

	2	8		
Main Steam	2	8	1	
Desuperheater, attemperator	2	8	1	1
Valves	2	8	1	2
Piping	2	8	1	3
Auxiliary Steam	2	8	2	
Condensate	2	8	3	
Main condensate pump	2	8	3	1
Condensate booster pump	2	8	3	2
Valves	2	8	3	3
Piping	2	8	3	4
Feedwater	2	8	4	
Boiler feed pump and drives	2	8	4	1
Feedwater heater	2	8	4	2
Valves	2	8	4	3
Piping	2	8	4	4
Drains and Vents	2	8	5	
Drains	2	8	5	1
Vents	2	8	5	2

OTHER REACTOR PLANT EQUIPMENT

	2	9		
Chemical Decontamination System	2	9	1	
Pumps and drives	2	9	1	1
Chemical mixing tanks	2	9	1	2
Heaters	2	9	1	3
Piping and valves	2	9	1	4
Reactor Plant Maintenance Equipment	2	9	2	
Remotely controlled tools	2	9	2	1
Radioactive maintenance facilities	2	9	2	2
Portable shielding	2	9	2	3

TURBINE-GENERATOR UNITS AND CONDENSER

TURBINE SIDE	3	1		
GENERATOR SIDE	3	2		
CIRCULATING WATER SYSTEMS	3	3		

	11	12	13	14	15	16
CONDENSERS	3	4				
CENTRAL LUBRICATING SYSTEM	3	5				
AUXILIARY LOOP FOR GENERATORS (HYDROGEN)	3	6				
OTHER TURBINE PLANT EQUIPMENT	3	7				
<u>ACCESSORY ELECTRICAL EQUIPMENT</u>	4					
TRANSMISSION AND SWITCH GEAR	4	1				
Transformers	4	1	1			
Circuit Breakers	4	1	2			
SWITCH BOARDS	4	2				
PROTECTIVE EQUIPMENT	4	3				
ELECTRICAL STRUCTURE	4	4				
POWER WIRING AND CONDUIT	4	5				
STATION SERVICE EQUIPMENT	4	6				
Normal Equipment	4	6	1			
Emergency Equipment	4	6	2			
Diesel generators	4	6	2	1		
Diesels	4	6	2	2		
Starter batteries	4	6	2	3		
Air starting system	4	6	2	4		
Gasoline starting system	4	6	2	5		
Supply breaker	4	6	2	6		
M. G. SET	4	7				
BATTERY BANK	4	8				
EMERGENCY BUS	4	9				
<u>MISCELLANEOUS EQUIPMENT</u>	5					
CRANES AND HOISTING EQUIPMENT (EXTERNAL TO REACTOR PLANT)	5	1				
COMPRESSED AIR AND VACUUM CLEANING EQUIPMENT	5	2				

OTHER POWER PLANT EQUIPMENT
INSTRUMENT AIR SUPPLY

<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>
5	3				
5	4

III. COMPONENT/PART

A. DESCRIPTION

Early efforts by LMEC and by Holmes & Narver (H&N) to develop a uniform system for identification of components for all reactor systems was influenced by suggestions from RDT to H&N that they should endeavor to develop a system similar to that in use for aerospace, called FARADA for failure rate data. Subsequently, it was agreed between H&N, Phillips Petroleum (PPC), Oak Ridge National Laboratory (ORNL), and LMEC that this would be done, and ground rules stipulated that the first four digits would be used to describe component and type in alphabetical codes and that six alpha columns would be used to describe the design parameters of the component. The first effort was published by H&N in 1968 as HN-193.

Subsequent investigation indicated that, for LMEC's requirements of description to include down to the basic part level, six columns instead of four are required and alpha instead of numeric for the type and parts descriptions. Each 12-column component/part description constitutes a unique identification number for a specific component — the first two columns of digits identify the component; the third, the basic component type; the fourth, the major subtype or function; the fifth, the part; and the sixth, the part identification. The last six columns identify design characteristics such as media handled, component material, size, pressure, temperature, power, and other values of special interest for a particular component. These last 6-column designations will vary from component to component.

Many blank areas have been left for future categorization or expansion as indicated by future volumes of failure information in these areas.

B. CODE INDEX

1. Numerical Listing

<u>Number</u>	<u>Component</u>
01	Air Locks
02	
03	
04	
05	
06	Vessels and Tanks
07	Vessel Internals, Removable (excluding fuel, moderator, reflector, and reactivity control elements)
08	Control and Safety Elements
09	Motors (electric)
10	Motors, Engines and Turbines (hydraulic, pneumatic, steam)
11	Engines and Turbines (internal combustion)
12	Transmissions and Drive Shafts
13	
14	Neutron Source
15	
16	Shielding
17	Pumps and Supports
18	Piping and Associated Fittings
19	Piping Supports
20	Valves
21	Valve Operators
22	Heat Exchangers (miscellaneous)
23	Rupture Discs
24	Tube and Fittings
25	Compressors
26	Air Dryers
27	Filters and Strainers
28	Blowers and Fans
29	
30	
31	Condensers
32	Steam Drums and Separators
33	Traps (general)
34	Coolers (liquid metal to air)
35	Coolers (other than liquid metal to air)
36	Cold Traps/Hot Traps
37	Plugging Meters
38	Heaters (electrical)
39	Intermediate Heat Exchangers
40	Steam Generators
41	Furnace Equipment
42	Recombiners
43	Desuperheaters
44	Superheaters and Reheaters
45	Moderators and Reflectors

<u>Number</u>	<u>Component</u>
46	Fuel and Breeder Elements
47	Fuel Handling Equipment (liquid metal, internal)
48	
49	Crane Structures
50	Hoist Units
51	
52	
53	Demineralizers (ion exchange unit)
54	Feedwater Heaters
55	Turbine-Generators (turbine side)
56	Turbine-Generator (generator side)
57	Electrical Generator (emergency and auxiliary)
58	Power Switch Gear, Circuit Breakers, Relays, Transformers
59	
60	
61	
62	Annunciators-Alarms
63	Data Aquisition System (DAS)
64	Indicators and Recorders
65	Controllers
66	Sensors (other than radiation)
67	Sensors (radiation)
68	Wiring and Connectors
69	Instrumentation - Terminal Boards, Patch Panels, Relays, Suppressors

2. Alphabetical Listing

<u>Number</u>	<u>Component</u>
26	Air Dryers
01	Air Locks
62	Annunciators-Alarms
28	Blowers and Fans
36	Cold Traps/Hot Traps
25	Compressors
31	Condensers
08	Control and Safety Elements
65	Controllers
34	Coolers (liquid metal to air)
35	Coolers (other than liquid metal to air)
49	Crane structures
63	Data Aquisition System (DAS)
53	Demineralizers (ion exchange units)
43	Desuperheaters
57	Electrical Generators (emergency and auxiliary)
11	Engine and Turbines (internal combustion)
54	Feedwater Heaters
27	Filters and Strainers

<u>Number</u>	<u>Component</u>
46	Fuel and Breeder Elements
47	Fuel Handling Equipment (liquid metal, internal)
41	Furnace Equipment
22	Heat Exchangers (miscellaneous)
38	Heaters (electrical)
50	Hoist Units
64	Indicators and Recorders
69	Instrumentation – Terminal Boards, Patch Panels, Relays, Suppressors
39	Intermediate Heat Exchangers
45	Moderators and Reflectors
09	Motors (electric)
10	Motors, Engines and Turbines (hydraulic, pneumatic, steam)
14	Neutron Sources
18	Piping and Associated Fittings
19	Piping Supports
37	Plugging Meters
58	Power Switch Gear, Circuit Breakers, Relays, Transformers
17	Pumps and Supports
42	Recombiners
23	Rupture Discs
66	Sensors (other than radiation)
67	Sensors (radiation)
16	Shielding
32	Steam Drums and Separators
40	Steam Generators
44	Superheaters and Reheaters
12	Transmissions and Drive Shafts
33	Traps (general)
24	Tube and Fittings
56	Turbine-Generator (generator side)
55	Turbine-Generator (turbine side)
21	Valve Operators
20	Valves
07	Vessel Internals, Removable (excluding fuel, moderator, reflector, and reactivity control elements)
06	Vessels and Tanks
68	Wiring and Connectors

C. CLASSIFICATION CODE (Columns 17 to 28)

	17	18	19	20	21	22	23	24	25	26	27	28
<u>AIR LOCKS</u>	0	1	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	0	1	X									
Personnel				A								
Fuel Handling				B								
Other Equipment				C								
SUB TYPE	0	1	X	X								
Normal Access - Personnel				A								
Emergency Access- Personnel				B								
MAJOR PART	0	1	X	X	X							
Compartment or Shell					A							
Door or Bulkhead					B							
Seal					C							
Insulation					D							
Emergency Hatch					E							
Auxilliary Penetration					F							
PART IDENTIFICATION	0	1	X	X	X	X						
Compression - Seal						A						
Inflatable - Seal						B						
Hand Wheel - Door						C						
Locking Mechanism - Door						D						
Valve						E						
Conduit						F						
Pipe						G						
DESIGN PRESSURE (psig)	0	1	X	X	X	X	X					
0-1							A					
1-3							B					
3-5							C					
5-10							D					
10-15							E					
15-20							F					
20-up							G					
ENVIRONMENTAL MEDIA OF PART	0	1	X	X	X	X	X	X	X	X	X	
Air											A	
Nitrogen											B	
Argon											C	
Helium											D	

	17	18	19	20	21	22	23	24	25	26	27	28	
MATERIAL OF PART	0	1	X	X	X	X	X	X	X	X	X	X	
Stainless Steel - Austenitic													A
Stainless Steel - Ferritic													B
Carbon Steel													C
Low-Alloy Steel													D
Rubber													E
Plastic													F
Asbestos													G
Non-ferrous Metal													H
<u>VESSELS AND TANKS</u>	0	6	X	X	X	X	X	X	X	X	X	X	
MAJOR TYPE	0	6	X										
Vessel					A								
Tank					B								
SUB TYPE	0	6	X	X									
Sodium					A								
Raw Water					B								
Treated Water					C								
Heavy Water					D								
Borated Solution					E								
NaK					F								
Organic Liquid					G								
Acid					H								
Gas					I								
Hydrazine-Morpholine					J								
MAJOR PART	0	6	X	X	X								
Nozzle					A								
Shell					B								
Manway					C								
Cover Plate					D								
Bottom Head					E								
Top Head					F								
Flange					G								
Communicating Chamber					H								
Seal Ring or Gasket					I								
Support					J								
Insulation					K								
Baffle					L								
Fasteners					M								

PART IDENTIFICATION

Cylindrical - Shell
 Truncated Cone - Shell
 Hemispherical Head
 Ellipsoidal Head
 Torispherical Head
 Toriconical Head
 Bolted Flange
 Welded Flange
 Post - Support
 Brace - Support
 Stiffener - Support
 Buttstrap - Support
 Stay or Staybolt - Support
 Hanger - Support
 Bolt - Fasteners
 Stud - Fasteners

PRESSURE (psig)

0-10
 10-30
 30-50
 50-100
 100-300
 300-500
 500-1000
 1000-up

CAPACITY (gallons)

0 to 10^2
 10^2 to 5×10^2
 5×10^2 to 10^3
 10^3 to 5×10^3
 5×10^3 to 10^4
 10^4 to 5×10^4
 5×10^4 to 10^5
 10^5 to 5×10^5
 5×10^5 to 10^6
 10^6 and up

WALL THICKNESS (inches)

0-1/4
 1/4-1/2
 1/2-1
 1-2
 2-3

	17	18	19	20	21	22	23	24	25	26	27	28
0	6	X	X	X	X							
A												
B												
C												
D												
E												
F												
G												
H												
I												
J												
K												
L												
M												
N												
P												
Q												
0	6	X	X	X	X	X						
A												
B												
C												
D												
E												
F												
G												
H												
0	6	X	X	X	X	X	X	X				
A												
B												
C												
D												
E												
F												
G												
H												
I												
J												
0	6	X	X	X	X	X	X	X	X			
A												
B												
C												
D												
E												

	17	18	19	20	21	22	23	24	25	26	27	28
WALL THICKNESS (inches) (Cont)	0	6	X	X	X	X	X	X	X			
3-4										F		
4-6										G		
6-8										H		
8-10										I		
10-12										J		
12-up										K		
TEMPERATURE (°F)	0	6	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
MATERIAL OF PART	0	6	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Stainless (Austenitic) Steel, Type 304												C
Stainless (Austenitic) Steel, Type 316												D
Stainless (Austenitic) Steel, Type 347												E
Ferritic Steel												F
Carboloy												G
Hastelloy												H
Stellite												I
Monel												J
Nickel or Nickel Alloy												K
Aluminum or Aluminum Alloy												L
Copper or Copper Alloy												M
Concrete												N
Titanium												P
Asbestos												Q
<u>VESSEL INTERNALS, Removable</u> (Excluding fuel, moderator, reflector, and control components)	0	7	X	X	X	X	X	X	X	X	X	X
MAJOR PART	0	7	X	X	X							
Supports						A						
Retainers						B						
Holddown Members						C						
Flow Baffles						D						
Orifices						E						
Strainers						F						

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART (Cont)	0	7	X	X	X							
Scrubbers and Driers					G							
Insulation					H							
Tube					I							
Cover					J							
Liner					K							
PART IDENTIFICATION	0	7	X	X	X	X						
Lower Grid - Support						A						
Upper Grid - Support						B						
Lock - Cover						C						
Meltdown - Liner						D						
Pressure - Tube						E						
Guide - Tube						F						
TEMPERATURE OF PART (°F)	0	7	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	0	7	X	X	X	X	X	X	X	X	X	
NaK												A
Sodium												B
Nitrogen												C
Argon												D
Helium												E
Water												F
Steam												G
MATERIAL OF PART	0	7	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 347												B
Stainless Steel, Type 316												C
Stainless Steel, Ferritic												D
Carbon Steel												E
Low-Alloy Steel												F
Zirconium												G
Nickel or High Nickel Alloys												H
Aluminum or Aluminum Alloys												I
Other Non-ferrous Alloys												J
Graphite												K

	17	18	19	20	21	22	23	24	25	26	27	28
<u>CONTROL AND SAFETY ELEMENTS</u>	0	8	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	0	8	X									
Shutdown			A									
Shim			B									
Regulating			C									
Oscillating			D									
SUB TYPE	0	8	X	X								
Fuel Displacement				A								
Absorber				B								
Reflector				C								
Moderator Level				D								
Moderator Dump				E								
Poison Injection				F								
High Temperature Melt Actuated				G								
Reflector Shield Disassembly				H								
MAJOR PART	0	8	X	X	X							
Housing					A							
Shroud					B							
Guide Tube					C							
Active Section					D							
Handling Head					E							
Locking Device					F							
Orifice					G							
PART IDENTIFICATION (undeveloped)	0	8	X	X	X	X						
GEOMETRY	0	8	X	X	X	X	X					
Cylindrical							A					
Rectangular							B					
Vaned							C					
Plate							D					
INSERTION TIME (secs)	0	8	X	X	X	X	X	X				
0-0.1								A				
0.1-0.2								B				
0.2-0.3								C				
0.3-0.4								D				
0.4-0.5								E				
0.5-0.6								F				
0.6-0.7								G				
0.7-0.8								H				
0.8-0.9								I				
0.9-1.0								J				
1.0-up								K				

	17	18	19	20	21	22	23	24	25	26	27	28
STROKE LENGTH (inches)	0	8	X	X	X	X	X	X	X			
0-5										A		
5-10										B		
10-15										C		
15-20										D		
20-30										E		
30-40										F		
40-50										G		
50-60										H		
60-70										I		
70-up										J		
TEMPERATURE (°F)	0	8	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	0	8	X	X	X	X	X	X	X	X	X	
Sodium												A
NaK												B
Air												C
Helium												D
Nitrogen												E
Argon												F
Hydrogen												G
Water												H
Carbon Dioxide												I
Borated Solutions												J
Steam												K
Boron Carbide												L
Graphite												M
MATERIAL OF PART	0	8	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 316												B
Stainless Steel, Type 347												C
Ferritic Steel												D
Carbon Steel												E
High-Alloy Steel												F
Nickel or Nickel Alloy												G
Copper or Copper Alloy												H
Aluminum or Aluminum Alloy												I

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	0	8	X	X	X	X	X	X	X	X	X	X
Plastic												J
Boron Carbide												K
Asbestos												L
Monel												M
Inconel												N
Stellite												P
Boron												Q
Rare Earths												R
<u>MOTORS (Electric)</u>	0	9	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	0	9	X									
Direct Current (dc)					A							
Alternating Current (ac)					B							
SUB TYPE	0	9	X	X								
Shunt Excitation - dc					A							
Series Excitation - dc					B							
Compound Excitation					C							
Induction - Squirrel Case Rotor - ac					D							
Induction - Wound Rotor - ac					E							
Synchronous - ac					F							
MAJOR PART	0	9	X	X	X							
Housing					A							
Stator					B							
Rotor					C							
Armature					D							
Commutator					E							
Mounting					F							
Shaft					G							
Lubrication System					H							
Fasteners					I							
Bushing					J							
Key					K							
Bearing					L							
PART IDENTIFICATION	0	9	X	X	X	X						
Brushes - Commutator						A						
Spring - Commutator						B						
Brush Holder - Commutator						C						
Junction Box Housing						D						
Manual - Starter and Speed Control						E						
Automatic - Starter and Speed Control						F						

	17	18	19	20	21	22	23	24	25	26	27	28
POWER (bhp)	0	9	X	X	X	X	X					
0-1								A				
1-2								B				
2-3								C				
3-5								D				
5-10								E				
10-20								F				
20-30								G				
30-50								H				
50-100								I				
100-200								J				
200-300								K				
300-500								L				
500-1000								M				
1000-up								N				
SPEED (rpm)	0	9	X	X	X	X	X	X				
0-250									A			
250-500									B			
500-1000									C			
1000-1500									D			
1500-1800									E			
1800-2000									F			
2000-2500									G			
2500-3000									H			
3000-3500									I			
3500-4000									J			
4000-5000									K			
5000-6000									L			
6000-7000									M			
7000-up									N			
VOLTAGE	0	9	X	X	X	X	X	X	X			
0-28										A		
28-100										B		
100-125										C		
125-200										D		
200-250										E		
250-400										F		
400-460										G		
460-600										H		
600-up										I		
TEMPERATURE (°F)	0	9	X	X	X	X	X	X	X	X	X	
0-100												A
100-150												B
150-200												C

	17	18	19	20	21	22	23	24	25	26	27	28
TEMPERATURE (°F) (Cont)	0	9	X	X	X	X	X	X	X	X		
200-250											D	
250-300											E	
300-400											F	
400-500											G	
500-600											H	
ENVIRONMENTAL MEDIA OF PART	0	9	X	X	X	X	X	X	X	X	X	X
Air												A
Nitrogen												B
Argon												C
Helium												D
Hydrogen												E
MATERIAL OF PART	0	9	X	X	X	X	X	X	X	X	X	X
Low-Carbon Steel												A
High Alloy Steel												B
Stainless (Austenitic) Steel, Type 304												C
Stainless (Austenitic) Steel, Type 316												D
Stainless (Austenitic) Steel, Type 347												E
Iron												F
Ferritic Steel												G
Copper or Copper Alloy												H
Aluminum or Aluminum Alloy												I
Nickel or Nickel Alloy												J
Monel												K
Carboloy												L
Carbon												M
MOTORS, ENGINES, AND TURBINES (Hydraulic, Pneumatic, Steam)	1	0	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	1	0	X									
Hydraulic												A
Pneumatic												B
Steam												C
SUB TYPE	1	0	X	X								
Hydraulic - Turbine												A
Hydraulic - Motor												B
Pneumatic - Motor												C
Steam - Engine												D
Steam - Turbine												E

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART	1	0	X	X	X							
Housing					A							
Shaft					B							
Bearing					C							
Rotor					D							
Vane					E							
Impeller					F							
Cover Plate					G							
Filter					H							
Valve					I							
Regulators					J							
Fastener					K							
Packing, Gasket, Seal					L							
PRESSURE (psig)	1	0	X	X	X	X	X					
0-10								A				
10-50								B				
50-100								C				
100-200								D				
200-500								E				
500-1,000								F				
1,000-2,000								G				
2,000-3,000								H				
3,000-5,000								I				
5,000-7,000								J				
7,000-10,000								K				
10,000-up								L				
SPEED (rpm)	1	0	X	X	X	X	X	X				
0-10									A			
10-50									B			
50-100									C			
100-200									D			
200-300									E			
300-500									F			
500-1000									G			
1000-2000									H			
3000-4000									I			
4000-5000									J			
5000-up									K			
HORSEPOWER (bhp)	1	0	X	X	X	X	X	X	X			
0-10										A		
10-20										B		
20-30										C		
30-50										D		
50-70										E		

	17	18	19	20	21	22	23	24	25	26	27	28
HORSEPOWER (bhp) (Cont)	1	0	X	X	X	X	X	X	X			
70-100										F		
100-150										G		
150-200										H		
200-300										I		
300-500										J		
500-700										K		
700-1000										L		
1000-up										M		
TEMPERATURE (°F)	1	0	X	X	X	X	X	X	X	X	X	
32-100												A
100-200												B
200-300												C
300-500												D
500-up												E
ENVIRONMENTAL MEDIA OF PART	1	0	X	X	X	X	X	X	X	X	X	X
Hydraulic Fluid												A
Synthetic Fluid												B
Compressed Air												C
Steam												D
MATERIAL OF PART	1	0	X	X	X	X	X	X	X	X	X	X
Low-Carbon Steel												A
High-Carbon Steel												B
Stainless Steel												C
Ferritic Steel												D
Other Steel												E
Cast Iron												F
Aluminum or Aluminum Alloy												G
Copper or Copper Alloy												H
Nickel or Nickel Alloy												I
Plastic or Rubber												J
Mica												K
Ceramics, Glass, Carbon												L
ENGINES AND TURBINES (Internal Combustion)	1	1	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	1	1	X									
Engine			A									
Turbine			B									

	17	18	19	20	21	22	23	24	25	26	27	28
SUB TYPE	1	1	X	X								
Diesel					A							
Gasoline					B							
Other					C							
MAJOR PART	1	1	X	X	X							
Manifold						A						
Carburetor						B						
Bearing						C						
Flywheel						D						
Piston						E						
Cylinder						F						
Crank Shaft						G						
Connecting Rod						H						
Pump						I						
Valves						J						
Fuel Injection						K						
Spark Ignition						L						
Muffler						M						
Gear						N						
Blades						P						
Shrouds						Q						
Diffusers						R						
PART IDENTIFICATION	1	1	X	X	X	X						
Timing Gear							A					
Water Pump							B					
Oil Pump							C					
Plug - Spark Ignition							D					
Distributor - Spark Ignition							E					
Induction Coil - Spark Ignition							F					
Intake Valve							G					
Exhaust Valve							H					
Exhaust Manifold							I					
Air Intake Manifold							J					
BRAKE HORSEPOWER (bhp)	1	1	X	X	X	X	X					
0-10								A				
10-20								B				
20-30								C				
30-50								D				
50-70								E				
70-100								F				
100-150								G				
150-200								H				
200-300								I				

	17	18	19	20	21	22	23	24	25	26	27	28
BRAKE HORSEPOWER (bhp) (Cont)	1	1	X	X	X	X	X					
300-500							J					
500-700							K					
700-1000							L					
1000-up							M					
TEMPERATURE (°F)	1	1	X	X	X	X	X	X	X	X		
32-100											A	
100-200											B	
200-300											C	
300-400											D	
400-500											E	
500-up											F	
ENVIRONMENTAL MEDIA OF PART	1	1	X	X	X	X	X	X	X	X	X	X
Combustible Gas												A
Air												B
Oil												C
Water												D
Gasoline												E
Kerosine												F
MATERIAL OF PART	1	1	X	X	X	X	X	X	X	X	X	X
Low-Carbon Steel												A
High-Carbon Steel												B
Stainless Steel												C
Ferritic Steel												D
Cast Iron												E
Aluminum or Aluminum Alloy												F
Copper or Copper Alloy												G
Plastic or Rubber												H
Mica												I
Ceramics, Glass, Carbon												J
<u>TRANSMISSIONS AND DRIVE SHAFTS</u>	1	2	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	1	2	X									
Mechanical			A									
Electrical			B									
Hydraulic			C									
Pneumatic			D									

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART	1	2	X	X	X							
Brake						A						
Shaft						B						
Coupling						C						
Electromagnetic						D						
Clutch						E						
Valve						F						
Pump						G						
Fastener						H						
Seal						I						
Bearing						J						
Housing or Box						K						
Gear						L						
Bell Crank						M						
Chain						N						
Cable						P						

PART IDENTIFICATION	1	2	X	X	X	X						
Flexible Shaft							A					
Rigid Shaft							B					
Bellows Seal							C					
Packing Seal							D					
O-Ring Seal							E					
Flexible Coupling							F					
Universal Joint Coupling							G					
Thrust Bearing							H					
Radial Bearing							I					
Gear Box							J					
Ball Screw Drive Shaft							K					

DESIGN LOAD (lb)	1	2	X	X	X	X	X					
0-25								A				
25-50								B				
50-100								C				
100-200								D				
200-300								E				
300-400								F				
400-500								G				
500-1000								H				
1000-2000								I				
2000-4000								J				
4000-8000								K				
8000-16000								L				
16000-32000								M				
32000-64000								N				
64000-up								P				

	17	18	19	20	21	22	23	24	25	26	27	28
DESIGN PRESSURE (psig)	1	2	X	X	X	X	X	X				
0-100										A		
100-200										B		
200-400										C		
400-800										D		
800-1200										E		
1200-2000										F		
2000-up										G		
HORSEPOWER RATING	1	2	X	X	X	X	X	X	X			
0-10										A		
10-20										B		
20-40										C		
40-80										D		
80-160										E		
160-320										F		
320-640										G		
640-up										H		
TEMPERATURE (°F)	1	2	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-400											D	
400-500											E	
500-700											F	
700-1000											G	
1000-1300											H	
1300-up											I	
ENVIRONMENTAL MEDIA OF PART	1	2	X	X	X	X	X	X	X	X	X	
NaK												A
Sodium												B
Water												C
Air												D
Nitrogen												E
Argon												F
Helium												G
Organic Liquid												H
MATERIAL OF PART	1	2	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 316												B
Stainless Steel, Type 347												C
Stainless Steel, Ferritic												D

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	1	2	X	X	X	X	X	X	X	X	X	X
Low Carbon Steel												E
Low Alloy Steel												F
Nickel or Nickel Alloy												G
Iron												H
Aluminum or Aluminum Alloy												I
Copper or Copper Alloy												J
Rubber or Plastic												K
Ceramic												L
Carbon or Graphite												M
<u>NEUTRON SOURCE</u>	1	4	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	1	4	X									
Photoneutron					A							
(α , n)					B							
MAJOR PART	1	4	X	X	X							
Rod						A						
Tube						B						
End Cap						C						
Handling Head						D						
Housing						E						
TEMPERATURE (°F)	1	4	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-500											D	
500-700											E	
700-900											F	
900-1100											G	
1100-1300											H	
1300-up											I	
ENVIRONMENTAL MEDIA OF PART	1	4	X	X	X	X	X	X	X	X	X	X
NaK												A
Sodium												B
Water												C
Nitrogen												D
Helium												E
Argon												F

	17	18	19	20	21	22	23	24	25	26	27	28	
MATERIAL OF PART	1	4	X	X	X	X	X	X	X	X	X	X	
Stainless Steel - Austenitic													A
Stainless Steel - Ferritic													B
Polonium													C
Beryllium													D
Antimony-124													E
Aluminum or Aluminum Alloy													F
Low-Alloy Steel													G
Carbon Steel													H
<u>SHIELDING</u>	1	6	X	X	X	X	X	X	X	X	X	X	
MAJOR TYPE	1	6	X										
Biological													A
Thermal (heat)													B
Blast													C
Special Purpose													D
Neutron													E
SUB TYPE	1	6	X	X									
Side Biological													A
Upper Biological (loading face)													B
Side Heat													C
Upper Heat													D
Upper Biological (rotating plug)													E
Upper Blast													F
Side Blast													G
Side Neutron													H
Upper Neutron													I
MAJOR PART	1	6	X	X	X								
Shield Structure and Supports													A
Seal													B
Cooling Tubes or Ducts													C
Alignment Device													D
Reflective Insulation													E
Lifting Fixtures													F
Rollers and Bearings													G
Fasteners													H
Penetration Tubes													I
SHIELD THICKNESS (inches)	1	6	X	X	X	X	X						
0-4													A
4-8													B
8-12													C
12-18													D

	17	18	19	20	21	22	23	24	25	26	27	28
SHIELD THICKNESS (inches) (Cont)	1	6	X	X	X	X	X					
18-34							E					
24-36							F					
36-48							G					
48-60							H					
60-72							I					
72-84							J					
84-96							K					
96-108							L					
108-up							M					
HEAT DISSIPATION (Btu/hr)	1	6	X	X	X	X	X	X				
0-2,000									A			
2,000-5,000									B			
5,000-10,000									C			
10,000-20,000									D			
20,000-50,000									E			
50,000-100,000									F			
100,000-up									G			
RADIATION FLUX OUTSIDE SHIELD (Mrem/hr)	1	6	X	X	X	X	X	X	X			
0-0.1										A		
0.1-0.3										B		
0.3-0.5										C		
0.5-0.7										D		
0.7-1.0										E		
1-2										F		
2-3										G		
3-5										H		
5-10										I		
10-20										J		
20-30										K		
30-50										L		
50-100										M		
100-200										N		
200-300										P		
300-500										Q		
500-up										R		
TEMPERATURE (°F)	1	6	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	

	17	18	19	20	21	22	23	24	25	26	27	28	
ENVIRONMENTAL MEDIA OF PART	1	6	X	X	X	X	X	X	X	X	X	X	
Sodium													A
NaK													B
Water													C
Steam													D
Borated Solutions													E
Air													F
Helium													G
Hydrogen													H
Nitrogen													I
Argon													J
MATERIAL OF PART	1	6	X	X	X	X	X	X	X	X	X	X	
Low-Carbon Steel													A
High-Alloy Steel													B
Stainless (Austenitic) Steel, Type 304													C
Stainless (Austenitic) Steel, Type 316													D
Stainless (Austenitic) Steel, Type 347													E
Iron													F
Boron Steel													G
Boron Stainless Steel													H
Boron Carbide													I
Boral													J
Calcium Borate													K
Graphite													L
Shot													M
Epoxy Resin (lead filled)													N
Sand													P
Earth													Q
Masonite													R
Uranium													S
Concrete													T
Nickel or Nickel Alloy													U
Copper or Copper Alloy													V
Aluminum or Aluminum Alloy													W
Lead													X
Paraffin													Y
Iron Oxide													Z

<u>PUMPS AND SUPPORTS</u>	1	7	X	X	X	X	X	X	X	X	X	X	
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MAJOR TYPE	1	7	X										
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Electromagnetic	A
Centrifugal	B
Axial	C
Gear	D
Rotary - Vane	E

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR TYPE (Cont)	1	7	X									
Rotary - Lobar					F							
Screw					G							
Diaphragm					H							
SUB TYPE	1	7	X	X								
Canned Rotor					A							
Frozen Seal					B							
Free Surface					C							
Conduction - ac					D							
Conduction - dc					E							
Induction - Stationary Magnet					F							
Induction - Rotating Magnet					G							
Single Stage					H							
Two-Stage					I							
Multi-Stage					J							
MAJOR PART	1	7	X	X	X							
Shaft						A						
Housing						B						
Impeller						C						
Seal						D						
Diffuser						E						
Bearings						F						
Inlet Nozzle						G						
Discharge Nozzle						H						
Overflow Pipe						I						
Baffle Assembly						J						
Duct						K						
Electrodes/Busbars						L						
Rotor - Magnet						M						
Rotor - Coils						N						
Stator - Magnet						P						
Stator Coils						Q						
Thermal Insulation						R						
Guide Vanes						S						
Support Structure						T						
PART IDENTIFICATION	1	7	X	X	X	X						
Frozen Seal										A		
Mechanical Seal										B		
Labyrinth Seal										C		
Hydraulic Bearings - Radial										D		
Hydraulic Bearings - Thrust										E		
Hydraulic Bearings - Combination										F		
Oil Lubricated - Radial										G		

	17	18	19	20	21	22	23	24	25	26	27	28
PART IDENTIFICATION (Cont)	1	7	X	X	X	X						
Oil Lubricated - Combination							H					
Rotor-Solid							I					
Rotor-Laminated							J					
Stator-Solid							K					
Stator-Laminated							L					
PRESSURE HEAD (psig)	1	7	X	X	X	X	X					
0-10								A				
10-20								B				
20-30								C				
30-50								D				
50-100								E				
100-200								F				
200-400								G				
400-1000								H				
1000-up								I				
FLOW RATE (gpm)	1	7	X	X	X	X	X	X				
0-50									A			
50-100									B			
100-200									C			
200-500									D			
500-1,000									E			
1,000-2,500									F			
2,500-5,000									G			
5,000-10,000									H			
10,000-up									I			
POWER RATING (hp)	1	7	X	X	X	X	X	X	X			
0-5										A		
5-10										B		
10-20										C		
20-30										D		
30-50										E		
50-100										F		
100-200										G		
200-400										H		
400-up										I		
TEMPERATURE (°F)	1	7	X	X	X	X	X	X	X	X		
32-200											A	
200-400											B	
400-600											C	
600-800											D	

	17	18	19	20	21	22	23	24	25	26	27	28
TEMPERATURE (°F) (Cont)	1	8	X	X	X	X	X	X	X	X		
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	1	7	X	X	X	X	X	X	X	X	X	X
Water												A
Organic Liquid												B
Liquid Sodium												C
Liquid NaK												D
Borated Solutions												E
Nitrogen												F
Argon												G
Helium												H
Air												I
MATERIAL OF PART	1	7	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Ferritic Steel												C
Stainless (Austenitic) Steel, Type 304												D
Stainless (Austenitic) Steel, Type 316												E
Stainless (Austenitic) Steel, Type 347												F
Other Type of Steel												G
Aluminum Bronze												H
Bronze												I
Aluminum												J
Magnesium												K
Stellite												L
Copper or Copper Alloy												M
Titanium												N
Beryllium or Beryllium Oxide												P
Zinc												Q
Ceramic												R
Asbestos												S
Plastics												T
Leather or Rubber												U
Others												V

PIPING AND ASSOCIATED FITTINGS 1 8 X X X X X X X X X X X

MAJOR TYPE 1 8 X

Liquid Metal	A
Water	B
Steam	C
Gas	D

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR TYPE (Cont)	1	8	X									
Organic Liquid				E								
Acid				F								
SUB TYPE	1	8	X	X								
Sodium - Liquid Metal					A							
NaK - Liquid Metal					B							
Heavy Water					C							
Light Water					D							
Nitrogen Gas					E							
Helium Gas					F							
Argon Gas					G							
Hydrogen Gas					H							
Carbon Dioxide Gas					I							
Air					J							
Diphenyl Organic Liquid					K							
Terphenyl Organic Liquid					L							
MAJOR PART	1	8	X	X	X							
Pipe						A						
Flange						B						
Branch Connection Reinforcement						C						
Cap						D						
Reducer						E						
Coupling						F						
Cross						G						
Elbow						H						
Tee						I						
Lateral						J						
Bushing						K						
Plug						L						
Bolt						M						
Gasket or Seal						N						
Returns						P						
Expansion Joints						Q						
Insulation						R						
PART IDENTIFICATION	1	8	X	X	X	X						
Welded Pipe							A					
Seamless Pipe							B					
Welding Neck Flange							C					
Slip-on Flange							D					
Lap Joint Flange							E					
Threaded Flange							F					
Blind Flange							G					
Socket Type Flange							H					

	17	18	19	20	21	22	23	24	25	26	27	28
PART IDENTIFICATION (Cont)	1	8	X	X	X	X						
Orifice Flange						I						
Reducing Flange						J						
Ring Joint Flange						K						
Saddle Reinforcement						L						
Split Tee Reinforcement						M						
Concentric Reducer						N						
Eccentric Reducer						P						
Elbow Reducer						Q						
90° Elbow						R						
45° Elbow						S						
Straight Tee						T						
Reducing Outlet Tee						U						
Bellows Expansion Joint						V						
Packed Expansion Joint						W						
PRESSURE (psig)	1	8	X	X	X	X	X					
0-10								A				
10-20								B				
20-50								C				
50-90								D				
90-150								E				
150-200								F				
200-400								G				
400-700								H				
700-1500								I				
1500-2500								J				
2500-3500								K				
3500-up								L				
PIPE SIZE (inches)	1	8	X	X	X	X	X	X				
0 to 3/4									A			
3/4 to 1-1/2									B			
1-1/2 to 3									C			
3 to 6									D			
6 to 10									E			
10 to 15									F			
15 to 20									G			
20 to 25									H			
25 to 30									I			
30 to 35									J			
35 to 40									K			
40 to 45									L			
45 to 50									M			
50 to up									N			

	17	18	19	20	21	22	23	24	25	26	27	28
SCHEDULE NUMBER	1	8	X	X	X	X	X	X	X			
5S										A		
10S										B		
20										C		
30										D		
40										E		
60										F		
80										G		
100										H		
120										I		
140										J		
160										K		
405										L		
805										M		
XS										N		
XXS										P		
TEMPERATURE (°F)	1	8	X	X	X	X	X	X	X	X	X	
-450-0											A	
0-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	1	8	X	X	X	X	X	X	X	X	X	X
Water												A
Steam												B
Air												C
Sodium												D
NaK												E
Borated Solutions												F
Nitrogen												G
Argon												H
Helium												I
Heavy Water												J
Carbon Dioxide												K
Acid												L
MATERIAL OF PART	1	8	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
High-Alloy Steel												B
Stainless (Austenitic) Steel, Type 304												C
Stainless (Austenitic) Steel, Type 316												D

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	1	8	X	X	X	X	X	X	X	X	X	X
Stainless (Austenitic) Steel, Type 347												E
Ferritic Steel												F
Other Steel												G
Stellite												H
Nickel or Nickel Alloy												I
Copper or Copper Alloy												J
Aluminum or Aluminum Alloy												K
Rubber												L
Plastic												M
Asbestos												N
Iron												P
Other												Q

PIPING SUPPORTS 1 9 X X X X X X X X X X X

MAJOR TYPE 1 9 X

Thermal Restraint	A
Gravitational Restraint	B
Dynamic Restraint	C
Thermal and Gravitational Restraint	D
Thermal and Dynamic Restraint	E
Gravitational and Dynamic Restraint	F
Thermal, Gravitational, and Dynamic Restraining	G

SUB TYPE 1 9 X X

Stop	A
Two Axis Stop	B
Double Acting Stop	C
Two Axis, Double Acting Stop	D
Horizontal Sliding Support	E
Rigid	F
Resilient	G
Constant Effort	H
Damping	I
Hanger	J
Guide	K
Resting or Sliding	L
Limit Stop	M
Double Acting Limit Stop	N
Two Axis Limit Stop	P

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART	1	9	X	X	X							
Strut						A						
Tie Rod						B						
Hanger Rod						C						
Spring						D						
Cage						E						
Turnbuckle						F						
Counterweight						G						
Cable						H						
Pipe Attachment						I						
Ball Joint						J						
Lever Arm						K						
Pulley						L						
Cradle or Saddle						M						
Clamp						N						
Sling						P						
Clevis and Pin						Q						
Channel						R						
Post						S						
Cross Arm						T						

PART IDENTIFICATION	1	9	X	X	X	X						
Ear Attachment							A					
Shoe Attachment							B					
Lug Attachment							C					
Stool Attachment							D					
Trunnion Attachment							E					
Skirt Attachment							F					
Ring Attachment							G					
Adjustable Cradle							H					
Fixed Position Cradle							I					
Jointed Strut							J					
Fin							K					
Sleeve							L					

MAXIMUM AXIAL DEFLECTION (inches)	1	9	X	X	X	X	X					
0-0.001								A				
0.001-0.1								B				
0.01-0.1								C				
0.1-1								D				
1-10								E				
10-up								F				

	17	18	19	20	21	22	23	24	25	26	27	28
MAXIMUM RADIAL DEFLECTION (inches)	1	9	X	X	X	X	X	X				
0-0.001										A		
0.001-0.01										B		
0.01-0.1										C		
0.1-1.0										D		
1.0-10										E		
10-up										F		
MAXIMUM ROTATION ABOUT AXIS (degrees)	1	9	X	X	X	X	X	X	X			
0-0.01										A		
0.01-0.1										B		
0.1-1.0										C		
1.0-10										D		
10-20										E		
20-30										F		
30-up										G		
TEMPERATURE (°F)	1	9	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	1	9	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Air												C
Water												D
Steam												E
Borated Solution												F
Argon												G
Nitrogen												H
Helium												I
Hydrogen												J
MATERIAL OF PART	1	9	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
High-Alloy Steel												B
Stainless Steel, Type 304												C

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	1	9	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 316												D
Stainless Steel, Type 347												E
Nickel or Nickel Alloy												F
Copper or Copper Alloy												G
Aluminum or Aluminum Alloy												H
Plastics												I
Powdered Metal Casting												J
Tungsten												K
Molybdenum												L
<u>VALVES</u>	2	0	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	0	X									
Ball												A
Butterfly												B
Diaphragm												C
Gate												D
Globe												E
Needle												F
Plug												G
Swing Disc												H
Tilt Disc												I
SUB TYPE	2	0	X	X								
Check												A
Throttling												B
Blocking												C
Pressure Reducing												D
Pressure Relief												E
Vacuum Relief												F
Flow Regulation												G
Pressure Regulation												H
Multiport												I
MAJOR PART	2	0	X	X	X							
Handwheel												A
Stem												B
Packing												C
Yoke												D
Bonnet												E
Bellows												F
Diaphragm												G
Seat												H
Gasket												I

	17	18	19	20	21	22	23	24	25	26	27	28
PIPE SIZE	2	0	X	X	X	X	X	X	X			
0-1/2										A		
1/2-1										B		
1-2										C		
2-3										D		
3-5										E		
5-10										F		
10-20										G		
20-30										H		
30-40										I		
40-50										J		
50-up										K		
TEMPERATURE (°F)	2	0	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	2	0	X	X	X	X	X	X	X	X	X	X
Water												A
Sodium												B
NaK												C
Fossil Fuel												D
Inert Gas												E
Other Gas												F
Steam												G
Borated Solution												H
Air												I
MATERIAL OF PART	2	0	X	X	X	X	X	X	X	X	X	X
Iron												A
Carbon Steel												B
High-Alloy Steel												C
Stainless (Austenitic) Steel, Type 304												D
Stainless (Austenitic) Steel, Type 316												E
Stainless (Austenitic) Steel, Type 347												F
Ferritic Steel												G
Other Steel												H
Aluminum or Aluminum Alloy												I
Copper or Copper Alloy												J
Nickel or Nickel Alloy												K
Carboloy												L

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	2	0	X	X	X	X	X	X	X	X	X	X
Hastelloy												M
Monel												N
Stellite												P
Titanium												Q
Magnesium												R
Plastic												S
Rubber												T
Asbestos												U
Zinc												V
Ceramic												W
Leather												X
Other												Y

<u>VALVE OPERATORS</u>	2	1	X	X	X	X	X	X	X	X	X	X
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MAJOR TYPE	2	1	X									
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Manual												A
Electric Motor and Servo												B
Pneumatic												C
Hydraulic												D
Solenoid												E
Other than listed												F

SUB TYPE	2	1	X	X								
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Straight Drive (shaft)												A
Reduction Gear												B
Magnetic (or mechanical) clutch												C
Gearing and Clutch												D
Cam Action												E
Spring Action												F
Flexible Shaft												G
Chain												H
Belt												I
Other than listed												J

MAJOR PART	2	1	X	X	X							
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Electric Motor												A
Handwheel												B
Clutch												C
Servo System												D
Lever Arm												E
Cylinder (hydraulic, pneumatic)												F
Switches												G
Tube and Tube Fittings												H

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART (Cont)	2	1	X	X	X							
Cam					I							
Packing Gland					J							
Shaft					K							
Gear					L							
Bearing					M							
Coupling					N							
Sleeve, Bushing					P							
Linkage - Universal Joint					Q							
Linkage - Swivel Joint					R							
Linkage - Ball Joint					S							
Linkage - Cross Bar Joint					T							
Pin					U							
Key					V							
Mechanical Spring					W							
Other than listed					X							
PART IDENTIFICATION	2	1	X	X	X	X						
General - Pneumatic or Hydraulic						A						
General - Electrical						B						
General - Mechanical						C						
Spring - Coil						D						
Spring - Flat						E						
Spring - Membrane						F						
Shaft - Hollow						G						
Shaft - Solid						H						
Gear - Worm						I						
Gear - Stub						J						
Gear - Bevel						K						
Gear - Miter						L						
Gear - Spur						M						
Gear - Helical						N						
Gear - Herringbone						P						
Bearing - Roller						Q						
Bearing - Ball						R						
Bearing - Sleeve						S						
Bearing - Tapered Roller						T						
Pin - Taper Dowel						U						
Pin - Straight Dowel						V						
Pin - Roll						W						
Pin - Cotter						X						
Other than listed						Y						
PRESSURE HEAD (psig)	2	1	X	X	X	X	X					
0-20							A					
20-50							B					
50-100							C					

	17	18	19	20	21	22	23	24	25	26	27	28
PRESSURE HEAD (psig) (Cont)	2	1	X	X	X	X	X					
100-200								D				
200-350								E				
350-500								F				
500-1000								G				
1000-2000								H				
2000-up								I				
RESPONSE TIME (Open to Close - seconds)	2	1	X	X	X	X	X	X				
0-1									A			
1-2									B			
2-5									C			
5-10									D			
10-20									E			
20-30									F			
30-45									G			
45-60									H			
60-90									I			
90-120									J			
120-up									K			
TORQUE (ft-lb)	2	1	X	X	X	X	X	X	X	X		
0-0.5											A	
0.5-1											B	
1-2											C	
2-3											D	
3-5											E	
5-10											F	
10-50											G	
50-100											H	
100-250											I	
250-500											J	
500-up											K	
TEMPERATURE (°F)	2	1	X	X	X	X	X	X	X	X	X	
0-200												A
200-400												B
400-600												C
600-800												D
800-1000												E
1000-1200												F
1200-up												G

	17	18	19	20	21	22	23	24	25	26	27	28	
ENVIRONMENTAL MEDIA OF PART	2	1	X	X	X	X	X	X	X	X	X	X	
Sodium													A
NaK													B
Water													C
Steam													D
Air													E
Inert Gas													F
Borated Solutions													G
MATERIAL OF PART	2	1	X	X	X	X	X	X	X	X	X	X	
Carbon Steel													A
Low-Alloy Steel													B
Ferritic Steel													C
Stainless (Austenitic) Steel, Type 304													D
Stainless (Austenitic) Steel, Type 316													E
Stainless (Austenitic) Steel, Type 347													F
Stainless (Austenitic) Steel, Other Type													G
Aluminum													H
Aluminum Bronze													I
Bronze													J
Hastelloy													K
Stellite													L
Copper													M
Copper Alloy													N
Titanium													P
Inconel													Q
Pot Metal (Copper or Lead)													R
Zinc													S
Lead or Tin													T
Ceramic													U
Plastics													V
Leather													W
Rubber													X
Asbestos													Y
Other than listed													Z
<u>HEAT EXCHANGER (Miscellaneous)</u>	2	2	X	X	X	X	X	X	X	X	X	X	
MAJOR TYPE	2	2	X										
Regenerator													A
Recuperator													B
Immersion Heater													C
Economizer													D

	17	18	19	20	21	22	23	24	25	26	27	28
SUB TYPE	2	2	X	X								
Shell and Tube					A							
Plate - Fin					B							
Rotary - Regenerator					C							
MAJOR PART	2	2	X	X	X							
Tube						A						
Header						B						
Shell						C						
Nozzle						D						
Baffle						E						
Plate						F						
Support						G						
Flange						H						
Bolt						I						
Gasket or Seal						J						
Tie Rod						K						
Head						L						
Tubesheet						M						
Tube - Tubesheet Weld or Bond						N						
PART IDENTIFICATION	2	2	X	X	X	X						
Finned Tube							A					
Flat Plate - Head							B					
Ellipsoidal - Head							C					
Primary Side Inlet - Nozzle							D					
Secondary Side Inlet - Nozzle							E					
Primary Side Outlet - Nozzle							F					
Secondary Side Outlet - Nozzle							G					
FLOW - PRIMARY SIDE (lb/hr)	2	2	X	X	X	X	X					
0-100								A				
100-500								B				
500-2,500								C				
2,500-10,000								D				
10,000-20,000								E				
20,000-50,000								F				
50,000-100,000								G				
100,000-up								H				
FLOW - SECONDARY SIDE (lb/hr)	2	2	X	X	X	X	X	X				
0-100									A			
100-500									B			
500-1,000									C			

	17	18	19	20	21	22	23	24	25	26	27	28
FLOW - SECONDARY SIDE (lb/hr) (Cont)	2	2	X	X	X	X	X	X				
1,000-2,000										D		
2,000-5,000										E		
5,000-10,000										F		
10,000-100,000										G		
100,000-up										H		
PRESSURE (psia)	2	2	X	X	X	X	X	X	X	X		
0-15											A	
15-30											B	
30-50											C	
50-100											D	
100-200											E	
200-500											F	
500-1000											G	
1000-1500											H	
1500-2000											I	
2000-2500											J	
2500-up											K	
TEMPERATURE (°F)	2	2	X	X	X	X	X	X	X	X	X	
0-100												A
100-200												B
200-400												C
400-600												D
600-800												E
800-1000												F
1000-1200												G
1200-up												H
ENVIRONMENTAL MEDIA OF PART	2	2	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Organic Liquid												C
Air												D
Nitrogen												E
Helium												F
Argon												G
Water												H
Steam												I
MATERIAL OF PART	2	2	X	X	X	X	X	X	X	X	X	X
Stainless Steel - Austenitic												A
Stainless Steel - Ferritic												B
Low-Carbon Steel												C

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART (Cont)	2	2	X	X	X	X	X	X	X	X	X	X
Soft Iron												D
Low-Alloy Steel												E
Copper or Copper Base Alloy												F
Nickel or Nickel Base Alloy												G
Graphite or Carbon												H
Ceramic												I
Other Non-ferrous Metals												J
Plastics and Rubber												K
<u>RUPTURE DISCS</u>	2	3	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	3	X									
Dished Diaphragm					A							
Shear Plate Diaphragm					B							
Dished Diaphragm with Cutting Edge					C							
SUB TYPE	2	3	X	X								
Single					A							
Double					B							
MAJOR PART	2	3	X	X	X							
Flange					A							
Cutter					B							
O-Ring					C							
Belleville Spring Washer					D							
Bolt					E							
Nut					F							
Welded Seal Ring					G							
Diaphragm					H							
Gasket					I							
Coupling					J							
Monitor Nozzle					K							
PART IDENTIFICATION	2	3	X	X	X	X						
Knife-edge Cutter						A						
Circular-edge Cutter						B						
Metal Gasket						C						
Non-metallic Gasket						D						
Metallic O-Ring						E						
Non-metallic O-Ring						F						

	17	18	19	20	21	22	23	24	25	26	27	28
RUPTURE PRESSURE (psig)	2	3	X	X	X	X	X					
0-5							A					
5-10							B					
10-20							C					
20-50							D					
50-100							E					
100-500							F					
500-1000							G					
1000-2000							H					
2000-up							I					
DISC DIAMETER (inches)	2	3	X	X	X	X	X	X				
0-2								A				
2-4								B				
4-6								C				
6-8								D				
8-10								E				
10-12								F				
12-16								G				
16-20								H				
20-24								I				
24-30								J				
30-up								K				
TEMPERATURE (°F)	2	3	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	2	3	X	X	X	X	X	X	X	X	X	X
Air												A
Argon												B
Nitrogen												C
Helium												D
Sodium												E
Sodium/Air												F
Sodium/Argon												G
Sodium/Nitrogen												H
Sodium/Helium												I
Water												J
Other than listed												K

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MATERIAL OF PART	2	3	X	X	X	X	X	X	X	X	X	X
Aluminum												A
Carbon Steel												B
300 Series Stainless Steel												C
High-Nickel-Alloy Steel												D
Low-Alloy Steel												E
Asbestos												F
Soft Iron												G
Plastic												H
Ferritic Steel												I
<u>TUBE AND FITTINGS</u>	2	4	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	4	X									
Hydraulic												A
Pneumatic												B
SUB TYPE	2	4	X	X								
Welded												A
Threaded												B
Flared												C
Clamp												D
Bolted Flange												E
Swedge												F
Snap-on												G
Quick Disconnect												H
MAJOR PART	2	4	X	X	X							
Tube												A
Connector												B
Elbow												C
Cross												D
Union												E
Plug												F
Plug and Bleeder												G
Tee												H
Nipple												I
Sleeve												J
Ferrule												K
Nut												L
Expansion Joint												M
Seal												N

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PART IDENTIFICATION	2	4	X	X	X	X						
Bulkhead-Connector							A					
Quick Disconnect-Connector							B					
90° - Elbow							C					
45° - Elbow							D					
Bulkhead/90° - Elbow							E					
Bulkhead/45° - Elbow							F					
Bulkhead/Tee							G					
O-Ring - Seal							H					
Coupling - Nut							I					
Lock - Nut							J					
PRESSURE (psig)	2	4	X	X	X	X	X					
0-20								A				
20-50								B				
50-100								C				
100-300								D				
300-500								E				
500-750								F				
750-1000								G				
1000-1500								H				
1500-2500								I				
2500-5000								J				
5000-up								K				
TUBE, OUTSIDE DIAMETER (inch)	2	4	X	X	X	X	X	X				
1/8-3/16									A			
3/16-1/4									B			
1/4-5/16									C			
5/16-3/8									D			
3/8-1/2									E			
1/2-5/8									F			
5/8-3/4									G			
3/4-1									H			
1-1-1/4									I			
1-1/4-1-1/2									J			
1-1/2-1-3/4									K			
1-3/4-2									L			
2-up									M			
TEMPERATURE (°F)	2	4	X	X	X	X	X	X	X	X		
-450-0											A	
0-100											B	
100-200											C	
200-400											D	
400-600											E	

	17	18	19	20	21	22	23	24	25	26	27	28
TEMPERATURE (°F) (Cont)	2	4	X	X	X	X	X	X	X	X		
600-800											A	
800-1000											B	
1000-1200											C	
1200-up											D	
ENVIRONMENTAL MEDIA OF PART	2	4	X	X	X	X	X	X	X	X	X	X
Argon												A
Helium												B
Nitrogen												C
Water												D
Steam												E
Air												F
Sodium												G
NaK												H
MATERIAL OF PART	2	4	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Ferretic Steel												B
Stainless (Austenitic) Steel, Type 304												C
Stainless (Austenitic) Steel, Type 347												D
Stainless (Austenitic) Steel, Type 316												E
High-Alloy Steel												F
Aluminum or Aluminum Alloy												G
Brass												H
Nickel or Nickel Alloy												I
Copper or Copper Alloy												J
Plastic												K
Nylon												L
Rubber												M
COMPRESSORS	2	5	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	5	X									
Axial Flow												A
Rotary												B
Centrifugal												C
Reciprocating												D
SUB TYPE	2	5	X	X								
Single Stage												A
Two-Stage												B
Multi-Stage												C

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART	2	5	X	X	X							
Cylinder						A						
Drive						B						
Crankshaft						C						
Housing						D						
Connecting Rod						E						
Piston						F						
Valve						G						
Heater						H						
Pump (oil)						I						
Shaft						J						
Journals and Bearings						K						
Blade or Vane						L						
Seal						M						
Filter						N						
Roller						P						
Impeller						Q						
PART IDENTIFICATION	2	5	X	X	X	X						
Piston Ring							A					
Piston Pin							B					
Seal (rotary)							C					
Seal (stationary)							D					
Drive Belt							E					
Drive Chain							F					
Drive Gear							G					
Direct Drive							H					
Suction Valve							I					
Discharge Valve							J					
PRESSURE (psig)	2	5	X	X	X	X	X					
0-10								A				
10-25								B				
25-50								C				
50-100								D				
100-200								E				
200-500								F				
500-1000								G				
1000-3000								H				
3000-5000								I				
5000-up								J				
INTAKE FLOW (scfm)	2	5	X	X	X	X	X	X				
0-100									A			
100-500									B			
500-1,000									C			

	17	18	19	20	21	22	23	24	25	26	27	28
INTAKE FLOW (scfm) (Cont)	2	5	X	X	X	X	X	X				
1,000-5,000									D			
5,000-10,000									E			
10,000-50,000									F			
50,000-100,000									G			
100,000-500,000									H			
500,000-up									I			
SPEED (rpm)	2	5	X	X	X	X	X	X	X	X		
0-100										A		
100-500										B		
500-1,000										C		
1,000-2,000										D		
2,000-4,000										E		
4,000-10,000										F		
10,000-up										G		
TEMPERATURE (°F)	2	5	X	X	X	X	X	X	X	X	X	
0-100											A	
100-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	2	5	X	X	X	X	X	X	X	X	X	X
Air												A
Liquid Metal												B
Water												C
Borated Solution												D
Nitrogen												E
Argon												F
Helium												G
Hydrogen												H
MATERIAL OF PART	2	5	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Ferritic Steel												C
Stainless (Austenitic) Steel, Type 304												D
Stainless (Austenitic) Steel, Type 316												E
Stainless (Austenitic) Steel, Type 347												F

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MATERIAL OF PART (Cont)	2	5	X	X	X	X	X	X	X	X	X	X
Other Steel												G
Aluminum or Aluminum Alloy												H
Copper or Copper Alloy												I
Nickel or Nickel Alloy												J
Beryllium												K
Zinc												L
Ceramic												M
Magnesium												N
Titanium												P
Asbestos												Q
Plastic												R
Rubber												S
Stellite												T
Other												U
<u>AIR DRYERS</u>	2	6	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	6	X									
Heat Reactivated				A								
Heat Reactivated with External Blower				B								
Heatless - Manual Operated				C								
Heatless - Automatic Regeneration				D								
MAJOR PART	2	6	X	X	X							
Valve					A							
Gage					B							
Heating Elements					C							
Pneumatic Elements					D							
Desiccant					E							
Timer					F							
Pressure Switch					G							
Filter					H							
Heat Exchanger					I							
Motor/Fan					J							
Compressor					K							
Diaphragm					L							
Screen					M							
Transformer					N							
Drain					P							
Tower					Q							
Flowmeter					R							
Clevis Assembly					S							
Pilot Light					T							

PART IDENTIFICATION

Plug Valve
 Solenoid Valve
 Safety Valve
 Hot Gas Bypass Valve
 Temperature Gage
 Pressure Gage
 Flow Gage
 Fasteners

17 18 19 20 21 22 23 24 25 26 27 28

2 6 X X X X

A
 B
 C
 D
 E
 F
 G
 H

FLOW (scfm)

0-50
 50-100
 100-200
 200-350
 350-500
 500-1,000
 1,000-2,000
 2,000-3,000
 3,000-5,000
 5,000-10,000
 10,000-50,000
 50,000-100,000
 100,000-up

2 6 X X X X X

A
 B
 C
 D
 E
 F
 G
 H
 I
 J
 K
 L
 M

PRESSURE (psig)

0-5
 5-10
 10-20
 20-50
 50-100
 100-200
 200-350
 350-500
 500-1000
 1000-up

2 6 X X X X X X

A
 B
 C
 D
 E
 F
 G
 H
 I
 J

DEW POINT (°F)

-160 - -120
 -120 - -80
 -80 - -40
 -40 - 0
 0 - 40
 40-80
 80-120
 120-160

2 6 X X X X X X X

A
 B
 C
 D
 E
 F
 G
 H

	17	18	19	20	21	22	23	24	25	26	27	28
TEMPERATURE (°F)	2	6	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	2	6	X	X	X	X	X	X	X	X	X	
Air												A
Refrigerant												B
Helium												C
Hydrogen												D
Argon												E
Nitrogen												F
Lubricant												G
MATERIAL OF PART	2	6	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Stainless (Austenitic) Steel, Type 304												B
Stainless (Austenitic) Steel, Type 316												C
Stainless (Austenitic) Steel, Type 347												D
Ferritic Steel												E
Aluminum or Aluminum Alloy												F
Copper or Copper Alloy												G
Nickel or Nickel Alloy												H
Alumina												I
Dorocel												J
Micro Metallic												K
Rubber												L
Plastic												M
Leather												N
Asbestos												P
Ceramic												Q
<u>FILTERS AND STRAINERS</u>	2	7	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	7	X									
Gas				A								
Liquid				B								
SUB TYPE	2	7	X	X								
Intermittent Service				A								
Continuous Service				B								

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MAJOR PART	2	7	X	X	X							
Filter Element						A						
Housing or Tank						B						
Access Cover						C						
Inlet Nozzle						D						
Discharge Nozzle						E						
Plate						F						
Frame						G						
PART IDENTIFICATION	2	7	X	X	X	X						
Metallic - Element							A					
Organic - Element							B					
Synthetic - Element							C					
Electric - Element (ionizer)							D					
SMALLEST ARRESTED PARTICLE (microns)	2	7	X	X	X	X	X	X	X			
0-1										A		
1-5										B		
5-10										C		
10-20										D		
20-30										E		
30-50										F		
50-up										G		
FLOW (gpm)	2	7	X	X	X	X	X	X	X	X		
0-10											A	
10-30											B	
30-50											C	
50-100											D	
100-300											E	
300-500											F	
500-1,000											G	
1,000-5,000											H	
5,000-10,000											I	
10,000-50,000											J	
50,000-100,000											K	
100,000-up											L	
TEMPERATURE (°F)	2	7	X	X	X	X	X	X	X	X	X	
32-200												A
200-400												B
400-600												C
600-800												D
800-1000												E

	17	18	19	20	21	22	23	24	25	26	27	28
TEMPERATURE (°F) (Cont)	2	7	X	X	X	X	X	X	X	X		
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	2	7	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Water												C
Steam												D
Helium												E
Hydrogen												F
Argon												G
Nitrogen												H
Air												I
Borated Solutions												J
MATERIAL OF PART	2	7	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
High-Alloy Steel												B
Stainless (Austenitic) Steel, Type 304												C
Stainless (Austenitic) Steel, Type 316												D
Stainless (Austenitic) Steel, Type 347												E
Ferritic Steel												F
Other Steel												G
Aluminum												H
Aluminum Bronze												I
Copper or Copper Alloy												J
Nickel or Nickel Alloy												K
Monel												L
Iron												M
Silica Gel												N
Asbestos												P
Cork												Q
Cork and Rubber												R
Rubber												S
Glass												T
Cellulose												U
Saran												V
Charcoal												W
Dynel												X
<u>BLOWERS AND FANS</u>	2	8	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	2	8	X									
Centrifugal												A
Axial Flow												B
Propeller												C

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SUB TYPE	2	8	X	X								
Single-Stage					A							
Two-Stage					B							
Multi-Stage					C							
MAJOR PART	2	8	X	X	X							
Support Structure						A						
Hub						B						
Motor						C						
Bearing						D						
Shaft						E						
Housing						F						
Guide Vanes						G						
Blade						H						
Transmission						I						
PART IDENTIFICATION	2	8	X	X	X	X						
Fixed Pitch Blade							A					
Adjustable Pitch Blade							B					
Scroll Housing							C					
Cylindrical Housing							D					
STATIC PRESSURE RISE (inches H ₂ O)	2	8	X	X	X	X	X					
0-5								A				
5-10								B				
10-15								C				
15-20								D				
20-25								E				
25-30								F				
30-35								G				
35-40								H				
40-50								I				
50-up								J				
FLOW (scfm)	2	8	X	X	X	X	X	X				
0-1,000									A			
1,000-5,000									B			
5,000-25,000									C			
25,000-100,000									D			
100,000-500,000									E			
500,000-1,000,000									F			
1,000,000-up									G			

	17	18	19	20	21	22	23	24	25	26	27	28
INPUT POWER (bhp)	2	8	X	X	X	X	X	X	X			
0-1										A		
1-5										B		
5-10										C		
10-50										D		
50-100										E		
100-500										F		
500-1000										G		
1000-up										H		
TEMPERATURE (°F)	2	8	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	2	8	X	X	X	X	X	X	X	X	X	
Air												A
Nitrogen												B
Argon												C
Helium												D
Other than listed												E
MATERIAL OF PART	2	8	X	X	X	X	X	X	X	X	X	X
Low-Alloy Steel												A
Stainless Steel, 300 Series												B
Stainless Steel, 400 Series												C
Aluminum or Aluminum Alloy												D
Copper or Copper Alloy												E
Magnesium												F
Zinc												G
Titanium												H
Beryllium												I
Lead or Lead Alloy												J
Plastic												K
Ceramic												L
Rubber												M
Asbestos												N
Leather												P
Pot Metal												Q

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<u>CONDENSERS</u>	3	1	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	1	X									
Direct Contact					A							
Surface Condenser (shell and tube)					B							
Atmosphere					C							
SUB TYPE	3	1	X	X								
Single Pass					A							
Two-Pass					B							
Three-Pass					C							
Multiple Pass					D							
MAJOR PART	3	1	X	X	X							
Duct						A						
Baffle						B						
Hotwell						C						
Tube						D						
Tubesheet						E						
Stuffing Box						F						
Tube Support Plates						G						
Water Box						H						
Shell						I						
Steam Jet Air Ejector (integral)						J						
Nozzle						K						
Vent						L						
Pipe						M						
Manway						N						
Expansion Joint						P						
Spring Mounted Support						Q						
PART IDENTIFICATION	3	1	X	X	X	X						
Water - Inlet Nozzle							A					
Water - Outlet Nozzle							B					
Steam - Inlet-Nozzle							C					
Condensate - Outlet Nozzle							D					
Air Exhaust Nozzle							E					
Ribs - Shell							F					
TUBING DIAMETER (inch)	3	1	X	X	X	X	X					
Less than 5/8								A				
5/8-3/4								B				
3/4-7/8								C				
7/8-1.0								D				
1.0-2.0								E				
Greater than 2.0								F				

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STEAM PRESSURE (in. Hg Absolute)	3	1	X	X	X	X	X	X				
0-0.5									A			
0.5-0.75									B			
0.75-1.0									C			
1.0-1.5									D			
1.5-2.0									E			
2.0-2.5									F			
2.5-3.0									G			
3.0-up									H			
HEAT TRANSFER, SURFACE AREA (ft ²)	3	1	X	X	X	X	X	X	X			
0-10,000										A		
10,000-50,000										B		
50,000-100,000										C		
100,000-200,000										D		
200,000-400,000										E		
400,000-600,000										F		
600,000-up										G		
COOLING WATER TEMPERATURE (°F)	3	1	X	X	X	X	X	X	X	X		
50 or Less											A	
50-60											B	
60-70											C	
70-80											D	
80-90											E	
90 or More											F	
ENVIRONMENTAL MEDIA OF PART	3	1	X	X	X	X	X	X	X	X	X	X
Salt Water												A
Brackish Water												B
Air												C
Demineralized Water												D
MATERIAL OF PART	3	1	X	X	X	X	X	X	X	X	X	X
Admiralty Metal												A
Arsenical Copper												B
Aluminum												C
Aluminum Brass												D
Muntz Metal												E
Aluminum Bronze												F
90-10 Copper-Nickel												G
70-30 Copper-Nickel												H
Type 304 Stainless Steel												I

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<u>TRAPS (GENERAL)</u>	3	3	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	3	X									
Vapor			A									
Condensate			B									
Freeze			C									
SUB TYPE	3	3	X	X								
Sodium Vapor				A								
NaK Vapor				B								
Water Vapor				C								
Organic Vapor				D								
MAJOR PART	3	3	X	X	X							
Pipe					A							
Tube					B							
Valve					C							
Mesh					D							
Strainer					E							
Pipe End Cap					F							
Pipe Tee					G							
Seal					H							
TEMPERATURE (°F)	3	3	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-400											D	
400-500											E	
500-700											F	
700-900											G	
900-1100											H	
1100-1300											I	
1300-up											J	
ENVIRONMENTAL MEDIA OF PART	3	3	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Water												C
Steam												D
Helium												E
Hydrogen												F
Argon												G
Nitrogen												H
Air												I
Borated Solutions												J

	17	18	19	20	21	22	23	24	25	26	27	28	
MATERIAL OF PART	3	3	X	X	X	X	X	X	X	X	X	X	
Carbon Steel													A
High-Alloy Steel													B
Stainless (Austenitic) Steel, Type 304													C
Stainless (Austenitic) Steel, Type 316													D
Stainless (Austenitic) Steel, Type 347													E
Ferritic Steel													F
Other Steel													G
Aluminum													H
Aluminum Bronze													I
Copper or Copper Alloy													J
Nickel or Nickel Alloy													K
Monel													L
Iron													M
Silica Gel													N
Asbestos													P
Cork													Q
Cork and Rubber													R
Rubber													S
Glass													T
Cellulose													U
Charcoal													V
<u>COOLERS (Liquid Metal to Air)</u>	3	4	X	X	X	X	X	X	X	X	X	X	
MAJOR TYPE	3	4	X										
Forced													A
Induced Draft													B
Natural Convection													C
SUB TYPE	3	4	X	X									
Horizontal Tube Bundle -													
Electrical Preheat													A
Horizontal Tube Bundle -													
Gas Fired Preheat													B
Pitched Tube Bundle -													
Electrical Preheat													C
Pitched Tube Bundle -													
Gas Fired Preheat													D
MAJOR PART	3	4	X	X	X								
Extended Surface Tube													A
Header													B
Shutters													C
Plenum Chamber													D

17 18 19 20 21 22 23 24 25 26 27 28

MAJOR PART (Cont)

	3	4	X	X	X	
Fan and Shroud						E
Fan Drive						F
Fan Motor						G
Ducting						H
Preheater						I
Supporting Structure						J
Stack						K
Drive Shaft						L
Electric Heaters						M
Gas Burner or Combustion Chamber						N
Air Filter						P
Blower						Q
Insulation						R

PART IDENTIFICATION

	3	4	X	X	X	X
Integral (finned tube)						A
Footed (finned tube)						B
Spiral Groove (finned tube)						C
Spiral Groove and Footed (finned tube)						D
Welded Box (header)						E
Manifold (header)						F
Cover Plate (header)						G
Gear Reducer (fan drive)						H
Direct Drive (fan drive)						I
Fixed Pitch Blade (fan)						J
Variable Pitch Blade (fan)						K
Blades (shutter)						L
Hydraulic Fan Motor						M
Electric Fan Motor						N

COOLING CAPACITY - PRIMARY
SIDE (Btu/hr)

	3	4	X	X	X	X	X
0 to 10^6							A
10^6 to 5×10^6							B
5×10^6 to 25×10^6							C
25×10^6 to 100×10^6							D
100×10^6 to 200×10^6							E
200×10^6 and up							F

FLOW - SECONDARY SIDE (scfm-air)

	3	4	X	X	X	X	X	X
0-1,000								A
1,000-5,000								B
5,000-25,000								C
25,000-100,000								D
100,000-500,000								E

	17	18	19	20	21	22	23	24	25	26	27	28
FLOW - SECONDARY SIDE (scfm-air) (Cont)	3	4	X	X	X	X	X	X				
500,000-1,000,000									F			
1,000,000-up									G			
FLOW (lbs/hr)	3	4	X	X	X	X	X	X	X			
0-1,000										A		
1,000-5,000										B		
5,000-25,000										C		
25,000-125,000										D		
125,000-625,000										E		
625,000-3,125,000										F		
3,125,000-up										G		
TEMPERATURE (°F)	3	4	X	X	X	X	X	X	X	X		
32-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
MATERIAL OF PART	3	4	X	X	X	X	X	X	X	X	X	X
Iron												A
Carbon Steel												B
High-Alloy Steel												C
Stainless (Austenitic) Steel, Type 304												D
Stainless (Austenitic) Steel, Type 316												E
Stainless (Austenitic) Steel, Type 347												F
Ferritic Steel												G
Other Steel												H
Aluminum or Aluminum Alloy												I
Copper or Copper Alloy												J
Nickel or Nickel Alloy												K
Carboloy												L
Hastelloy												M
Monel												N
Stellite												P
Titanium												Q
Magnesium												R
Plastic												S
Rubber												T
Asbestos												U
Zinc												V
Ceramic												W
Leather												X
Other than listed												Y

17 18 19 20 21 22 23 24 25 26 27 28

COOLERS (Other Than Liquid Metal
to Air)

MAJOR TYPE

Oil-to-Air
Water-to-Air
Nitrogen-to-Air
Argon-to-Air
Radiator
Tower - Evaporative

SUB TYPE

Shell and Tube
Plate - Fin

MAJOR PART

Shell
Tube
Plate
Head
Header
Baffle
Tie Rod
Support
Louvres
Fan
Duct
Tubesheet
Nozzle
Seal

PART IDENTIFICATION

Finned Tube
Primary Side - Inlet Nozzle
Secondary Side - Inlet Nozzle
Primary Side - Outlet Nozzle
Secondary Side - Outlet Nozzle

FLOW - PRIMARY SIDE (lb/hr)

0-100
100-500
500-1,000
1,000-2,000
2,000-5,000
5,000-10,000
10,000-100,000
100,000-up

3 5 X X X X X X X X X X

3 5 X

A
B
C
D
E
F

3 5 X X

A
B

3 5 X X X

A
B
C
D
E
F
G
H
I
J
K
L
M
N

3 5 X X X X

A
B
C
D
E

3 5 X X X X X

A
B
C
D
E
F
G
H

	17	18	19	20	21	22	23	24	25	26	27	28
FLOW - SECONDARY SIDE (scfm-air)	3	5	X	X	X	X	X	X				
0-1,000										A		
1,000-5,000										B		
5,000-25,000										C		
25,000-100,000										D		
100,000-500,000										E		
500,000-1,000,000										F		
1,000,000-up										G		
PRESSURE PRIMARY SIDE (psia)	3	5	X	X	X	X	X	X	X			
0-15										A		
15-30										B		
30-50										C		
50-100										D		
100-200										E		
200-500										F		
500-1000										G		
1000-1500										H		
1500-2000										I		
2000-up										J		
TEMPERATURE (°F)	3	5	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	3	5	X	X	X	X	X	X	X	X	X	
Oil												A
Air												B
Water												C
Nitrogen												D
Argon												E
MATERIAL OF PART	3	5	X	X	X	X	X	X	X	X	X	X
Stainless Steel - Austenitic												A
Stainless Steel - Ferritic												B
Low-Alloy Steel												C
Soft Iron												D
Graphite or Carbon												E
Wood												F

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MATERIAL OF PART (Cont)	3	5	X	X	X	X	X	X	X	X	X	X
Copper or Copper Alloy												G
Aluminum or Aluminum Alloy												H
Nickel or Nickel Alloy												I
Rubber or Plastics												J
Ceramic or Glass												K
<u>COLD TRAPS/HOT TRAPS</u>	3	6	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	6	X									
Hot Trap				A								
Cold Trap				B								
SUB TYPE	3	6	X	X								
Forced Circulation				A								
Natural Circulation				B								
MAJOR PART	3	6	X	X	X							
Economizer Coil					A							
Wire Mesh					B							
Corrugated Sheet or Foil					C							
Shell or Housing					D							
Heater					E							
Cooling Jacket					F							
Insulation					G							
Nozzle					H							
Tie Rods					I							
Support Plate					J							
PART IDENTIFICATION	3	6	X	X	X	X						
Relief Nozzle						A						
Inlet Nozzle - Primary Coolant						B						
Outlet Nozzle - Primary Coolant						C						
Inlet Nozzle - Secondary Coolant						D						
Outlet Nozzle - Secondary Coolant						E						
SECONDARY COOLING MEDIA	3	6	X	X	X	X	X					
NaK							A					
Kerosene							B					
Nitrogen							C					
Air							D					
Water							E					
Dowtherm							F					

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TRAP CAPACITY - OXIDES (lb)	3	6	X	X	X	X	X	X				
0-25										A		
25-50										B		
50-75										C		
75-100										D		
100-150										E		
150-200										F		
200-300										G		
300-500										H		
500-up										I		
TEMPERATURE (°F)	3	6	X	X	X	X	X	X	X	X		
200-250											A	
250-300											B	
300-350											C	
350-400											D	
400-450											E	
450-500											F	
500-700											G	
700-900											H	
900-1100											I	
1100-1300											J	
ENVIRONMENTAL MEDIA OF PART	3	6	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Nitrogen												C
Argon												D
Helium												E
MATERIAL OF PART	3	6	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Stainless Steel, Type 304												C
Stainless Steel, Type 316												D
Stainless Steel, Type 347												E
Stainless Steel, Type 410												F
Other Type of Steel												G
Zirconium												H
<u>PLUGGING METER</u>	3	7	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	7	X									
Fixed Orifice												A
Slotted Valve												B

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SUB TYPE	3	7	X	X								
Manual				A								
Automatic				B								
MAJOR PART	3	7	X	X	X							
Valve					A							
Orifice					B							
Thermocouple Well					C							
Pipe Section					D							
FLOW (gpm)	3	7	X	X	X	X	X					
0-0.2							A					
0.2-0.5							B					
0.5-1.0							C					
1.0-1.5							D					
1.5-2.0							E					
2.0-up							F					
TEMPERATURE (°F)	3	7	X	X	X	X	X	X	X	X		
150-200										A		
200-250										B		
250-300										C		
300-500										D		
500-up										E		
MATERIAL OF PART	3	7	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 316												B
Stellite												C
Inconel												D
Carbide												E
Nickel or Nickel Alloy												F
Chromium or Chromium Alloy												G
<u>HEATERS (Electrical)</u>	3	8	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	8	X									
Resistance			A									
Induction			B									
Dielectric			C									
Electric Arc			D									

	17	18	19	20	21	22	23	24	25	26	27	28
SUB TYPE	3	8	X	X								
Immersion - Resistance					A							
Contact - Resistance					B							
Radiant - Resistance					C							
MAJOR PART	3	8	X	X	X							
Resistance Wire						A						
Sheath						B						
End Cap						C						
Lead						D						
Reflector						E						
Support Bracket						F						
Insulation						G						
Lamps						H						
Housing						I						
Terminal						J						
Iron Core or Jacket						K						
Nozzel						L						
Electrode						M						
PART IDENTIFICATION	3	8	X	X	X	X						
Threaded Stud - Terminal							A					
Screw - Terminal							B					
Plug - Terminal							C					
Hermetic Seal - Terminal							D					
End Cap - Welded							E					
End Cap - Threaded							F					
RATING (watts)	3	8	X	X	X	X	X					
0-100								A				
100-250								B				
250-500								C				
500-750								D				
750-1,000								E				
1,000-2,500								F				
2,500-5,000								G				
5,000-10,000								H				
10,000-up								I				
RATING (volts)	3	8	X	X	X	X	X	X				
120									A			
240									B			
480									C			
600									D			

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TEMPERATURE OF SHEATH (°F)	3	8	X	X	X	X	X	X	X	X		
0-250											A	
250-500											B	
500-1000											C	
1000-1500											D	
1500-2000											E	
2000-3000											F	
3000-4000											G	
4000-up											H	
ENVIRONMENTAL MEDIA OF PART	3	8	X	X	X	X	X	X	X	X	X	X
Nitrogen												A
Argon												B
Air												C
Helium												D
Sodium												E
NaK												F
Water												G
MATERIAL OF PART	3	8	X	X	X	X	X	X	X	X	X	X
Stainless Steel (300 Series)												A
Stainless Steel (400 Series)												B
Copper and Copper Alloys												C
Magnesium Oxide												D
Mica												E
Alumina												F
Silicone												G
Plastic												H
Quartz												I
High-Nickel Alloy												J
Lava												K
Carbon Steel												L
<u>INTERMEDIATE HEAT EXCHANGER</u>	3	9	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	3	9	X									
Horizontal Unit - Primary on Shell Side												A
Horizontal Unit - Primary on Tube Side												B
Vertical Unit - Primary on Shell Side												C
Vertical Unit - Primary on Tube Side												D

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SUB TYPE	3	9	X	X								
Straight Tube					A							
Spiral Tube					B							
U-Tube					C							
Expansion Bends in Tube					D							
MAJOR PART	3	9	X	X	X							
Bellows					A							
Tubes					B							
Baffle					C							
Tubesheet					D							
Nozzle					E							
Tie Rod					F							
Gasket					G							
Outer Jacket					H							
Insulation					I							
Shroud Support					J							
Flange					K							
O-Ring - Metal					L							
Shell					M							
Head					N							
Shroud					P							
PART IDENTIFICATION	3	9	X	X	X	X						
Primary Inlet - Nozzle						A						
Primary Outlet - Nozzle						B						
Secondary Inlet - Nozzle						C						
Secondary Outlet - Nozzle						D						
PRESSURE (psig)	3	9	X	X	X	X	X					
0-5							A					
5-15							B					
15-25							C					
25-40							D					
40-60							E					
60-100							F					
100-150							G					
150-200							H					
200-up							I					
FLOW RATE (lb/hr)	3	9	X	X	X	X	X	X				
Below 10^4								A				
1×10^4 to 1×10^5								B				
1×10^5 to 2×10^5								C				
2×10^5 to 5×10^5								D				

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FLOW RATE (lb/hr) (Cont)	3	9	X	X	X	X	X	X				
5 x 10 ⁵ to 1 x 10 ⁶									E			
1 x 10 ⁶ to 2 x 10 ⁶									F			
2 x 10 ⁶ to 1 x 10 ⁷									G			
1 x 10 ⁷ to 3 x 10 ⁷									H			
3 x 10 ⁷ and up									I			
TEMPERATURE (°F)	3	9	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	3	9	X	X	X	X	X	X	X	X	X	X
Air												A
Argon												B
Nitrogen												C
Sodium												D
Helium												E
MATERIAL OF PART	3	9	X	X	X	X	X	X	X	X	X	X
Stainless (Austenitic) Steel, Type 304												A
Stainless (Austenitic) Steel, Type 316												B
Stainless (Austenitic) Steel, Type 347												C
Nickel or Nickel Alloy												D
Copper or Copper Alloy												E
Magnesium												F
Aluminum												G
Titanium												H
Inconel												I
Monel												J
Carboloy												K
Cast Iron												L
Low Alloy Steel												M
Ferritic Steel												N
Asbestos												P
Ceramic												Q
Other than listed												R

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<u>STEAM GENERATORS</u>	4	0	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	0	X									
Drum Type - Natural Circulation				A								
Once-Through Type				B								
Special Purpose				C								
SUB TYPE	4	0	X	X								
Vertical (shell and hockey-stick tubes)					A							
Vertical (shell and sine-wave tubes)					B							
Horizontal (shell and U-tubes)					C							
Horizontal (shell and bayonet tubes)					D							
MAJOR PART	4	0	X	X	X							
Baffle Plate					A							
Shell					B							
Head					C							
Header					D							
Inlet Nozzle, Steam-Water					E							
Inlet Nozzle, Primary Side					F							
Outlet Nozzle, Steam-Water					G							
Outlet Nozzle, Primary Side					H							
Tubesheet					I							
Shroud					J							
Tube - Single Wall					K							
Tube - Double Wall					L							
Tube Cap					M							
Rupture Disc					N							
Manway					P							
Drain					Q							
Expansion Bellows					R							
PRESSURE-STEAM (psig)	4	0	X	X	X	X	X					
0-100								A				
100-300								B				
300-500								C				
500-1000								D				
1000-2000								E				
2000-3000								F				
3000-4000								G				
4000-up								H				

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FLOW-PRIMARY (lb/hr)	4	0	X	X	X	X	X	X				
10 to 10×10^3									A			
10×10^3 to 50×10^3									B			
50×10^3 to 10×10^4									C			
10×10^4 to 50×10^4									D			
50×10^4 to 10×10^5									E			
10×10^5 to 50×10^5									F			
50×10^5 to 10×10^6									G			
10×10^6 to 50×10^6									H			
50×10^6 and up									I			
FLOW-STEAM (lb/hr)	4	0	X	X	X	X	X	X	X			
10 to 10×10^3										A		
10×10^3 to 50×10^3										B		
50×10^3 to 10×10^4										C		
10×10^4 to 50×10^4										D		
50×10^4 to 10×10^5										E		
10×10^5 to 50×10^5										F		
50×10^5 to 10×10^6										G		
10×10^6 to 50×10^6										H		
50×10^6 and up										I		
TEMPERATURE-STEAM (°F)	4	0	X	X	X	X	X	X	X	X		
200-700											A	
700-1040											B	
1040-1200											C	
1200-up											D	
ENVIRONMENTAL MEDIA- PRIMARY SIDE	4	0	X	X	X	X	X	X	X	X	X	
Water												A
Air												B
Sodium												C
NaK												D
Inert Gas												E
Salt												F
Other than listed												G
MATERIAL OF PART	4	0	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 316												B
Stainless Steel, Type 347												C
Nickel or Nickel Alloy												D
Copper or Copper Alloy												E

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MATERIAL OF PART (Cont)	4	0	X	X	X	X	X	X	X	X	X	X
Magnesium												F
Aluminum												G
Titanium												H
Inconel												I
Monel												J
Carboloy												K
Cast Iron												L
Low-Alloy Steel												M
Ferritic Steel												N
Ceramic												P
Asbestos												Q
Other than listed												R
<u>FURNACE EQUIPMENT</u>	4	1	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	1	X									
Gas Fuel					A							
Liquid Fuel					B							
SUB TYPE	4	1	X	X								
Vaporizing Burner - Liquid Fuel					A							
Atomizing Burner - Liquid Fuel					B							
Premix Burner - Gas Fuel					C							
Nozzle Mix Burner - Gas Fuel					D							
MAJOR PART	4	1	X	X	X							
Burner Unit					A							
Furnace					B							
Flame Holder					C							
Pump					D							
Valve					E							
Insulation					F							
Seal					G							
Line or Duct					H							
Startup Oil Heater					I							
PART IDENTIFICATION	4	1	X	X	X	X						
Fuel Line						A						
Air Inlet - Duct						B						
Furnace Metal Casing - Seal						C						

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BURNER OUTPUT (Btu/hr)	4	1	X	X	X	X	X					
0-10 ³							A					
10 ³ -10 ⁴							B					
10 ⁴ -10 ⁵							C					
10 ⁵ -10 ⁶							D					
10 ⁶ -up							E					
TEMPERATURE (°F)	4	1	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-500											D	
500-700											E	
700-1100											F	
1100-1300											G	
1300-1600											H	
1600-1900											I	
1900-2300											J	
2300-up											K	
ENVIRONMENTAL MEDIA OF PART	4	1	X	X	X	X	X	X	X	X	X	X
Combustable Products												A
Air												B
Hydrocarbon Gaseous Fuel												C
Hydrocarbon Liquid Fuel												D
MATERIAL OF PART	4	1	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Stainless Steel, Austenitic												B
Stainless Steel, Ferritic												C
Low-Alloy Steel												D
Plastics and Rubber												E
Ceramics												F
Carbon												G
Mica												H
Non-ferrous Metals												I
RECOMBINERS	4	2	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	2	X									
Catalytic							A					
Flame							B					

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MAJOR PART	4	2	X	X	X							
Combustion Chamber						A						
Catalyst Chamber						B						
Burner						C						
Gas Inlet Nozzle						D						
Steam Outlet Nozzle						E						
Valve						F						
Bypass Line						G						
Pressure Relief Nozzle						H						
GAS FLOW RATE (scfm)	4	2	X	X	X	X	X					
0-1,000								A				
1,000-2,000								B				
2,000-5,000								C				
5,000-10,000								D				
10,000-20,000								E				
20,000-30,000								F				
30,000-up								G				
TEMPERATURE (°F)	4	2	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-500											D	
500-700											E	
700-900											F	
900-1300											G	
1300-1800											H	
1800-up											I	
ENVIRONMENTAL MEDIA OF PART	4	2	X	X	X	X	X	X	X	X	X	X
Decomposed Gas Mixture												A
Air												B
Steam												C
Water												D
MATERIAL OF PART	4	2	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Austenitic												A
Stainless Steel, Ferritic												B
Carbon Steel												C
Low-Alloy Steel												D
Carbon Steel												E
Alumina and Platinum												F
Other Non-ferrous Metals												G
Ceramics												H

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<u>DESUPERHEATERS</u>	4	3	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	3	X									
Controlled Water Spray			A									
Submerged Tube			B									
MAJOR PART	4	3	X	X	X							
Valve					A							
Drum or Tank					B							
Lifting Lug					C							
Support Plate					D							
Pipe Section					E							
Flange					F							
Nozzle					G							
Tube					H							
Support Lug					I							
Seal					J							
PART IDENTIFICATION	4	3	X	X	X	X						
Drain Valve						A						
Bypass Valve						B						
Superheated Steam Inlet Nozzle						C						
Superheated Steam Outlet Nozzle						D						
Water Inlet Nozzle						E						
Saturated Steam Outlet Nozzle						F						
STEM FLOW (lb/hr)	4	3	X	X	X	X	X					
0-100							A					
100-300							B					
300-500							C					
500-1000							D					
1000-1500							E					
1500-2000							F					
2000-2500							G					
2500-up							H					
STEAM PRESSURE (psia)	4	3	X	X	X	X	X	X				
0-200								A				
200-500								B				
500-800								C				
800-1100								D				
1100-1500								E				
1500-2000								F				
2000-2500								G				
2500-up								H				

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TEMPERATURE (°F)	4	3	X	X	X	X	X	X	X	X		
400-600											A	
600-800											B	
800-1000											C	
1000-1200											D	
1200-up											E	
MATERIAL OF PART	4	3	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Austenitic												A
Stainless Steel, Ferritic												B
Low-Alloy Steel												C
Carbon Steel												D
Non-ferrous Metal												E
Soft Iron												F
<u>MODERATORS AND REFLECTORS</u>	4	5	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	5	X									
Graphite					A							
Graphite - Borated					B							
Beryllium					C							
Beryllium Oxide					D							
Heavy Water					E							
Organic Liquid					F							
Light Water					G							
Metal Hydride					H							
SUB TYPE	4	5	X	X								
Removable					A							
Fixed					B							
MAJOR PART	4	5	X	X	X							
Skin or Cladding					A							
Pedestal					B							
Seal Ring					C							
Top Closure Plate					D							
Bottom Closure Plate					E							
Vent Tube					F							
Guide					G							
Pin					H							
Through Tube					I							
Container					J							

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TEMPERATURE (°F)	4	5	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	4	5	X	X	X	X	X	X	X	X	X	X
Water												A
Sodium												B
NaK												C
Nitrogen												D
Helium												E
Argon												F
Argon and Sodium Vapor												G
Helium and Sodium Vapor												H
Organic Liquid												I
MATERIAL OF PART	4	5	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Austenitic												A
Stainless Steel, Ferritic												B
Stainless Steel, Martensitic												C
Carbon Steel												D
Low-Alloy Steel												E
High-Nickel-Alloy Steel												F
Beryllium												G
Graphite												H
Beryllium-Oxide												I
Other Non-ferrous Alloy												J
<u>FUEL AND BREEDER ELEMENTS</u>	4	6	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	6	X									
Metallic Uranium												A
Metallic Plutonium												B
Uranium Oxide												C
Plutonium Oxide												D
Uranium-Plutonium Oxide												E
Uranium Carbide												F
Uranium-Plutonium Carbide												G
Plutonium Carbide												H

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SUB TYPE	4	6	X	X								
Core Subassembly					A							
Radial Blanket Subassembly					B							
Axial Upper Blanket Subassembly					C							
Axial Lower Blanket Subassembly					D							
MAJOR PART	4	6	X	X	X							
Rod or Pin					A							
Cylinder or Housing					B							
Plate					C							
Bottom End Fixture					D							
Top End Fixture					E							
Pellet					F							
Spacer					G							
Cladding					H							
Strainer					I							
Orifice					J							
Spring					K							
Support Grid					L							
PART IDENTIFICATION	4	6	X	X	X	X						
End Closure Rod						A						
Outer Housing						B						
Inner Housing						C						
Cored Pellet						D						
Solid Pellet						E						
Wire Wrap Spacer						F						
Grid Spacer						G						
Hexagonal Shell						H						
Square Housing						I						
Cylindrical Housing						J						
Fixed Orifice						K						
Adjustable Orifice						L						
Bearing Housing						M						
Seal Housing						N						
SURFACE HEAT FLUX (Btu/hr-ft ²)/(10 ⁵)	4	6	X	X	X	X	X					
0-1							A					
1-2							B					
2-3							C					
3-4							D					
4-6							E					
6-8							F					
8-10							G					
10-up							H					

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COOLANT FLOW (ft/sec)	4	6	X	X	X	X	X	X				
0-2										A		
2-5										B		
5-10										C		
10-15										D		
15-20										E		
20-30										F		
30-50										G		
50-70										H		
70-100										I		
100-up										J		
FUEL ENRICHMENT (% U ²³⁵ and Pu ²³⁹)	4	6	X	X	X	X	X	X	X	X		
0-1											A	
1-5											B	
5-10											C	
10-20											D	
20-30											E	
30-50											F	
50-up											G	
TEMPERATURE (°F)	4	6	X	X	X	X	X	X	X	X	X	
0-200												A
200-400												B
400-700												C
700-1000												D
1000-1500												E
1500-2000												F
2000-2500												G
2500-3000												H
3000-up												I
ENVIRONMENTAL MEDIA OF PART	4	6	X	X	X	X	X	X	X	X	X	X
Sodium												A
Helium												B
Argon												C
Nitrogen												D
Water												E
Carbon Dioxide												F
Gaseous Fission Products												G
Hydrogen												H
MATERIAL OF PART	4	6	X	X	X	X	X	X	X	X	X	X
Stainless (Austenitic) Steel, Type 304												A
Stainless (Austenitic) Steel, Type 316												B
Stainless (Austenitic) Steel, Type 347												C

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MATERIAL OF PART (Cont)	4	6	X	X	X	X	X	X	X	X	X	X
Low-Carbon Steel												D
High-Alloy Steel												E
Ferritic Steel												F
Other Steel												G
Inconel												H
Monel												I
Carboloy												J
Hastelloy												K
Stellite												L
Aluminum or Aluminum Alloy												M
Nickel or Nickel Alloy												N
Molybdenum												P
Niobium												Q
Tantalum												R
Cobalt Base Alloys												S
Carbides												T
Tungsten												U
Ceramics												V
Other than listed												W

FUEL HANDLING EQUIPMENT
(Liquid Metal, Internal)

	4	7	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	7	X									
Storage Rack or Basket												A
Gripper												B
Transfer Arm												C
Transfer Rotor												D
Offset Handling Mechanism												E
Holddown Device												F

MAJOR PART	4	7	X	X	X							
Housing												A
Gripping Head												B
Shaft												C
Seal												D
Bell Crank												E
Support Structure												F
Interlock												G
Rack												H
Bearing												I
Plate												J
Fastener												K
Rod												L
Spring												M

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PART IDENTIFICATION	4	7	X	X	X	X						
Drive Shaft						A						
Jaws - Gripping Head						B						
O-Ring - Seal						C						
Bellows - Seal						D						
Gripper - Housing						E						
Tie Rod						F						
Push Rod						G						
Compression Spring						H						
Locking Spring						I						
TEMPERATURE (°F)	4	7	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-400											D	
400-600											E	
600-800											F	
800-1000											G	
1000-1200											H	
1200-up											I	
ENVIRONMENTAL MEDIA OF PART	4	7	X	X	X	X	X	X	X	X	X	X
Sodium												A
Water												B
Organic												C
Helium												D
Argon												E
Nitrogen												F
Air												G
Lead												H
MATERIAL OF PART	4	7	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Stainless Steel, Austenitic												C
Stainless Steel, Ferritic												D
High-Nickel Alloy												E
Carbon or Graphite												F
Copper or Copper Alloy												G
Aluminum or Aluminum Alloy												H
Rubber or Plastic												I
Asbestos												J
Ceramic												K
Mica												L
Graphite or Carbon												M

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<u>CRANE STRUCTURES</u>	4	9	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	4	9	X									
Traveling					A							
Gantry					B							
MAJOR PART	4	9	X	X	X							
Bridge Girder						A						
Rails						B						
Truck						C						
Wheel						D						
Operator Cab						E						
Legs						F						
Bearing and Oil Seals						G						
CAPACITY (Short Tons)	4	9	X	X	X	X	X					
0-10								A				
10-20								B				
20-30								C				
30-50								D				
50-80								E				
80-110								F				
110-150								G				
150-up								H				
MATERIAL OF PART	4	9	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Aluminum or Aluminum Alloy												C
Non-ferrous Metals												D
Rubber or Plastic												E
<u>HOIST UNIT</u>	5	0	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	0	X									
Main					A							
Auxiliary					B							
MAJOR PART	5	0	X	X	X							
Truck						A						
Wheels						B						
Axle						C						
Bearing						D						
Seal						E						

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MAJOR PART (Cont)	5	0	X	X	X							
Fastener					F							
Drum					G							
Sheaves					H							
Pulley Block					I							
Housing					J							
CAPACITY (Short Tons)	5	0	X	X	X	X	X					
0-10								A				
10-20								B				
20-30								C				
30-50								D				
50-80								E				
80-110								F				
110-150								G				
150-up								H				
MATERIAL OF PART	5	0	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Aluminum-Aluminum Alloy												C
Other Non-ferrous Metals												D
Rubber or Plastic												E
<u>DEMINERALIZERS</u> <u>(Ion Exchange Units)</u>	5	3	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	3	X									
In-Place Regeneration					A							
Powdered Resin					B							
External Regeneration					C							
MAJOR PART	5	3	X	X	X							
Tank					A							
Sight Glass					B							
Valve					C							
Trap					D							
Piping					E							
PART IDENTIFICATION	5	3	X	X	X	X						
Ion Exchange Tank						A						
Cation Regeneration Tank						B						
Anion Regeneration Tank						C						
Caustic Day Tank						D						
Acid Day Tank						E						

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CONDENSATE FLOW RATE (gpm)	5	3	X	X	X	X	X					
0-50							A					
50-100							B					
100-200							C					
200-400							D					
400-800							E					
800-1600							F					
1600-3200							G					
3200-up							H					
TOTAL DISSOLVED SOLIDS (ppb)	5	3	X	X	X	X	X	X				
0-5								A				
5-10								B				
10-20								C				
20-30								D				
30-40								E				
40-50								F				
50-70								G				
70-100								H				
100-150								I				
TEMPERATURE (°F)	5	3	X	X	X	X	X	X	X	X		
0-100											A	
100-120											B	
120-140											C	
140-160											D	
160-180											E	
180-200											F	
200-up											G	
ENVIRONMENTAL MEDIA OF PART	5	3	X	X	X	X	X	X	X	X	X	X
Stainless Steel												A
Carbon Steel												B
Rubber												C
Plastic												D
Wrought Steel												E
<u>FEEDWATER HEATERS</u>	5	4	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	4	X									
Direct Contract					A							
Surface Condenser (Shell and Tube)					B							

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SUB TYPE	5	4	X	X								
Single Pass					A							
Two-Pass					B							
Three-Pass					C							
Multiple Pass					D							
MAJOR PART	5	4	X	X	X							
Duct						A						
Baffle						B						
Hotwell						C						
Tube						D						
Tubesheet						E						
Stuffing Box						F						
Tube Support Plates						G						
Water Box						H						
Shell						I						
Steam Jet Air Ejector (integral)						J						
Nozzle						K						
Vent						L						
Pipe						M						
Manway						N						
Expansion Joint						P						
Spring Mounted Support						Q						
PART IDENTIFICATION	5	4	X	X	X	X						
Water-Inlet Nozzle							A					
Water-Outlet Nozzle							B					
Steam-Inlet Nozzle							C					
Condensate-Outlet Nozzle							D					
Air Outlet Nozzle							E					
Ribs - Shell							F					
TUBING DIAMETER (inch)	5	4	X	X	X	X	X					
Less than 5/8								A				
5/8-3/4								B				
3/4-7/8								C				
7/8-1.0								D				
1.0-1.5								E				
1.5-2.0								F				
2.0-up								G				
STEAM PRESSURE (psig)	5	4	X	X	X	X	X	X				
0-100									A			
100-300									B			
300-500									C			

	17	18	19	20	21	22	23	24	25	26	27	28
STEAM PRESSURE (psig) (Cont)	5	4	X	X	X	X	X	X				
500-1000										D		
1000-1500										E		
1500-2000										F		
2000-2500										G		
2500-3000										H		
3000-up										I		
HEAT TRANSFER SURFACE AREA (ft ²)	5	4	X	X	X	X	X	X	X			
0-2,500										A		
2,500-10,000										B		
10,000-20,000										C		
20,000-40,000										D		
40,000-80,000										E		
80,000-200,000										F		
200,000-up										G		
FEEDWATER INLET TEMPERATURE (°F)	5	4	X	X	X	X	X	X	X	X		
70-100											A	
100-150											B	
150-200											C	
200-250											D	
250-300											E	
300-400											F	
400-500											G	
500-up											H	
STEAM INLET TEMPERATURE (°F)	5	4	X	X	X	X	X	X	X	X	X	X
0-200												A
200-400												B
400-600												C
600-800												D
800-1000												E
1000-up												F
MATERIAL OF PART	5	4	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Type 304												A
Stainless Steel, Type 316												B
Stainless Steel, Type 347												C
Nickel or Nickel Alloy												D
Copper or Copper Alloy												E
Magnesium												F
Aluminum												G

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MATERIAL OF PART (Cont)	5	4	X	X	X	X	X	X	X	X	X	X
Titanium												H
Inconel												I
Monel												J
Carboloy												K
Cast Iron												L
Low-Alloy Steel												M
Ferritic Steel												N
Ceramic												P
Asbestos												Q
Other than listed												R
<u>TURBINE-GENERATOR (turbine side)</u>	5	5	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	5	X									
Tandem Compound, Single Flow					A							
Tandem Compound, Double Flow					B							
Tandem Compound, Four Flow					C							
Tandem Compound, Six Flow					D							
Tandem Compound, Eight Flow					E							
Cross Compound, 3600-1800 rpm					F							
Cross Compound, 3600-3600 rpm					G							
Single Stage - Noncondensing (auxiliary)					H							
Single Stage - Condensing (auxiliary)					I							
SUB TYPE	5	5	X	X								
Re-heat					A							
Non-reheat					B							
MAJOR PART	5	5	X	X	X							
Valve					A							
Casing					B							
Nozzle Plate					C							
Diaphragm					D							
Rotor					E							
Blade					F							
Wheel					G							
Shroud					H							
Bearing					I							
Coupling					J							
Piping					K							
Support					L							
Lubrication System					M							
Control System					N							
Insulation System (heat)					P							

	17	18	19	20	21	22	23	24	25	26	27	28
PART IDENTIFICATION	5	5	X	X	X	X						
Casing - High Pressure							A					
Casing - Intermediate Pressure							B					
Casing - Low Pressure							C					
Valve - Control							D					
Valve - Stop							E					
Valve - Intercept Reheat							F					
Valve - Reheat							G					
Piping - Inlet							H					
Piping - Crossover							I					
TURBINE CAPACITY (mwe)	5	5	X	X	X	X	X					
Below 500								A				
500-750								B				
750-1000								C				
1000-1250								D				
1250-1500								E				
1500-1750								F				
1750-2000								G				
2000-2500								H				
2500-up								I				
INLET STEAM PRESSURE (psig)	5	5	X	X	X	X	X	X				
Below 1000									A			
1000-2000									B			
2000-3000									C			
3000-3500									D			
3500-4000									E			
4000-up									F			
ABSOLUTE EXHAUST PRESSURE (Inches of Hg)	5	5	X	X	X	X	X	X	X			
0-0.5										A		
0.5-1.0										B		
1.0-1.5										C		
1.5-2.0										D		
2.0-up										E		
INLET STEAM TEMPERATURE (°F)	5	5	X	X	X	X	X	X	X	X		
Below 600											A	
600-800											B	
800-1000											C	
1000-1200											D	
1200-up											E	

	17	18	19	20	21	22	23	24	25	26	27	28
MATERIAL OF PART	5	5	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Stainless Steel, Type 316												C
Stainless Steel, Type 304												D
Stainless Steel, Type 321												E
Stainless Steel, Type 347												F
Nickel-Base Alloy Steel												G
Stellite												H
Titanium												I
Beryllium												J
Asbestos (heat isolation)												K
Other than listed												L

TURBINE-GENERATOR
(Generator Side)

	5	6	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	6	X									
Conventional Cooling					A							
Hydrogen-Gas Cooling					B							
Liquid Cooling					C							

MAJOR PART

	5	6	X	X	X							
Housing						A						
Stator						B						
Rotor						C						
Bearing						D						
Brush						E						
Coupling						F						

PART IDENTIFICATION

	5	6	X	X	X	X						
Housing - Support							A					
Housing - Seal							B					
Housing - Anchor							C					
Stator - Winding							D					
Rotor - Winding							E					
Rotor - Slipring or Commutator							F					
Rotor - Shaft							G					

POWER RATING (kva)

	5	6	X	X	X	X	X					
Less than 500								A				
500-750								B				
750-1000								C				
1000-1250								D				
1250-1500								E				

	17	18	19	20	21	22	23	24	25	26	27	28
POWER RATING (kva) (Cont)	5	6	X	X	X	X	X					
1500-1750								F				
1750-2000								G				
2000-2500								H				
2500-up								I				
POWER FACTOR	5	6	X	X	X	X	X	X				
Less than 0.75									A			
0.75-0.80									B			
0.80-0.85									C			
0.85-0.90									D			
0.90-0.95									E			
0.95-up									F			
OUTPUT VOLTAGE (kv) (30/60~)	5	6	X	X	X	X	X	X	X			
Less than 20										A		
20-25										B		
25-30										C		
30-35										D		
35-up										E		
MATERIAL OF PART	5	6	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B
Stainless Steel, Type 304												C
Stainless Steel, Type 316												D
Stainless Steel, Type 321												E
Stainless Steel, Type 347												F
Nickel-Base Alloy Steel												G
Other Type Steel												H
Aluminum												I
Aluminum or Bronze												J
Copper												K
Copper or Alloy												L
Beryllium or Beryllium Oxide												M
Rubber												N
Plastics (bakelite, mylar, nylon, etc.)												P
Ceramic												Q
Other than listed												R
<u>ELECTRICAL GENERATORS</u> <u>(Emergency and Auxiliary)</u>	5	7	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	5	7	X									
Direct Current (dc)												A
Alternating Current (ac)												B

	17	18	19	20	21	22	23	24	25	26	27	28
SUB TYPE	5	7	X	X								
Shunt Excitation - dc					A							
Compound Excitation - dc					B							
Independent Excitation - ac					C							
Direct Connected Excitation - ac					D							
MAJOR PART	5	7	X	X	X							
Stator					A							
Rotor					B							
Bearing					C							
Brush					D							
Coupling					E							
Housing					F							
PART IDENTIFICATION	5	7	X	X	X	X						
Housing - Support						A						
Housing - Seal						B						
Housing - Anchor						C						
Stator - Winding						D						
Rotor - Winding						E						
Rotor - Commutator						F						
Rotor - Shaft						G						
POWER RATING (kva)	5	7	X	X	X	X	X					
0-100							A					
100-200							B					
200-400							C					
400-800							D					
800-1600							E					
1600-3000							F					
3000-5000							G					
5000-up							H					
TEMPERATURE (°F)	5	7	X	X	X	X	X	X	X	X		
0-100										A		
100-200										B		
200-300										C		
300-400										D		
400-500										E		
500-700										F		
700-up										G		
MATERIAL OF PART	5	7	X	X	X	X	X	X	X	X	X	X
Carbon Steel												A
Low-Alloy Steel												B

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MATERIAL OF PART (Cont)	5	7	X	X	X	X	X	X	X	X	X	X
Stainless Steel, Austenitic												C
Stainless Steel, Ferritic												D
High-Nickel Alloy Steel												E
Copper or Copper Alloy												F
Aluminum or Aluminum Alloy												G
Plastic and Rubber												H
Ceramics												I
Carbon												J
Mica												K

POWER SWITCH GEAR, CIRCUIT
BREAKERS, RELAYS, TRANS-
FORMERS

	5	8	X	X	X	X	X	X	X	X	X	X
--	---	---	---	---	---	---	---	---	---	---	---	---

MAJOR TYPE

5 8 X

Power Switch Gear
Circuit Breaker
Relay
Transformer

A
B
C
D

SUB TYPE

5 8 X X

Remote Control - Switch Gear
Manual Control - Switch Gear
Oil Filled - Transformer
Air Cooled - Transformer
Low Voltage - Relay
Overload - Relay

A
B
C
D
E
F

MAJOR PART

5 8 X X X

Housing
Contact or Ratio Tap
Lever
Arc Suppressor
Core
Coil
Armature
Plunger

A
B
C
D
E
F
G
H

PART IDENTIFICATION

5 8 X X X X

Primary Coil
Secondary Coil
Solenoid Coil

A
B
C

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AMPERE RATING	5	8	X	X	X	X	X					
0-10							A					
10-50							B					
50-100							C					
100-300							D					
300-500							E					
500-1,000							F					
1,000-1,500							G					
1,500-2,000							H					
2,000-3,000							I					
3,000-5,000							J					
5,000-10,000							K					
10,000-up							L					
VOLTAGE RATING	5	8	X	X	X	X	X	X				
0-50								A				
50-200								B				
200-350								C				
350-600								D				
600-1,000								E				
1,000-2,000								F				
2,000-4,000								G				
4,000-8,000								H				
8,000-16,000								I				
16,000-50,000								J				
50,000-100,000								K				
100,000-200,000								L				
200,000-up								M				
TEMPERATURE (°F)	5	8	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-400											D	
400-500											E	
500-up											F	
MATERIAL OF PART	5	8	X	X	X	X	X	X	X	X	X	X
Low-Carbon Steel												A
Stainless Steel, Austenitic												B
Stainless Steel, Ferritic												C
Low-Alloy Steel												D
High-Nickel Alloy												E
Iron												F
Copper or Copper Alloy												G
Aluminum or Aluminum Alloy												H

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MATERIAL OF PART (Cont)	5	8	X	X	X	X	X	X	X	X	X	X
Monel												I
Carboloy												J
Carbon or Graphite												K
Epoxy Resin												L
<u>ANNUNCIATORS - ALARMS</u>	6	2	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	2	X									
Bell				A								
Light				B								
Buzzer				C								
Horn				D								
SUB TYPE/FUNCTION	6	2	X	X								
Temperature - High				A								
Temperature - Low				B								
Level - High				C								
Level - Low				D								
Pressure - High				E								
Pressure - Low				F								
Flow - High				G								
Flow - Low				H								
Leak				I								
Smoke				J								
Radiation				K								
Short Period				L								
High Power Level				M								
<u>DATA AQUISITION SYSTEMS (DAS)</u>	6	3	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	3	X									
Digital				A								
Analog				B								
Hybrid				C								
SUB TYPE	6	3	X	X								
Digital Output - Punched Tape				A								
Digital Input - Magnetic Tape				B								
Analog Output - Punched Tape				C								
Analog Output - Magnetic Tape				D								
X-Y Plotter				E								
Oscilloscope				F								
Chart				G								

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MAJOR PART	6	3	X	X	X							
Chart Recorder					A							
Cross Correlation Computer					B							
Analog Cross Spectral Density Analyzer					C							
Multi-Channel Noise Analyzer					D							
Punched Tape Machine					E							
Magnetic Tape Machine					F							
X-Y Plotter Machine					G							
Amplifier					H							
Printer					I							
Card Reader					J							
Analog-Digital Converter					K							
Oscilloscope					L							
SAMPLING RATE (points per minute)	6	3	X	X	X	X	X					
1-5								A				
5-10								B				
10-20								C				
20-50								D				
50-100								E				
100-250								F				
250-up								G				
COOLING LOAD (watts)	6	3	X	X	X	X	X	X				
1-10									A			
10-20									B			
20-40									C			
40-100									D			
100-300									E			
300-500									F			
500-1000									G			
1000-up									H			
<u>INDICATORS AND RECORDERS</u>	6	4	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	4	X									
Moving Pointer Indicators			A									
Moving Scale Indicators			B									
Moving Material Indicators			C									
Single-Point Continuous Recorders			D									
Multi-point Continuous Recorders			E									
Multi-point Intermittent Recorders			F									
Special Recorders			G									

	17	18	19	20	21	22	23	24	25	26	27	28
SUB TYPE	6	4	X	X								
Pressure					A							
Vacuum					B							
Temperature					C							
Flow					D							
Level					E							
pH					F							
Humidity					G							
Voltage					H							
Amperes					I							
Motion					J							
Log Count Rate (low range)					K							
Log N Period (intermediate range)					L							
Power - Neutron Flux (high range)					M							
MAJOR PART	6	4	X	X	X							
Housing						A						
Chart Plate						B						
Pen Arm						C						
Chart Drive						D						
Transducer						E						
Door Cover						F						
Bourdon Tube						G						
Transmission						H						
Dial						I						
Pointer						J						
Bellows						K						
Diaphragm						L						
Connector						M						
Valve						N						
<u>CONTROLLERS</u>	6	5	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	5	X									
Electronic					A							
Hydraulic					B							
Mechanical					C							
Pneumatic					D							
SUB TYPE	6	5	X	X								
Position Actuated Transmitter (PAT)					A							
Current Actuated Transmitter (CAT)					B							
Set Point Regulators					C							
Manual					D							

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MAJOR PART	6	5	X	X	X							
Bellows					A							
Spring					B							
Housing					C							
Diaphragm					D							
Relay					E							
Flapper					F							
Valve					G							
Gear					H							
Amplifier					I							
Contact					J							
Nozzle					K							
CONTROL MODE	6	5	X	X	X	X	X					
Proportional								A				
Proportional and Reset								B				
Proportional and Reset and Rate								C				
<u>SENSORS (Other Than Radiation)</u>	6	6	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	6	X									
Temperature				A								
Pressure				B								
Flow				C								
Stress				D								
Level				E								
Purity				F								
Leak				G								
SUB TYPE	6	6	X	X								
Thermocouple				A								
Pyrometer				B								
Resistance Thermometer				C								
Filled System Thermometer				D								
Bourdon Tube				E								
Diaphragm				F								
Bellows				G								
Manometer				H								
Electromagnetic Flowmeter				I								
Differential Pressure Flowmeter				J								
Variable Area Flowmeter				K								
Turbine Flowmeter				L								
Float Level Sensor				M								
Differential Pressure Level Sensor				N								
Sonic and Radiowave Reflection				P								
Plugging Meter				Q								

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SUB TYPE (Cont)	6	6	X	X								
Electrochemical Oxygen Meter					R							
Electrical Contact Leak Detector					S							
Volume Change Leak Detector					T							
Bonded Strain Gage					U							
Welded Strain Gage					V							
MAJOR PART	6	6	X	X	X							
Element					A							
Core					B							
Housing					C							
Tube					D							
Diaphragm					E							
Bellows					F							
Turbine					G							
Shaft					H							
Transducer					I							
Float					J							
Float Arm					K							
Wave Generator					L							
Spring					M							
Seal					N							
Insulation					P							
Nozzle					Q							
Wire					R							
Fastener					S							
PRESSURE (psig)	6	6	X	X	X	X	X					
0-10								A				
10-20								B				
20-30								C				
30-50								D				
50-70								E				
70-100								F				
100-150								G				
150-200								H				
200-300								I				
300-500								J				
500-700								K				
700-1000								L				
1000-1500								M				
1500-2000								N				
2000-up								P				

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FLOW (gpm)	6	6	X	X	X	X	X	X				
0-100									A			
100-200									B			
200-300									C			
300-500									D			
500-1,000									E			
1,000-3,000									F			
3,000-5,000									G			
5,000-10,000									H			
10,000-50,000									I			
50,000-100,000									J			
100,000-500,000									K			
500,000-up									L			
STRAIN (psi)	6	6	X	X	X	X	X	X	X	X		
0-100										A		
100-500										B		
500-1,000										C		
1,000-5,000										D		
5,000-10,000										E		
10,000-50,000										F		
50,000-100,000										G		
100,000-200,000										H		
200,000-up										I		
TEMPERATURE (°F)	6	6	X	X	X	X	X	X	X	X	X	
0-100											A	
100-200											B	
200-400											C	
400-600											D	
600-800											E	
800-1000											F	
1000-1200											G	
1200-up											H	
ENVIRONMENTAL MEDIA OF PART	6	6	X	X	X	X	X	X	X	X	X	X
Sodium												A
NaK												B
Steam												C
Water												D
Borated Solutions												E
Air												F
Nitrogen												G
Hydrogen												H
Argon												I
Helium												J

	17	18	19	20	21	22	23	24	25	26	27	28
<u>SENSORS (Radiation)</u>	6	7	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE	6	7	X									
Proportional and Fission Counter				A								
Uncompensated Ionization Chamber				B								
Compensated Ionization Chamber				C								
Scintillation Counter				D								
SUB TYPE	6	7	X	X								
Fast Neutrons					A							
Thermal Neutrons					B							
Gamma Particles					C							
Beta Particles					D							
Alpha Particles					E							
MAJOR PART	6	7	X	X	X							
Shell, Case, Envelope						A						
Electrode						B						
Connector						C						
End Cap						D						
Insulator						E						
Fill Tube						F						
Seal						G						
Calibration Source						H						
Wires, if integral part of sensor						I						
Sensitive coating						J						
Filling gas						K						
Scintillation crystal						L						
Electron Multiplier						M						
PART IDENTIFICATION	6	7	X	X	X	X						
Signal - Electrode							A					
Compensating Voltage - Electrode							B					
High Voltage - Electrode							C					
Coaxial - Connector							D					
Triaxial - Connector							E					
OPERATING VOLTAGE (volts)	6	7	X	X	X	X	X					
0-100								A				
100-300								B				
300-500								C				
500-800								D				
800-1100								E				
1100-2000								F				
2000-3000								G				
3000-up								H				

	17	18	19	20	21	22	23	24	25	26	27	28
NEUTRON AND GAMMA SENSITIVITY	6	7	X	X	X	X	X	X				
0-10 ⁻³ cps/nv										A		
10 ⁻³ -10 ⁻² cps/nv										B		
10 ⁻² -10 ⁻¹ cps/nv										C		
10 ⁻¹ -10 cps/nv										D		
10-10 ² cps/nv										E		
10 ⁻²¹ -10 ⁻¹⁸ A/nv										F		
10 ⁻¹⁸ -10 ⁻¹⁴ A/nv										G		
10 ⁻¹⁴ -10 ⁻¹² A/nv										H		
10 ⁻¹³ -10 ⁻¹² A/R/hr										I		
10 ⁻¹² -10 ⁻¹¹ A/R/hr										J		
10 ⁻¹¹ -10 ⁻¹⁰ A/R/hr										K		

MAXIMUM OPERATING RANGE OF SENSOR	6	7	X	X	X	X	X	X	X			
10 ⁰ -10 ⁴ neutron flux density										A		
10 ⁰ -10 ⁵ neutron flux density										B		
10 ¹ -10 ⁶ neutron flux density										C		
10 ² -10 ⁸ neutron flux density										D		
10 ² -10 ¹⁰ neutron flux density										E		
10 ⁴ -10 ¹¹ neutron flux density										F		
10 ⁴ -10 ¹² neutron flux density										G		
10 ⁶ -10 ¹⁴ neutron flux density										H		
10 ⁷ -10 ¹⁶ neutron flux density										I		
10 ¹² -10 ¹⁸ neutron flux density										J		
10 ⁻⁵ -10 ⁻¹ R/hr										K		
10 ⁻⁵ -10 ⁰ R/hr										L		
10 ⁻⁴ -10 ⁰ R/hr										M		
10 ⁻³ -10 ¹ R/hr										N		
10 ⁻³ -10 ³ R/hr										P		
10 ⁻² -10 ³ R/hr										Q		
10 ⁻² -10 ⁷ R/hr										R		
10 ⁻¹ -10 ⁸ R/hr										S		

TEMPERATURE (°F)	6	7	X	X	X	X	X	X	X	X		
0-100											A	
100-200											B	
200-300											C	
300-400											D	
400-500											E	
500-750											F	
750-1000											G	
1000-1250											H	
1250-up											I	

	17	18	19	20	21	22	23	24	25	26	27	28	
PRINCIPAL FILLING GAS	6	7	X	X	X	X	X	X	X	X	X	X	
Nitrogen													A
Argon													B
BF ₃													C
Helium													D
Other than listed													E
MATERIAL OF PART	6	7	X	X	X	X	X	X	X	X	X	X	
Stainless steel													A
Cadmium													B
Uranium													C
Boron													D
Aluminum													E
Magnesium													F
Titanium													G
Beryllium													H
Thorium													I
Plutonium													J
Sodium iodide													K
Teflon													L
Alumina													M
Magnesia													N
Beryllia													P
Plastic													Q
Glass													R
Other than listed													S
<u>WIRING AND CONNECTORS</u>	6	8	X	X	X	X	X	X	X	X	X	X	
MAJOR TYPE	6	8	X										
Instrument													A
Power													B
Grounding													C
SUB TYPE	6	8	X	X									
Single Phase - ac													A
Three Phase - ac													B
Direct Current													C
MAJOR PART	6	8	X	X	X								
Cable													A
Wire													B
Receptacles													C
Grounding Electrodes													D

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART (Cont)	6	8	X	X	X							
Raceways					E							
Boxes					F							
Outlets					G							
Conduit					H							
Connectors					I							
DESIGN CURRENT CARRYING CAPACITY (amps)	6	8	X	X	X	X	X					
0-1								A				
1-3								B				
3-5								C				
5-10								D				
10-20								E				
20-30								F				
30-50								G				
50-100								H				
100-200								I				
200-300								J				
300-500								K				
500-1000								L				
1000-up								M				
VOLTAGE	6	8	X	X	X	X	X	X				
0-10									A			
10-30									B			
30-50									C			
50-100									D			
100-200									E			
200-300									F			
300-500									G			
500-1,000									H			
1,000-2,000									I			
2,000-5,000									J			
5,000-10,000									K			
10,000-50,000									L			
50,000-up									M			
TEMPERATURE (°F)	6	8	X	X	X	X	X	X	X	X	X	
0-200												A
200-400												B
400-600												C
600-800												D
800-1000												E
1000-1200												F
1200-up												G

	17	18	19	20	21	22	23	24	25	26	27	28
ENVIRONMENTAL MEDIA OF PART	6	8	X	X	X	X	X	X	X	X	X	
Air												A
Water												B
Steam												C
Borated Solutions												D
Nitrogen												E
Argon												F
Helium												G
Hydrogen												H
Sodium												I
NaK												J

	6	8	X	X	X	X	X	X	X	X	X	X
MATERIAL OF PART												
Copper or Copper Alloy												A
Nickel or Nickel Alloy												B
Aluminum or Aluminum Alloy												C
Low-Carbon Steel												D
High-Alloy Steel												E
Stainless (Austenitic) Steel, Type 304												F
Stainless (Austenitic) Steel, Type 316												G
Stainless (Austenitic) Steel, Type 347												H
Iron												I
Other Steel												J
Asbestos												K
Cambric												L
Varnish												M
Teflon (TFE)												N
Neoprene												P
Cotton												Q
Glass												R
Rubber (natural)												S
Rubber (silicone)												T

INSTRUMENTATION-TERMINAL
BOARDS, PATCH PANELS, RELAYS,
AND SUPPRESSORS

	6	9	X	X	X	X	X	X	X	X	X	X
MAJOR TYPE												
Terminal Boards												A
Patch Panels												B
Relays												C
Suppressors												D

	6	9	X	X	X
MAJOR PART					
Connectors					A
Coils					B

	17	18	19	20	21	22	23	24	25	26	27	28
MAJOR PART	6	9	X	X	X							
Diodes					C							
Contacts					D							
Insulation					E							
Jumpers					F							
Terminals					G							
Time Delays					H							
VOLTAGE	6	9	X	X	X	X	X					
0-10							A					
10-30							B					
30-50							C					
50-100							D					
100-200							E					
200-300							F					
300-500							G					
500-1,000							H					
1,000-2,000							I					
2,000-5,000							J					
5,000-10,000							K					
10,000-50,000							L					
50,000-up							M					
TEMPERATURE (°F)	6	9	X	X	X	X	X	X	X	X		
0-200											A	
200-400											B	
400-600											C	
600-800											D	
800-1000											E	
1000-1200											F	
1200-up											G	
ENVIRONMENTAL MEDIA OF PART	6	9	X	X	X	X	X	X	X	X	X	
Air												A
Nitrogen												B
Argon												C
Helium												D
Hydrogen												E
Other												F
MATERIAL OF PART	6	9	X	X	X	X	X	X	X	X	X	X
Copper or Copper Alloy												A
Nickel or Nickel Alloy												B
Aluminum-Aluminum Alloy												C
Ceramic												D
Varnish												E
Micarda												F

IV. CAUSE OF FAILURE, MODE OF FAILURE, EFFECT OF FAILURE

A. DESCRIPTION

The usual method of classifying component failures is by failure, mode, and effect. In such a classification it is generally found that cause and mode are loosely lumped under mode. However, it is a recognized fact that unless the cause is clearly defined it is not possible to establish a recommended corrective action which will assure reduction of the importance of this source of failure.

LMEC has endeavored — through two years of consultation with experts in the various disciplines of mechanical, chemical, and metallurgical engineering — to develop a set of simple but definitive cause, mode, and effect categories for failures in mechanical and process systems. Electrical and electronic categories were taken from literature.

B. CLASSIFICATION CODE

1. Cause of Failure (Columns 29 to 31)

	29	30	31
ENVIRONMENTAL	1	0	0
Deficiency - Mechanical Process	1	1	0
Coolant deficiency (including Loss)	1	1	1
Continued operation with component known to be degraded	1	1	2
Coolant level low	1	1	3
Lubrication deficiency (including loss)	1	1	4
Pressure/vacuum loss	1	1	5
Pressure/vacuum low	1	1	6
Mechanical support deterioration	1	1	7
Temperature below tolerance	1	1	8
Unscheduled thermal power reduction (including dip)	1	1	9
Other	1	1	Z
Dynamic Stress/Fatigue/Wear	1	2	0
Incipient crack propagation (initial)	1	2	1
Pressure cycle (overload)	1	2	2
Thermal cycle (overload)	1	2	3
Normal cyclic loading (working stress)	1	2	4
Wear (mild degradation)	1	2	5
Wear (excessive degradation)	1	2	6
Vibration (self-induced)	1	2	7
Vibration (excessive, shock-induced)	1	2	8
Other	1	2	Z

	29	30	31
Fluid/Effluent/Chemical Reaction Product Release	1	3	0
Caustic release	1	3	1
Halogen ion release	1	3	2
Hydrogen release	1	3	3
Radiological release	1	3	4
Toxic fume release	1	3	5
Leak (external)	1	3	6
Leak (internal)	1	3	7
Run (viscous fluid - solder, resin, etc.)	1	3	8
Spill	1	3	9
Other	1	3	Z
Dynamic Function (position or directional)	1	4	0
Closed	1	4	1
Dropped/fell over/fell on or in	1	4	2
Lowered	1	4	3
Opened	1	4	4
Raised	1	4	5
Rotated or shifted	1	4	6
Swung	1	4	7
Worked loose	1	4	8
Improper differential motion	1	4	9
Other	1	4	Z
Electrical Functions - Transient	1	5	0
Current surge	1	5	1
Voltage surge	1	5	2
Voltage dip	1	5	3
Voltage oscillation	1	5	4
Frequency disturbance transient	1	5	5
Power loss	1	5	6
Erroneous circuit activation	1	5	7
Phase shift	1	5	8
	1	5	9
Other	1	5	Z
Electrical Function - Steady-State or Slow Drift	1	6	0
Power overload	1	6	1
Power low	1	6	2
Voltage high	1	6	3
Voltage low	1	6	4
Frequency shift	1	6	5
Frequency harmonic or steady disturbance (modulation)	1	6	6
	1	6	7
	1	6	8
	1	6	9
Other	1	6	Z

	29	30	31
Overload - Non-electrical Energy Transient	1	7	0
Flow surge or pulse	1	7	1
Mechanical force - excessively applied	1	7	2
Thermal power surge	1	7	3
Pressure surge	1	7	4
Shockwave	1	7	5
Temperature surge	1	7	6
Rotational velocity surge (run away)	1	7	7
Linear velocity excessive	1	7	8
Waterhammer	1	7	9
Other	1	7	Z
Overload - Static or Slowly Changing in Excess of Maximum Tolerance	1	8	0
Creep (structural members, piping, etc.)	1	8	1
Coolant flow (high magnitude)	1	8	2
Coolant level high	1	8	3
Power (thermal)	1	8	4
Pressure	1	8	5
Fluid weight/mass excessive	1	8	6
Temperature	1	8	7
Thermal ratcheting (metallurgical)	1	8	8
Structural weight excessive	1	8	9
Other	1	8	Z
Process Function	1	9	0
Base metal oxide precipitation	1	9	1
Cavitation (inside tanks, vessels, pipe, pumps, etc.)	1	9	2
Coolant flow (critical)	1	9	3
Coolant flow (high velocity)	1	9	4
Liquid metals oxide precipitation	1	9	5
Thermal power (oscillations)	1	9	6
Induced vibration or oscillation (affecting process - i. e., temperature, reactivity)	1	9	7
	1	9	8
	1	9	9
Other	1	9	Z
IMPURITY OR CONTAMINATION	2	0	0
In Gas System	2	1	0
Air	2	1	1
Ammonia	2	1	2
Carbon dioxide/monoxide	2	1	3
Hydrogen	2	1	4
Halogen	2	1	5
Nitrogen	2	1	6
Oxygen	2	1	7
Liquid metal vapor condensation	2	1	8
Water vapor condensation	2	1	9
Other	2	1	Z

	29	30	31
In Gasket Material	2	2	0
Halogens	2	2	1
Oil	2	2	2
	2	2	3
	2	2	4
	2	2	5
	2	2	6
	2	2	7
	2	2	8
	2	2	9
Other	2	2	Z
In Electrical Insulation Material	2	3	0
Alcohol	2	3	1
Caustic compound	2	3	2
Cleaning solvent	2	3	3
Oil	2	3	4
Liquid metal	2	3	5
Moisture - atmosphere condensation	2	3	6
Water	2	3	7
	2	3	8
	2	3	9
Other	2	3	Z
In Thermal Insulation Material	2	4	0
Alcohol	2	4	1
Caustic compound	2	4	2
Cleaning solvent	2	4	3
Oil	2	4	4
Liquid metal	2	4	5
Moisture - atmosphere condensation	2	4	6
Water	2	4	7
	2	4	8
	2	4	9
Other	2	4	Z
In Liquid Metals	2	5	0
Air	2	5	1
Grit (small abrasive particles)	2	5	2
Hydrogen	2	5	3
Iron, etc., in solution or suspension	2	5	4
Nitrogen	2	5	5
Oil or carbon in solution or suspension (organics)	2	5	6
Oxygen	2	5	7
Water/steam	2	5	8
Foreign objects (metal, rags, plastics, parts, etc.)	2	5	9
Other	2	5	Z

	29	30	31
In Metals	2	6	0
	2	6	1
	2	6	2
	2	6	3
	2	6	4
	2	6	5
	2	6	6
	2	6	7
	2	6	8
	2	6	9
Other	2	6	Z
In Water	2	7	0
Air	2	7	1
Carbon	2	7	2
Grit	2	7	3
Halogen	2	7	4
Iron, etc., in solution or suspension	2	7	5
Oil	2	7	6
Acid (pH low)	2	7	7
Alkaline (pH high)	2	7	8
Sodium/NaK	2	7	9
Other	2	7	Z
HUMAN ERROR	3	0	0
Maintenance Judgment Error	3	1	0
Component substitution authorization error	3	1	1
Failure detection method inadequate	3	1	2
Inspection interval too long	3	1	3
Materials substitution authorization error	3	1	4
Component cleaning method inadequate or improperly devised	3	1	5
Unsafe procedure	3	1	6
	3	1	7
	3	1	8
	3	1	9
Other	3	1	Z
Maintenance Repair Error	3	2	0
Assembly error	3	2	1
Adjustment/setting error	3	2	2
Emergency or temporary repair treated as permanent (forgotten)	3	2	3
Electrical terminal connection loose/wrong	3	2	4
Material/component wrong	3	2	5
Mechanical attachment loose/wrong	3	2	6
Unsafe action or procedure	3	2	7
Workmanship poor, foreign material left in system	3	2	8
Misuse of equipment or wrong tool used	3	2	9
Other	3	2	Z

	29	30	31
Operations Error	3	3	0
Action (unintentional)	3	3	1
Calculation of parameter error	3	3	2
Control adjustment to wrong position	3	3	3
Emergency response wrong	3	3	4
Failed to act (omission)	3	3	5
Monitoring equipment hookup or calibration error	3	3	6
Operation or relocation position error	3	3	7
Limit or alarm setting adjustment to wrong position	3	3	8
Misuse of equipment or accidental activation	3	3	9
Other	3	3	Z
Supervisory or Management Error	3	4	0
Operation continuation/economic risk decision following indication of wear	3	4	1
Unqualified personnel assigned to task with inadequate instruction or supervision	3	4	2
Procedure non-existent	3	4	3
Procedure deficiently prepared	3	4	4
Procedure use not specifically required	3	4	5
Procedure compliance not verified	3	4	6
Warehouse inadequately stocked	3	4	7
Preventive maintenance or inspection inadequate	3	4	8
Indecision	3	4	9
Other	3	4	Z
INHERENT (Infant or Break-in Failure)	4	0	0
Design, Engineering Inadequacy	4	1	0
Coolant or insulation provision marginal or inadequate	4	1	1
State-of-the-art knowledge deficiency	4	1	2
Expansion or clearance provision incorrect	4	1	3
Lubrication provision inadequate	4	1	4
Protective action provision (protective system) deficient	4	1	5
Supports (structural) or hangers inadequately sized or located	4	1	6
System/component functionally incompatible (mounting, location, or selection)	4	1	7
Thermal gradient, distortion or temperature cycle analysis incorrect	4	1	8
Vibration isolation provision ineffective	4	1	9
Other	4	1	Z
Design, Safeguards Inadequacy	4	2	0
Drawings do not meet standard	4	2	1
Checking, approval procedure ignored	4	2	2
No design review board clearance	4	2	3
No part selection - part application clearance	4	2	4
No test request reference	4	2	5
No reliability demonstration reference	4	2	6
No qualification status reference	4	2	7
	4	2	8
	4	2	9
Other	4	2	Z

	29	30	31
Design, Human Factors, and Personnel Safety Inadequacy	4	3	0
Accessibility poor for operation or maintenance of equipment	4	3	1
Audio aids (emergency) poor, indistinct, or non-existent	4	3	2
Automation	4	3	3
Control console and instrumentation layout awkward or poor visibility	4	3	4
Patch board test assemblies too complex	4	3	5
Personnel selection too relaxed (intelligence, health, color blind, etc.)	4	3	6
Training methods poorly organized	4	3	7
Visual aids (emergency) inadequate or too complex	4	3	8
Visual aids (identification, color coded, etc.) poor or non-existent	4	3	9
Other	4	3	Z
Material Selection Error	4	4	0
Ductility excessive	4	4	1
Environmental effects improperly analyzed	4	4	2
State-of-the-art knowledge deficiency	4	4	3
Hardness excessive	4	4	4
Incompatible material	4	4	5
Chemical or isotopic control specification poor	4	4	6
Segregation control specification poor	4	4	7
Surface finish or crack control specification poor	4	4	8
Other specification deficiency	4	4	9
Other	4	4	Z
Manufacture/Fabrication	4	5	0
Manufacturer unqualified to produce item	4	5	1
Material used does not meet specification	4	5	2
Material used, wrong	4	5	3
Method, process or specification deficient	4	5	4
State-of-the-art needs improvement in developing this item	4	5	5
Workmanship poor (tolerance not adhered to, etc.)	4	5	6
Material sensitized (metallurgically)	4	5	7
Heat treatment poor or improper (include stress relief, etc.)	4	5	8
Finish poor or improper	4	5	9
Other	4	5	Z
Product Assurance (including installation) Inadequacy	4	6	0
Contractor/vendor qualification check, none/poor	4	6	1
Construction/production control by contractor poor	4	6	2
Source inspection, field inspection poor	4	6	3
Engineering provisions inadequate	4	6	4
Program/user control generally poor	4	6	5
Qualification tests, acceptance tests, life tests poor	4	6	6
Standards poor or non-existent	4	6	7
Vendor control poor	4	6	8
Receiving inspection stock control poor	4	6	9
Other	4	6	Z

	29	30	31
Construction/Installation Error	4	7	0
Construction method or specification deficient	4	7	1
Initial startup or shakedown problem	4	7	2
Installation method or specification deficient	4	7	3
Material used, deviated from specification	4	7	4
Material used, wrong	4	7	5
Safety standard (guards, marking, signs, traffic control, etc.) not adhered to	4	7	6
Weather exposure on non-weather-proof equipment	4	7	7
Workmanship poor	4	7	8
Foreign object or material left in system	4	7	9
Other	4	7	Z
UNKNOWN - GENERAL	5	0	0
RADIATION DAMAGE	6	0	0
ACT OF WAR	8	0	0
NATURAL PHENOMENA (Excessive or Damaging)	9	0	0
Earthquake	9	1	0
Fire	9	2	0
Lightning	9	3	0
Water	9	4	0
Flood	9	4	1
Rain	9	4	2
Sleet	9	4	3
Snow	9	4	4
Tide	9	4	5
Tsunami (tidal wave)	9	4	6
Wind	9	5	0
Wind storm, strong gust, gale	9	5	1
Sandstorm	9	5	2
Tornado or hurricane	9	5	3
Unknown	9	Z	Z

2. Mode (Type) of Failure (Columns 32 and 33)

	32	33
Electrical - Fault Oriented	1	0
Arcing/ionization/corona	1	1
Burned out	1	2
Short circuit including ground loop/primary fault	1	3
Circuit intermittent (loosened connection, capacitive breakdown, etc.)	1	4
Circuit shorted to other circuit	1	5
Fuse blown/breaker trip	1	6
Overheated component	1	7
Insulation resistivity loss (low megger)/leakage	1	8
Wear-out, degradation, or aging	1	9
Other	1	Z
Electrical - Functionally Oriented (does not include instrumentation)	2	0
Open circuit	2	1
Hunting - erratic operation including cross-current loading	2	2
Ground potential non-uniform	2	3
Non-operational	2	4
Operation improperly oriented	2	5
Operation too slow (below normal tolerance)	2	6
Synchronization loss	2	7
Run away	2	8
Magnetic depletion or loss	2	9
Other	2	Z
Chemical Reactions	3	0
Acid formation	3	1
Caustic formation	3	2
Fire/smoke (carbon-oxygen)	3	3
Fire/smoke (liquid metal - oxygen)	3	4
Hydrogen - oxygen (explosion)	3	5
Oxygen - iron (rust)	3	6
Water - liquid metal	3	7
Water - aluminum	3	8
Water - zirconium	3	9
Other	3	Z
Instrumentation Function	4	0
Calibration faulty (out of tolerance, outdated, etc.)	4	1
Drift beyond specified limit	4	2
Operation faulty or non-operative	4	3
Output error	4	4
Sensitivity loss	4	5
Control setting in error due to instrument malfunction	4	6
Shutdown caused by instrument malfunction	4	7
Spurious scram caused by instrument malfunction	4	8
Spurious alarm caused by instrument malfunction	4	9
Other	4	Z

	32	33
Mechanical	5	0
Clog/blockage/plug/restricting flow	5	1
Degradation of functional capability to below tolerance (includes aging and wear-out)	5	2
Disconnection or loose	5	3
Distortion (bowing, bending, deflections, twisting, etc.)	5	4
Jammed/stuck/inoperative/movement obstruction	5	5
Misalignment	5	6
Seizure	5	7
Resonant vibration or slow oscillation	5	8
Ruptured/broken/fragmented	5	9
Other	5	Z
Metallurgical - Physical (except fracture)	6	0
Crack generation/propagation	6	1
Deformation	6	2
Embrittlement	6	3
Erosion (cavitation, etc.)	6	4
Erosion (fluid impingement attack)	6	5
Melt	6	6
Porous	6	7
Scored/galled	6	8
Yielded	6	9
Other	6	Z
Metallurgical - Physical Fracture (complete separation)	7	0
Brittle - anisotropy	7	1
Brittle - inherent or segregation	7	2
Brittle - notch or crack	7	3
Ductile - creep	7	4
Ductile - overload	7	5
Embrittlement - hydrogen or nitrogen (including work-hardening and fatigue)	7	6
Embrittlement - caustic	7	7
	7	8
	7	9
Other	7	Z
Metallurgical - Composition Change (no fracture)	8	0
Carburization	8	1
Decarburization	8	2
Film (protective) depletion	8	3
Hydrided	8	4
Nitrided	8	5
Rust (oxidized)	8	6
Surface deposition (mass transfer)	8	7
Radiation hardening (NDT change)	8	8
	8	9
Other	8	Z

	32	33
Metal Corrosion	9	0
Uniform (general, direct attack)	9	1
Pitting	9	2
Selective solution of specific constituent elements of the alloy (preferential attack)	9	3
Stress corrosion	9	4
Fretting (vibration activated)	9	5
Corrosion fatigue	9	6
Crevice	9	7
Galvanic	9	8
Unidentified	9	9
Other	9	Z
Reactivity Change Mechanism	A	0
Bowling, fuel element	A	1
Bowling, reflector element	A	2
Coolant channel voiding (boiling/large gas bubbles/etc.)	A	3
Cold shock (accidental introduction of cold coolant into hot region)	A	4
Control element shift, drop, or rotation	A	5
Core rearrangement	A	6
Gas entrainment (accidental sucking of inert gas or air into coolant loop)	A	7
Hot shock (accidental introduction of hot coolant into cold loop region)	A	8
Other	A	9
Other	B	0
Burned	B	1
Decomposed	B	2
Degassed	B	3
Disintegrated	B	4
Dried out	B	5
Soaked	B	6
Closed	B	7
Opened	B	8
Radiological contamination	B	9
Undiagnosed	B	Z

3. Effect of Failure (Columns 34 to 36)

	34	35	36
ENVIRONMENTAL	1	0	0
Deficiency - Mechanical Process	1	1	0
Coolant deficiency (including loss)	1	1	1
Continued operation with component known to be degraded	1	1	2
Coolant level low	1	1	3
Lubrication deficiency (including loss)	1	1	4
Pressure/vacuum loss	1	1	5
Pressure/vacuum low	1	1	6
Mechanical support deterioration	1	1	7
Temperature below tolerance	1	1	8
Unscheduled thermal power reduction (including dip)	1	1	9
Other	1	1	Z
Dynamic Stress/Fatigue/Wear	1	2	0
Incipient crack propagation (initial)	1	2	1
Pressure cycle (overload)	1	2	2
Thermal cycle (overload)	1	2	3
Normal cyclic loading (working stress)	1	2	4
Wear (mild degradation)	1	2	5
Wear (excessive degradation)	1	2	6
Vibration (self-induced)	1	2	7
Vibration (excessive, shock-induced)	1	2	8
Other	1	2	Z
Fluid/Effluent/Chemical Reaction Product Release	1	3	0
Caustic release	1	3	1
Halogen ion release	1	3	2
Hydrogen release	1	3	3
Radiological release	1	3	4
Toxic fume release	1	3	5
Leak (external)	1	3	6
Leak (internal)	1	3	7
Run (viscous fluid - solder, resin, etc.)	1	3	8
Spill	1	3	9
Other	1	3	Z
Dynamic Function (position or directional)	1	4	0
Closed	1	4	1
Dropped/fell over/fell on or in	1	4	2
Lowered	1	4	3
Opened	1	4	4
Raised	1	4	5
Rotated or shifted	1	4	6
Swung	1	4	7
Worked loose	1	4	8
Improper differential motion	1	4	9
Other	1	4	Z

	34	35	36
Electrical Functions - Transient	1	5	0
Current surge	1	5	1
Voltage surge	1	5	2
Voltage dip	1	5	3
Voltage oscillation	1	5	4
Frequency disturbance transient	1	5	5
Power loss	1	5	6
Erroneous circuit activation	1	5	7
Phase shift	1	5	8
	1	5	9
Other	1	5	Z
Electrical Function - Steady-State or Slow Drift	1	6	0
Power overload	1	6	1
Power low	1	6	2
Voltage high	1	6	3
Voltage low	1	6	4
Frequency shift	1	6	5
Frequency harmonic or steady disturbance (modulation)	1	6	6
	1	6	7
	1	6	8
	1	6	9
Other	1	6	Z
Overload - Non-electrical Energy Transient	1	7	0
Flow surge or pulse	1	7	1
Mechanical force - excessively applied	1	7	2
Thermal power surge	1	7	3
Pressure surge	1	7	4
Shockwave	1	7	5
Temperature surge	1	7	6
Rotational velocity surge (run away)	1	7	7
Linear velocity excessive	1	7	8
Waterhammer	1	7	9
Other	1	7	Z
Overload - Static or Slowly Changing in Excess of Maximum Tolerance	1	8	0
Creep (structural members, piping, etc.)	1	8	1
Coolant flow (high magnitude)	1	8	2
Coolant level high	1	8	3
Power (thermal)	1	8	4
Pressure	1	8	5
Fluid weight/mass excessive	1	8	6
Temperature	1	8	7
Thermal ratcheting (metallurgical)	1	8	8
Structural weight excessive	1	8	9
Other	1	8	Z

	34	35	36
Process Function	1	9	0
Base metal oxide precipitation	1	9	1
Cavitation (inside tanks, vessels, pipe, pumps, etc.)	1	9	2
Coolant flow (critical)	1	9	3
Coolant flow (high velocity)	1	9	4
Liquid metals oxide precipitation	1	9	5
Thermal power (oscillations)	1	9	6
Induced vibration or oscillation (affecting process - i.e., temperature, reactivity)	1	9	7
	1	9	8
	1	9	9
Other	1	9	Z
IMPURITY OR CONTAMINATION	2	0	0
In Gas System	2	1	0
Air	2	1	1
Ammonia	2	1	2
Carbon dioxide/monoxide	2	1	3
Hydrogen	2	1	4
Halogen	2	1	5
Nitrogen	2	1	6
Oxygen	2	1	7
Liquid metal vapor condensation	2	1	8
Water vapor condensation	2	1	9
Other	2	1	Z
In Gasket Material	2	2	0
Halogens	2	2	1
Oil	2	2	2
	2	2	3
	2	2	4
	2	2	5
	2	2	6
	2	2	7
	2	2	8
	2	2	9
Other	2	2	Z
In Electrical Insulation Material	2	3	0
Alcohol	2	3	1
Caustic compound	2	3	2
Cleaning solvent	2	3	3
Oil	2	3	4
Liquid metal	2	3	5
Moisture - atmosphere condensation	2	3	6
Water	2	3	7
	2	3	8
	2	3	9
Other	2	3	Z

	34	35	36
In Thermal Insulation Material	2	4	0
Alcohol	2	4	1
Caustic compound	2	4	2
Cleaning solvent	2	4	3
Oil	2	4	4
Liquid metal	2	4	5
Moisture - atmosphere condensation	2	4	6
Water	2	4	7
	2	4	8
	2	4	9
Other	2	4	Z
In Liquid Metals	2	5	0
Air	2	5	1
Grit (small abrasive particles)	2	5	2
Hydrogen	2	5	3
Iron, etc., in solution or suspension	2	5	4
Nitrogen	2	5	5
Oil or carbon in solution or suspension (organics)	2	5	6
Oxygen	2	5	7
Water/steam	2	5	8
Foreign objects (metal, rags, plastics, parts, etc.)	2	5	9
Other	2	5	Z
In Metals	2	6	0
	2	6	1
	2	6	2
	2	6	3
	2	6	4
	2	6	5
	2	6	6
	2	6	7
	2	6	8
	2	6	9
Other	2	6	Z
In Water	2	7	0
Air	2	7	1
Carbon	2	7	2
Grit	2	7	3
Halogen	2	7	4
Iron, etc., in solution or suspension	2	7	5
Oil	2	7	6
Acid (pH low)	2	7	7
Alkaline (pH high)	2	7	8
Sodium/NaK	2	7	9
Other	2	7	Z

	34	35	36
HUMAN ERROR	3	0	0
Maintenance Judgment Error	3	1	0
Component substitution authorization error	3	1	1
Failure detection method inadequate	3	1	2
Inspection interval too long	3	1	3
Materials substitution authorization error	3	1	4
Component cleaning method inadequate or improperly devised	3	1	5
Unsafe procedure	3	1	6
	3	1	7
	3	1	8
	3	1	9
Other	3	1	Z
Maintenance Repair Error	3	2	0
Assembly error	3	2	1
Adjustment/setting error	3	2	2
Emergency or temporary repair treated as permanent (forgotten)	3	2	3
Electrical terminal connection loose/wrong	3	2	4
Material/component wrong	3	2	5
Mechanical attachment loose/wrong	3	2	6
Unsafe action or procedure	3	2	7
Workmanship poor, foreign material left in system	3	2	8
Misuse of equipment or wrong tool used	3	2	9
Other	3	2	Z
Operations Error	3	3	0
Action (unintentional)	3	3	1
Calculation of parameter error	3	3	2
Control adjustment to wrong position	3	3	3
Emergency response wrong	3	3	4
Failed to act (omission)	3	3	5
Monitoring equipment hookup or calibration error	3	3	6
Operation or relocation position error	3	3	7
Limit or alarm setting adjustment to wrong position	3	3	8
Misuse of equipment or accidental activation	3	3	9
Other	3	3	Z
Supervisory or Management Error	3	4	0
Operation continuation/economic risk decision following indication of wear	3	4	1
Unqualified personnel assigned to task with inadequate instruction or supervision	3	4	2
Procedure non-existent	3	4	3
Procedure deficiently prepared	3	4	4
Procedure use not specifically required	3	4	5
Procedure compliance not verified	3	4	6
Warehouse inadequately stocked	3	4	7
Preventive maintenance or inspection inadequate	3	4	8
Indecision	3	4	9
Other	3	4	Z

	34	35	36
INHERENT (Infant or Break-in Failure)	4	0	0
Design, Engineering Inadequacy	4	1	0
Coolant or insulation provision marginal or inadequate	4	1	1
State-of-the-art knowledge deficiency	4	1	2
Expansion or clearance provision incorrect	4	1	3
Lubrication provision inadequate	4	1	4
Protective action provision (protective system) deficient	4	1	5
Supports (structural) or hangers inadequately sized or located	4	1	6
System/component functionally incompatible (mounting, location, or selection)	4	1	7
Thermal gradient, distortion or temperature cycle analysis incorrect	4	1	8
Vibration isolation provision ineffective	4	1	9
Other	4	1	Z
Design, Safeguards Inadequacy	4	2	0
Drawings do not meet standard	4	2	1
Checking, approval procedure ignored	4	2	2
No design review board clearance	4	2	3
No part selection - part application clearance	4	2	4
No test request reference	4	2	5
No reliability demonstration reference	4	2	6
No qualification status reference	4	2	7
	4	2	8
	4	2	9
Other	4	2	Z
Design, Human Factors, and Personnel Safety Inadequacy	4	3	0
Accessibility poor for operation or maintenance of equipment	4	3	1
Audio aids (emergency) poor, indistinct, or non-existent	4	3	2
Automation	4	3	3
Control console and instrumentation layout awkward or poor visibility	4	3	4
Patch board test assemblies too complex	4	3	5
Personnel selection too relaxed (intelligence, health, color blind, etc.)	4	3	6
Training methods poorly organized	4	3	7
Visual aids (emergency) inadequate or too complex	4	3	8
Visual aids (identification, color coded, etc.) poor or non-existent	4	3	9
Other	4	3	Z
Material Selection Error	4	4	0
Ductility excessive	4	4	1
Environmental effects improperly analyzed	4	4	2
State-of-the-art knowledge deficiency	4	4	3
Hardness excessive	4	4	4
Incompatible material	4	4	5

Material Selection Error (Cont)	34	35	36
Chemical or isotopic control specification poor	4	4	6
Segregation control specification poor	4	4	7
Surface finish or crack control specification poor	4	4	8
Other specification deficiency	4	4	9
Other	4	4	Z
Manufacture/Fabrication	4	5	0
Manufacturer unqualified to produce item	4	5	1
Material used does not meet specification	4	5	2
Material used, wrong	4	5	3
Method, process or specification deficient	4	5	4
State-of-the-art needs improvement in developing this item	4	5	5
Workmanship poor (tolerance not adhered to, etc.)	4	5	6
Material sensitized (metallurgically)	4	5	7
Heat treatment poor or improper (include stress relief, etc.)	4	5	8
Finish poor or improper	4	5	9
Other	4	5	Z
Product Assurance (including installation) Inadequacy	4	6	0
Contractor/vendor qualification check, none/poor	4	6	1
Construction/production control by contractor poor	4	6	2
Source inspection, field inspection poor	4	6	3
Engineering provisions inadequate	4	6	4
Program/user control generally poor	4	6	5
Qualification tests, acceptance tests, life tests poor	4	6	6
Standards poor or non-existent	4	6	7
Vendor control poor	4	6	8
Receiving inspection stock control poor	4	6	9
Other	4	6	Z
Construction/Installation Error	4	7	0
Construction method or specification deficient	4	7	1
Initial startup or shakedown problem	4	7	2
Installation method or specification deficient	4	7	3
Material used, deviated from specification	4	7	4
Material used, wrong	4	7	5
Safety standard (guards, marking, signs, traffic control, etc.) not adhered to	4	7	6
Weather exposure on non-weather-proof equipment	4	7	7
Workmanship poor	4	7	8
Foreign object or material left in system	4	7	9
Other	4	7	Z
GENERAL SYSTEM OR COMPONENT EFFECT	5	0	0
Acceptable incipient damage (no requirement for repair)	5	1	0
Plant availability loss (check Malfunction Importance)	5	2	0
Labor and material loss only	5	3	0
Elastic stress only	5	4	0
System/component inoperative	5	5	0
Personnel injury (check Malfunction Importance)	5	6	0
Potential injury to personnel	5	7	0
Potential damage to equipment	5	8	0
No effect	5	9	0
TRANSIENT DISTURBANCE ONLY	6	0	0

V. METHODS OF FAILURE DETECTION

A. DESCRIPTION

Catastrophic failures or incidents can often be prevented through early detection while still in the incipient stage. Knowledge of the relative effectiveness of failure detection methods is of utmost importance.

B. CLASSIFICATION CODE (Column 37)

	<u>37</u>
Not used	0
Alarm	A
Audio noise	B
Direct observation (unscheduled)	C
During routine inspection	D
During preventive maintenance	E
During repair of primary failure component	F
During repair or inspection of system associated to failure component	G
Operational monitors	H
Protective system	I
Routine area watch - direct observation	J
Routine instrument reading - direct observation	K
Vibrational frequency monitoring system	L
During periodic circuit check	M
During actuation	N
Sample analysis	P
During modification period	Q
Other	Z

VI. CORRECTIVE ACTION

A. CORRECTIVE ACTION PERFORMED (Column 38)

	<u>38</u>
None	O
Component part replaced	A
Component or circuit corrective modification	B
Information display change	C
Local repair	D
Maintenance procedure or schedule change	E
Operating limits change	F
Operational procedure and/or training change	G
System/component design change	H
Temporary reassembly for continued operation (no spare parts)	I
Temporary repair or jury rig	J
Vendor design modification	K
Vendor repair of component/part	L

B. FACILITY RECOMMENDATION FOR FUTURE (Column 39)

	<u>39</u>
None	O
Additional research and development required	A
Change operating procedures	B
Correct poor design methods	C
Design modification to part or circuit	D
Improve display information	E
Improve maintenance procedure and training	F
Improve maintenance schedule	G
Improve process	H
Increase redundancy	I
Materials - select for environment	J
Quality assurance needs improvement	K
Reduce procurement lead time or increase spares	L
Reduce operating limits	M
Reliability acceptance procedures need improvement	N
Standards need improvement	O
System redesign	P
Vendor improve future design	Q
Vendor redesign and general replacement	R
New vendors be located or encouraged to enter field	S

VII. SAFETY OR PROGRAMMATIC SIGNIFICANCE

A. DESCRIPTION

This categorization of the importance of events is both a simplification and expansion of that used in the UKAEA Fault Reporting System for Nuclear Reactors. It is considered a reasonable first effort but is expected to change considerably with failure information development.

B. CLASSIFICATION CODE (Columns 41 and 42)

	41	42
Event or human error actions which place the reactor or plant in a dangerous state	1	0
Resulting in significant hazard and/or damage to reactor	1	1
Resulting in significant hazard and/or damage to plant	1	2
Resulting in significant hazard or damage to plant or reactor	1	3
Prevented from resulting in significant hazard or damage to reactor or plant or personnel by circumstances outside those envisaged in the equipment design (inherent shutdown mechanism)	1	4
Prevented from resulting in significant hazard or damage to reactor or personnel by the ultimate available protection	1	5
Event or human error which reduces reactor safety	2	0
Failure to operate of any trip equipment which reduces reactor safety	2	1
Affecting the correct functioning of important plant equipment (other than trip equipment) thus reducing reactor safety (non-fail-safe malfunctions)	2	2
Incorrect adjustment of plant trip levels which reduces reactor safety	2	3
Have not reduced reactor safety but have occurred so frequently as to raise doubts on the safety of the system	2	4
Error by operator in the control of important plant equipment which reduces reactor safety	2	5
Unsafe deviations from approved procedures	2	6
Manual trip required	2	7
Event or human error which does not reduce safety	3	0
Malfunctions or actions which do not reduce safety when considered separately (fail-safe malfunctions)	3	1
Plant trip - functioned correctly but outage resulted	3	2
Plant trip - spurious	3	3

Event or human error which does not reduce safety (Cont)	<u>41</u>	<u>42</u>
Faults found during routine testing	3	4
Giving rise to high maintenance attention	3	5
Incorrectly displayed information (visual signals)	3	6
Incorrectly annunciated information from alarm system	3	7
Power setback	3	8
Availability and management affect only	4	0
Time loss due to lack of spare parts	4	1
Time loss due to startup prevention	4	2
Time loss due to requirement to shut down	4	3
Plant efficiency loss due to downgrading or cutback	4	4
Plant efficiency loss due to loop or section shutdown	4	5
Personnel injury with no effect upon plant operation or reactor safety	5	0
Personnel injury without time loss	5	1
Personnel injury with time loss	5	2
Radiation exposure, excessive with physical damage	5	3
Radiation exposure, excessive without serious physical damage	5	4
Problems (not describable in above categories)	6	0
Operating problems	6	1
Maintenance problems	6	2
Functional problems	6	3
Initial preliminary operation shakedown test	6	4
Plant modification preliminary operation shakedown test	6	5
Component under planned test	6	6
Preventive maintenance	6	7

VIII. FACILITY IDENTIFICATION

A. DESCRIPTION

The AEC Docket Number for nuclear reactors has been shortened to use fewer EAM card columns. Facility numbers have been arbitrarily selected to fit vacancies.

AEC Docket No. 50-XXX has become Facility Code No. 0-XXXX.

AEC Docket No. 115-XXX has become Facility Code No. 5-XXXX.

AEC codes on AEC sites were given initial code numbers 1, 2, 3, and 4 based on type of coolant.

Test facilities and loops were given initial code numbers 6, 7, 8, and 9.

B. CLASSIFICATION CODE (Columns 43 to 47)

	43	44	45	46	47
Privately-Owned Nuclear Reactors	0	X	X	X	X
Indian Point-1	0	0	0	0	3
Dresden-1	0	0	0	1	0
Fermi	0	0	0	1	6
Yankee (Rowe)	0	0	0	2	9
Pathfinder	0	0	1	3	0
Humboldt Bay	0	0	1	3	3
CVTR	0	0	1	4	4
Saxton	0	0	1	4	6
Big Rock Point	0	0	1	5	5
Peach Bottom-1	0	0	1	7	1
VESR	0	0	1	8	3
San Onofre	0	0	2	0	6
Connecticut Yankee	0	0	2	1	3
Malibu	0	0	2	1	4
Oyster Creek	0	0	2	1	9
Nine Mile Point	0	0	2	2	0
SEFOR	0	0	2	3	1
Dresden-2	0	0	2	3	7
N.S. Savannah	0	0	2	3	8

Privately-Owned Nuclear Reactors (Cont)

	43	44	45	46	47
Ginna	0	0	2	4	4
Millstone Point	0	0	2	4	5
Indian Point-2	0	0	2	4	7
Dresden-3	0	0	2	4	9
Turkey Point-3	0	0	2	5	0
Turkey Point-4	0	0	2	5	1
Quad Cities-1	0	0	2	5	4
Palisades	0	0	2	5	5
Browns Ferry-1	0	0	2	5	9
Browns Ferry-2	0	0	2	6	0
Robinson-2	0	0	2	6	1
Monticello	0	0	2	6	3
Quad Cities-2	0	0	2	6	5
Point Beach-1	0	0	2	6	6
Ft. St. Vrain	0	0	2	6	7
Oconee-1	0	0	2	6	9
Oconee-2	0	0	2	7	0
Vermont Yankee	0	0	2	7	1
Burlington	0	0	2	7	2
Diablo Canyon	0	0	2	7	5
Peach Bottom-2	0	0	2	7	7
Peach Bottom-3	0	0	2	7	8
Surry-1	0	0	2	8	0
Surry-2	0	0	2	8	1
Prairie Island	0	0	2	8	2
Fort Calhoun	0	0	2	8	5
Indian Point-3	0	0	2	8	6
Oconee-3	0	0	2	8	7
Three Mile Island	0	0	2	8	9
Pilgrim	0	0	2	9	3
Zion-1	0	0	2	9	5
Brown Ferry-3	0	0	2	9	6
Cooper Station	0	0	2	9	8
Easton Station	0	0	3	0	0
Point Beach-2	0	0	3	0	1

Privately-Owned Nuclear Reactors (Cont)

	43	44	45	46	47
Crystal River-3	0	0	3	0	2
Oyster Creek-2	0	0	3	0	3
Zion-2	0	0	3	0	4
Kewanee	0	0	3	0	5
Prairie Island-2	0	0	3	0	6
Bolsa Island-1	0	0	3	0	7
Bolsa Island-2	0	0	3	0	8
Maine Yankee	0	0	3	0	9
Salem-2	0	0	3	1	1
Rancho Seco	0	0	3	1	2
Russelville	0	0	3	1	3
Cook-1	0	0	3	1	5
Cook-2	0	0	3	1	6
Calverts Cliffs-1	0	0	3	1	7
Calverts Cliffs-2	0	0	3	1	8
Bell	0	0	3	1	9
Hatch	0	0	3	2	1
Shoreham	0	0	3	2	2
Liquid-Metal-Cooled Nuclear Reactors (on AEC sites)	1	X	X	X	X
Sodium Cooled	1	0	1		
EBR-II	1	0	1	0	1
SRE	1	0	1	0	2
LAMPRE-I	1	0	1	0	3
PFFBR	1	0	1	0	4
NaK Cooled	1	0	2		
EBR-I	1	0	2	0	1
Water-Cooled Nuclear Reactors (on AEC sites)	2	X	X	X	X
Boiling Water	2	0	1		
EBWR	2	0	1	0	1
Pressurized Water	2	0	2		
Shippingport Core 2	2	0	2	0	1
AEC-Owned Nuclear Reactors (on private property)	5	X	X	X	X
Elk River	5	0	0	0	1
Piqua OMR	5	0	0	0	2
Hallam (HNPF)	5	0	0	0	3
BONUS	5	0	0	0	4
La Crosse	5	0	0	0	5

	43	44	45	46	47
Liquid-Metal-System Test Facilities (AEC-owned)	6	X	X	X	X
Argonne National Laboratory	6	0	1		
FARET Simulation Loop	6	0	1	0	1
Loop (2 in.)	6	0	1	0	2
Quality Control	6	0	1	0	3
Components Test Loop	6	0	1	0	4
Two-Phase Heat Transfer Standby Loop	6	0	1	0	5
Small TREAT Na Closed Loop	6	0	1	0	6
Large TREAT Na Loop	6	0	1	0	7
Autoclave with Small Pump Loop	6	0	1	0	8
E. M. Flowmeter Calibration	6	0	1	0	9
Tantalum Still	6	0	1	1	0
Falex Wear Test Devices in Sodium Pots	6	0	1	1	1
Sodium Analytical Loop	6	0	1	1	2
Boiling Sodium Test	6	0	1	1	3
Component and Materials Evaluation Loop (CAMEL)	6	0	1	1	4
Atomic Power Development Associates	6	0	2		
High Temperature Na-U Paste Flow Loop	6	0	2	0	1
Sodium Endurance Loop	6	0	2	0	2
Sodium Technology Loop	6	0	2	0	3
Sodium Purification System	6	0	2	0	4
Hydrogen Detector Loop	6	0	2	0	5
Sodium-Water Leak	6	0	2	0	6
Atomics International	6	0	3		
Ultrapure Na Preparation	6	0	3	0	1
Sodium Test Loop	6	0	3	0	2
Systems Quality Sodium Loop	6	0	3	0	3
SNAP 2 Test Loop	6	0	3	0	4
SNAP 8 DS Primary Loop	6	0	3	0	5
SNAP 8 DS Secondary System	6	0	3	0	6
Brookhaven National Laboratory	6	0	4		
13 Thermal Circulation Loops	6	0	4	0	1
Corrosion Loop - FCL-1	6	0	4	0	2
Corrosion Loop - FCL-2	6	0	4	0	3
High Heat Flux Loop	6	0	4	0	4
Analytical Loop	6	0	4	0	5
Sodium Heat Transfer Loop	6	0	4	0	6
General Electric Advanced Products Operation	6	0	5		
Loop No. 2 - Mass Transfer	6	0	5	0	1
Loop No. 3 - Mass Transfer	6	0	5	0	2
Loop No. 8 - Mass Transfer	6	0	5	0	3
Geoscience Limited Laboratory	6	0	6		
Forced Circulation Boiling K System No. 1	6	0	6	0	1
Forced Circulation Boiling K and Hg	6	0	6	0	2
Liquid Metal Droplet Vaporization Research	6	0	6	0	3

	43	44	45	46	47
Liquid Metal Engineering Center	6	0	7		
Sodium Components Test Installation (SCTI)	6	0	7	0	1
Large Components Test Loop (LCTL)	6	0	7	0	2
Sodium Pump Test Facility (SPTF)	6	0	7	0	3
HNPF Pump Test Loop	6	0	7	0	4
Control Element Test Stand (CETS)	6	0	7	0	5
Pump Seal Test Rig No. 1	6	0	7	0	6
Pump Seal Test Rig No. 2	6	0	7	0	7
Precision Mechanisms in Sodium, Vessels 2, 3, & 4	6	0	7	0	8
Precision Mechanisms in Sodium, Vessels 5, 6, 7, & 8	6	0	7	0	9
Precision Mechanisms in Sodium, Vessels 10 & 13	6	0	7	1	0
Los Alamos Scientific Laboratory (Univ. of Calif.)	6	0	8		
10 Thermal Convection Compatibility Test Loops	6	0	8	0	1
Hot Trap Evaluation Loop	6	0	8	0	2
Steam Generator Trap	6	0	8	0	3
Fission Product Loop	6	0	8	0	4
Open Capsule Loop	6	0	8	0	5
Cold Trap Experimental Loop	6	0	8	0	6
Forced Convection Na Loop	6	0	8	0	7
Analytical Loop No. 1	6	0	8	0	8
Analytical Loop No. 2	6	0	8	0	9
Forced Convection Temp. Gradient Loop	6	0	8	1	0
Sodium Supply Loop	6	0	8	1	1
MSA Research Corporation	6	0	9		
Two Mechanical Property Test Systems	6	0	9	0	1
Mechanical Property Test System	6	0	9	0	2
Oak Ridge National Laboratory	6	1	0		
Boiling K Natural-Circulation Loop No. 1	6	1	0	0	1
Boiling K Natural-Circulation Loop No. 2	6	1	0	0	2
Lithium Thermal Convection Loop	6	1	0	0	3
Molecular-Distillation Still	6	1	0	0	4
Intermediate K System	6	1	0	0	5
Small K System No. 1	6	1	0	0	6
Small K System No. 2	6	1	0	0	7
Forced Circulation Boiling K System	6	1	0	0	8
NaK Corrosion Loop	6	1	0	0	9
Test Facility for United Nuclear Electrochemical					
Oxygen Meter	6	1	0	1	0
Electromagnetic Pump Test	6	1	0	1	1
Liquid Metal Flowmeter Calibration	6	1	0	1	2
Liquid Metal Jet Pump Loop	6	1	0	1	3
Pacific Northwest Laboratory	6	1	1		
Radioisotope Transport and Deposition Loop	6	1	1	0	1
Sodium Loop	6	1	1	0	2
Mechanical Property Study Loop	6	1	1	0	3
Heat Transfer System	6	1	1	0	4
Static Sodium Facility	6	1	1	0	5

	43	44	45	46	47
United Nuclear Corporation	6	1	2		
FCL-1	6	1	2	0	1
FCL-2	6	1	2	0	2
FCL-3	6	1	2	0	3
FCL-4	6	1	2	0	4
Thermal Convection Loops	6	1	2	0	5
NASA LM Heat Transfer	6	1	2	0	6
Liquid-Metal-System Test Facilities (NASA-owned)	7	X	X	X	X
Aerojet-General Corporation	7	0	1		
Power Conversion System Loop (PCS-1)	7	0	1	0	1
Liquid NaK Loop 3 (LNL-3)	7	0	1	0	2
Liquid Mercury Loop 5 (LML-5)	7	0	1	0	3
Mercury Corrosion Loops (CL-1 through CL-4)	7	0	1	0	4
Seventh-Scale Loop	7	0	1	0	5
Liquid-Metal-System Test Facilities (privately owned)	8	X	X	X	X
Babcock and Wilcox	8	0	1		
Na-Heated Steam Generator Mockup	8	0	1	0	1
Natural Circulation Loop	8	0	1	0	2
Large Size Loop	8	0	1	0	3
General Electric Advanced Products Operation	8	0	3		
Loop No. 1 - High Flux Heaters	8	0	3	0	1
Loop No. 4 - Stress Rupture	8	0	3	0	2
Loop No. 5R - Stress Rupture	8	0	3	0	3
Loop No. 6R - Cyclic Stress	8	0	3	0	4
Loop No. 7 - Multi-purpose Tests	8	0	3	0	5
Loop No. 9 - Corrosion Mockup Large Reactor System	8	0	3	0	6
Loop No. 10 - Main Sodium Service and Supply System	8	0	3	0	7
Loop No. 11 - Heat Transfer and Fluid Flow Loop	8	0	3	0	8
Loop No. 12 - Thermal Shock Loop	8	0	3	0	9
Loop No. 13 - Sodium Water Reaction System	8	0	3	1	0
Loop No. 14 - Sodium Disposal and Cleaning Station	8	0	3	1	1
Loop No. 15 - SEFOR Refueling Cell Mockup	8	0	3	1	2
General Electric Nuclear Systems Programs Dept	8	0	4		
50-kw Condensing Heat Transfer	8	0	4	0	1
100-kw Boiling K Heat Transfer	8	0	4	0	2
300-kw Two-Fluid Heat Transfer	8	0	4	0	3
3000-kw K Turbine Test	8	0	4	0	4
Two-Phase Corrosion Loop	8	0	4	0	5
Advanced Material Test Loop	8	0	4	0	6
Electromagnetic Pump Test Loop	8	0	4	0	7
Bearing and Seal Test Loop	8	0	4	0	8
Bearing Friction and Wear Test Loop	8	0	4	0	9
Boiler Development Loop	8	0	4	1	0
2600°K Lithium Loop	8	0	4	1	1
Valve Test Loop	8	0	4	1	2

	43	44	45	46	47
MSA Research Corporation	8	0	5		
Heat Transfer System	8	0	5	0	1
Pump Development Test Loop - 4 in.	8	0	5	0	2
Pump Development Test - 2 in.	8	0	5	0	3
Oak Ridge National Laboratory	8	0	6		
Vacuum Test Facility (G. E.)	8	0	6	0	1
Vacuum Test Facility (Stokes)	8	0	6	0	2
Westinghouse	8	0	7		
Thermal Convection Loop	8	0	7	0	1
Fission Product Loop (FPL-1)	8	0	7	0	2
General Purpose Test Loop (GPL-1)	8	0	7	0	3
Mass Transfer Loops	8	0	7	0	4
Fission Product Loop (FPL-2)	8	0	7	0	5
General Purpose Test Loop (GPL-2)	8	0	7	0	6
"Frosting" Study Loop	8	0	7	0	7
Bench Scale Loops (thermal and forced convection)	8	0	7	0	8
Vanadium Test Loop (VTL-1)	8	0	7	0	9
Vanadium Test Loop (VTL-2)	8	0	7	1	0
Foreign Liquid Metal Facilities	9	X	X	X	X
Nuclear Reactors	9	0	1		
BN-350 Nuclear Power Plant - USSR	9	0	1	0	1
Breeder Reactor-5 (BR-5) - USSR	9	0	1	0	2
Dounreay Fast Reactor (DFR) - Scotland	9	0	1	0	3
RAPSODIE - France	9	0	1	0	4
Technology Facilities	9	0	2		
10-Mwt Test Loop - Cadarache, France	9	0	2	0	1
5-Mwt Grand Quevilly Station -France	9	0	2	0	2
5-Mwt Interatom Loop - Germany	9	0	2	0	3
Reactor Engineering Lab (REL) - England	9	0	2	0	4
Dounreay Experimental Reactor Experience					
(DERE) - Scotland	9	0	2	0	5
NOAH Rig - Dounreay, Scotland	9	0	2	0	6

IX. FACILITY OPERATING CONDITION
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Steady Full Power	1
Steady Power - 0 to less than 20%	2
Steady Power - 20 to less than 50%	3
Steady Power - 50 to less than 75%	4
Steady Power - 75 to less than 100%	5
Hot Standby	6
Raising Power (generator on)	7
Raising Power (generator off)	8
Reducing Power	9
Shutting Down (normal)	A
Shutting Down (emergency)	B
Subcritical	C
Startup (cold)	D
Startup (hot)	E
Shakedown Tests or Training	F
Experiment Transient Run	G
In-core Fuel Handling (reactor operating)	H
In-core Fuel Handling (reactor shut down)	Ø
Out-of-Core Fuel Handling	P
Down (scheduled maintenance)	Q
Down (unscheduled repair)	R
Down (programmed standby)	S
Reactivity Measurements	T
Nuclear Flux Measurements	U
Loop Fill or Drain	V

PART 2 GLOSSARY

The purpose of this glossary is to provide definitions for terms used in the Failure Data Handbook. As with any new and dynamic field, standardization of terminology is generally an afterthought; therefore, the glossary cannot be all-inclusive.

The definitions given are based on commonly accepted usage, most of them having been extracted from various government agency publications and military standards. These publications are referenced at the end of the definition by the document number in parentheses. References used which may not be well known are:

AFBM 58-10 – Air Force Ballistic Missile Division, "Reliability Program for Ballistic Missile and Space Systems"

FBM-RAP – Navy Fleet Ballistic Missile Division, "Reliability Assurance Provisions, Glossary of Terms"

NPC 200-3 and NPC 250-1 – National Aeronautics and Space Administration documents, "Program Provisions for Space System Contractors – Quality Assurance" and "– Reliability"

TR 58-111 – Air Force Systems Command, RADC, "Reliability Text Book, Definitions and Terms."

Some of the statistical terms are based on the:

"International Dictionary of Applied Mathematics," W. F. Frieberger – Editor-in-Chief, D. Van Nostrand Co., Inc., Copyright 1960.

Entries are printed in capital letters and listed alphabetically. When definitions vary between referenced documents, each definition is presented in a separate paragraph. When two or more terms have the same meaning, definitions are given only under the preferred term, and referenced under other terms by the phrase, "See.....," indicating the term under which the definition appears. For example: BURN-IN – See EARLY FAILURE PERIOD.

ABORT

Abandonment of test objective by elective action, with or without loss of equipment.

ABSOLUTE PERFORMANCE (Minimum) PERIOD

Elapsed equipment operating time to first failure. The period usually guaranteed by the supplier. Not to be confused with mean time to first failure.

ACCEPT

To certify that material, process, product, or specific characteristics thereof, conform to the criteria, standards, or limits established by the applicable design specification.

ACCEPT AS-IS

To certify that specific product discrepancies will not adversely affect the function of the product or degrade the reliability of the product or any portion of the subsystem or system of which it is a part.

ACCEPTABLE QUALITY LEVEL (AQL)

A nominal value expressed in terms of percent defective (or defects) per hundred units for a given group of defects of a product. It is a measure of quality of the fraction of defectives which will be accepted some preassigned percentage of the time by a sampling plan.

ACCEPTABLE RELIABILITY LEVEL (ARL)

A nominal value expressed in terms of hours of MTBF, percent failure per 1000 operating hours, or other figure of merit, obtained under specified conditions of test, required for acceptance of parts or equipment. It is a measure of reliability which will be accepted some preassigned percentage of the time by a reliability sampling plan.

ACCEPTANCE CRITERIA

Those design, specification, and contract requirements, procedures, and instructions that are related to and provide minimum standards for acceptance of specific materials, products, processes, or service characteristics.

ACCEPTANCE SAMPLING PLAN

A plan for inspecting a sample as a basis for accepting or rejecting a lot. The plan states the method of sample selection, the sample size, and the criteria for accepting, rejecting, or taking another sample. May be applied to parts or processes.

ACCEPTANCE TEST

See TEST, ACCEPTANCE.

ANALYSIS OF VARIANCE

A statistical procedure for evaluating the difference between successive parts, or the variation of performance when various environmental or other conditions are imposed on equipment under test. Analysis of such variations provides a method of estimating reliability and quality.

Separation of total sum-of-squares variations (from the mean) into components which can be assigned to variation between the classes or subclasses according to which the data are classified. These constituent portions of the sum of squares indicate, through mean-squares, the magnitude of class differences. The extent to which they differ from the residual mean-square is a test of the hypothesis that such differences are governing the situation. (IRE)

APPARENT RELIABILITY

See RELIABILITY, APPARENT.

APPLICATION FACTOR (Ka)

A failure rate modifier for use in calculating the accumulated effects of piece-part operating parameters and characteristics, based upon stress derating under operating environments.

APPORTIONMENT

See RELIABILITY APPORTIONMENT.

ARITHMETIC MEAN

The sum of a set of values, divided by the number in the set. Also see MEAN and AVERAGE.

ASSEMBLY

A combination of parts or subassemblies that may be taken apart without destruction, which has no application or use of its own, but is essential for the completeness of a more complex item with which it is combined. (AFBM 58-10)

AVAILABILITY

The probability that the system is operating satisfactorily at any point in time when used under stated conditions, where the total time considered includes operating time, active repair time, administrative time, and logistic time.

AVERAGE

A value which represents or summarizes the relevant features of a set of values, and which is commonly used to refer to arithmetic mean.

AVERAGE LIFE

The average of the useful length of life for a number of items of similar equipments, until worn out, or no longer feasible or economical to repair. Not to be confused with "mean time between failures." In computing average life, only a failure which destroyed the equipment and ended its life would count; repairable failures would not be counted.

The mean value for a normal distribution of lives. Generally applied to mechanical failures resulting from "wearout." (TR 58-111 and IRE)

BINOMIAL DISTRIBUTION

A discrete distribution of one random variable with one parameter. If $f(x)$ is the probability of obtaining exactly x successes in n trials, and p is the probability of success in a single trial, then

$$f(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{(n-x)}$$

for

$$x = 0, 1, 2, \dots, n$$

BURN-IN

See EARLY FAILURE PERIOD.

CHARACTERISTIC

Any dimensional, visual, functional, mechanical, electrical, chemical, physical, or material feature or property; and any process-control element that describes the design, fabrication, and operating requirements of an article.

CHI-SQUARE DISTRIBUTION

A sequence of a random variable having a normal distribution with parameters χ_i and σ_i , respectively. In the expression

$$\chi^2 = \sum_{i=1}^v \left(\frac{\bar{x} - x_i}{\sigma_i} \right)^2,$$

the random variable is said to have a chi-square distribution with parameter v . The parameter is termed the "degrees of freedom" of the chi-square distribution. Chi-square may also be defined as the sum of squares of (n) independent variables divided by their common variance.

CHI-SQUARED FUNCTION

A gamma function that expresses a distribution of many independent standardized variables.

COMPONENT

An assembly, or combination of parts, subassemblies, or assemblies mounted together to perform a design function.

COMPONENT RELIABILITY

See RELIABILITY, COMPONENT, and PART.

COMPONENT STRESS

The stresses on component parts from the reliability viewpoint are those factors of usage (or test) which tend to affect the failure rate of these parts. This includes voltage, power, temperature, frequency, rise time, etc.; however, the principal stress, other than electrical, is usually the thermal-environmental stress.

(TR 58-111 and IRE)

COMPUTED RELIABILITY

See RELIABILITY, COMPUTED.

CONFIDENCE

Quantitatively, the computed degree of assurance, or chance, that a given probability statement is true. Example: 90% confidence that reliability is no less than 50%.

Qualitatively, the intuitive assurance, or judgment, that a given statement is correct.

CONFIDENCE FACTOR

The percentage figure that expresses numerically the calculated chance that a given probability statement is true. If expressed as a decimal, one minus the confidence factor gives the chance that the statement is incorrect.

The percentage figure that expresses confidence level, or proportion of times the statement should be correct that the estimated population parameter lies within the given interval or probability limits. (TR 58-111)

CONFIDENCE INTERVAL

A range of values which is believed to include, with a preassigned degree of confidence (confidence level), the true characteristic of the lot or universe a given percentage of the time. For example: 95% confidence limits for a sample of 10 with a ratio of successes to total number tested of 0.9 (9 successes and 1 failure) would be 0.54 and 1.0. That is, even with an observed success ratio of 0.9 (90%), the best that can be said is that the true ratio lies between 0.54 (54%) and 1.0 (100%) an estimated 95% of the time, when the estimate is based on a sample of 10 trials. (TR 58-111 and IRE)

CONFIDENCE LEVEL (Confidence Coefficient)

The degree of desired trust or assurance in a given result. A confidence level is always associated with some assertion and measures the probability that a given assertion is true. For example, it could be the probability that a particular characteristic will fall within specified limits; i.e., the chance that the true value of P lies between $P = a$ and $P = b$.

(TR 58-111, IRE, and FBM-RAP)

The probability that a given statement is correct, or the chance that a given value lies between two confidence limits (the confidence interval).

(MIL-STD-721)

CONFIDENCE LIMITS

Extremes of a confidence interval within which the true value has a designated chance (confidence level) of being included. (MIL-STD-721)

The upper and lower extremes of the confidence interval. (TR 58-111)

CONSUMER'S RELIABILITY RISK

The risk of the consumer (usually standardized at 10%) that a product will be accepted by a reliability test when its reliability is actually below a specified value for rejection. (IRE)

The risk or probability that a lot of goods will be accepted by a reliability test when it should properly be rejected. (MIL-STD-721)

CONSUMER'S RISK

Associated with any acceptance procedure or test, the consumer's risk is the chance of accepting an item that should be rejected.

CONTAINMENT, PRIMARY

The system or complex immediately surrounding the primary system (reactor vessel, piping, and components), constituting a first external barrier to the release of energy, missiles, and radio-activity.

CONTAINMENT, SECONDARY

The ultimate consequence-limiting barrier in protection of the public.

CONTRACT

The contract executed by the customer and the contractor which, in addition to the terms and conditions thereof, includes (by reference or otherwise) specifications, drawings, exhibits, and other data necessary to its proper performance.

CONTRACTOR

The individual(s) or concern(s) who enter into a contract with the customer.

COOLANT REACTIVITY COEFFICIENT

The reactivity change resulting from a change in the amount of coolant in part or all of the reactor system.

CORRECTIVE ACTION

The action required to prevent recurrence of a defect, deficiency, failure, or problem by means of a design change, process improvement, tooling change, inspection procedure improvement, change in operational procedure, etc.

CRITICAL CHARACTERISTIC

Any characteristic whose deviation would constitute a serious detriment to safety, availability, performance, operating life, or interface compatibility.

CRITICAL DESIGN AREA (of Component)

That portion of a product in which the existence of an inadequate design would result in failure of the product to serve the purpose for which it is intended. (FBM-RAP)

With respect to reliability, any design area or component where high reliability is required to assure availability or safety compliance.

DEBUGGING

A reliability conditioning procedure which is a method of aging the equipment by exposing it to specified environmental and test conditions in accordance with an established procedure to eliminate early failure and stabilize the equipment. Also see EARLY FAILURE PERIOD and INFANT MORTALITY.

A process of "shakedown operation" of each finished equipment which is performed prior to placing it in use. During this period, "weak" system elements are expected to fail and be replaced by elements of normal quality which are

not subject to early failure. This process exposes the equipment to all field operational stresses. The debugging process is not, however, intended to detect inherent weaknesses in system design. These should have been eliminated in the preproduction stages by appropriate techniques. (MIL-STD-721)

DEFECT

Any deviation of an item or product from specified requirements, without regard to the magnitude of the deviation.

Any imperfection, deficiency, flaw, lack of completeness, or other condition at variance with technical requirements.

(FBM-RAP and AFBM 58-10)

DEGRADATION

Gradual deterioration in performance, strength, resistance to environmental stress, etc.

Gradual deterioration of nominal performance. (TR 58-111)

DEGRADATION FAILURE

See FAILURE CLASSIFICATION.

DEGREES OF FREEDOM

The concept of degrees of freedom refers essentially to the number of independent comparisons contributing to a root-mean-square estimate of variance. Thus, if the variance of a sample of n values is calculated from the sum of squares of deviations about the sample mean, the number of degrees of freedom which is divided into the sum of squares to form the necessary mean-square is $n-1$. If $n-1$ of the deviations are given, the last one can be calculated from the necessary condition that the sum of the deviations must be zero. The degree of freedom enters into distributions based on such estimates of variance as the "F" distribution, the "t" distribution, and the chi-square distribution.

DEPENDENT FAILURE

See FAILURE CLASSIFICATION.

DERATING

The process, in design, of employing a part or material which will carry a greater load, or is more accurate, or will provide a larger output, than is necessary for the application. The design margin thus provided can be used for the enhancement of reliable operation.

DERATING FACTOR

A numerical measure of the design margin provided by derating. If a 1-watt resistor is used where a 1/2-watt rating would normally suffice, the resistor has been derated by a factor of 2.

A factor by which the ratings of parts are reduced where they are subjected to extreme environments for which their normal ratings do not apply, or to provide additional safety margins in critical applications. (FBM-RAP)

DESIGN CRITERIA

A document prescribing criteria to be satisfied in designing a particular part, component, subsystem, or system. Typical criteria include performance requirements under specified environments, interface requirements, size, weight, ruggedness, safety margins, and derating factors.

DESIGN DISCLOSURE

Those engineering drawings, specifications, and quality requirements that completely define all of the parameters of a produce, subsystem, system, or facility.

DESIGN FREEZE

The point in time, during the design phase, when the incorporation of design changes is terminated or requires customer approval, usually shortly before production commences.

DESIGN LIMIT

A value of temperature, power rating, or other performance parameter below which a component or system can be operated with an acceptable level of reliability and availability.

DESIGN MARGIN

Similar to DERATING FACTOR, or SAFETY FACTOR. Overdesign margins make the design tolerant to variations in material, workmanship, and process variables, and to variations in loads or operating conditions. Other things being equal, in most cases, small design margins will result in low reliability and large margins in high reliability. For the same reliability, small margins require much tighter control of workmanship and material variations (higher quality).

DESIGN REVIEW

A formal review of a design to provide approval from the reliability, manufacturing, quality control, cost, technical adequacy, etc., points of view prior to release. Design review may be conducted at several points during the development of the final design.

DESIGN STRENGTH DISTRIBUTION

Expression of design strength as a range of values that have been determined by random testing or by some combination of randomly selected design variables. This range will be characterized by some statistical distribution form. The nature and properties of this distribution can be derived by standard statistical methods.

DEVIATION

A specific authorization, granted before the fact, to depart from a particular requirement of specifications or related documents.

DISTRIBUTION FUNCTION

Any of several mathematical expressions describing various types of distributions, such as the binomial, chi-square, or normal distribution.

DOWN TIME

The total time during which the system is not in acceptable operating condition. Down time can, in turn, be subdivided into a number of categories such as active repair time, logistic time, and administrative time (defined below).

- 1) Active repair time is that portion of down time during which one or more technicians are working on the system to effect a repair. This time includes preparation time, fault-location time, and final checkout time for the system, and perhaps other subdivisions as required in special cases.
- 2) Logistic time is that portion of down time during which repair is delayed solely because of the necessity for waiting for a replacement part or other subdivision of the system.
- 3) Administrative time is that portion of down time not included under active repair time and logistic time.

DUTY CYCLE

A requirement of operational service commonly defined by one or several sequential steps of operation which have to be performed at variable degrees of regularity.

EARLY FAILURE PERIOD

That period of equipment life starting just after final assembly where equipment failures occur initially at a higher-than-normal rate due to the presence of defective parts and abnormal operating procedures; also called the "debugging" or "burn-in" period. (TR 58-111 and IRE)
Also see LIFE CHARACTERISTIC.

EFFECTIVENESS

The probability that the system can successfully meet an operational requirement within a given time when operated under specified conditions. This term is a function of the operational reliability, safety, availability, and operational capability.

ENGINEERING CODE

A document established by engineering authorities or government agencies, usually possessing certain statutory authority, prescribing requirements based on certain considerations (frequently public health and safety), and stating the criteria and engineering standards against which compliance with such requirements is measured.

ENGINEERING STANDARD

A set of values, procedures, methods, or techniques established by general consent, custom, or authority that describes technical limitations and applications for a material, product, process, or service in a consistent and uniform manner.

ENVIRONMENT

The aggregate of all the conditions and influences which affect the operation of equipment and components; e.g., physical location and operating

characteristics of surrounding equipment and/or components; temperatures, humidity, contaminants of surrounding air or gases; operational characteristics of fluids, shock, and vibration; radiation; duty cycle; etc.

ENVIRONMENTAL ANALYSIS

Evaluation of an environment to determine environmental conditions and their probable effect on the performance of the product. (FBM-RAP)

ENVIRONMENTAL CONDITION

A single condition or influence under which the product operates. This condition may affect the operation of the product and can be a result of external or self-generated stimuli or combinations thereof.

A single inherent condition or influence under which the product operates, which is not determined by the product, and which may affect operation of the product; e.g., air temperature, air pressure, vibration along a specified axis, etc. (FBM-RAP)

ENVIRONMENTAL CYCLE (Sequence)

The exposure of the product to all of the specified environments one at a time.

ENVIRONMENTAL EVALUATION

See ENVIRONMENTAL ANALYSIS.

ENVIRONMENTAL STRESS

The stress or load imposed on equipment by a given environmental condition or combination of environments.

ENVIRONMENTAL TEST

See TEST, ENVIRONMENTAL.

ENVIRONMENTAL TOLERANCE

The resistance of equipment to environmental stress. Ability to tolerate such stresses without impairment of function.

The ability of system or portion thereof to operate within a specified environmental range. (TR 58-111)

Examples: Operation within a great range of temperature, humidity, ambient pressure, vibration, etc.

EVENT

A specific occurrence of importance; can be time and/or sequence oriented.

EXPONENTIAL DISTRIBUTION

A random variable t has an exponential distribution with mean $1/\lambda \geq 0$ if its cumulative distribution function F has the form $F(t) = 1 - e^{-\lambda t}$ for $t \geq 0$. (IRE)

EXPONENTIAL FAILURE LAW

An equipment is said to obey the exponential failure law if its failure rate is a constant λ , ($= 1/m$); or, equivalently, its probability of surviving to time t without failure is $e^{-\lambda t}$. ($P_s = e^{-t/m}$). (TR 58-111)

FAIL SAFE

A condition which provides safeguards in such a manner as to minimize the effects of a failure.

FAILURE

The cessation of ability of an item to meet the minimum specified performance. (MIL-R-27542) Also see FAILURE CLASSIFICATION and MALFUNCTION.

FAILURE ANALYSIS

A post-mortem detail study or a test of failed equipment to determine the exact nature of the failure.

Analysis of failure information to determine probable cause of failure and logical corrective action. (FBM-RAP)

FAILURE ANALYSIS TEST

See TEST, FAILURE ANALYSIS.

FAILURE CAUSE

Why a failure or a series of repetitive failures occurred. Cause description usually involves several levels; such as inherent cause, immediate cause, basic cause, etc. If an amplifier fails, the immediate cause may be a malfunctioning diode. However, the basic cause may be a misapplication of the diode in the circuitry, inadequate inspection of the diodes employed in assembling the amplifier, etc.

FAILURE CLASSIFICATION

The assignment of descriptors to failures for the purpose of categorization, usually for analytical studies. The most frequent classifications are cause and/or effect oriented.

1) Cause-Oriented Classification:

a) Degradation Failure — Failure that results from a gradual change in performance characteristics of an equipment or part with time. (TR 58-111)
Also see FAILURE, WEAROUT.

b) Human-Initiated Failure — Those failures which are traceable principally to some human action, either of commission or omission, occurring in any activity subsequent to design and manufacture.

c) Random or Chance Failure — Failures which occur unpredictably in any given time period.

Any catastrophic failure whose probability of occurrence is invariant with time, and whose occurrence within any given interval of time is consequently unpredictable. Or alternatively, failures which are individually unpredictable. Examples: Seal leakage, shorted electric equipment, heater wire breakage, etc. (TR 58-111)

Any chance failure whose occurrence with time is unpredictable. (MIL-STD-721)

d) Primary or Independent Failure — Those failures which occur or can occur without being related to the prior malfunctioning of associated items.

2) Effect-Oriented Classifications:

See MALFUNCTION and PROBLEM.

FAILURE, SECONDARY

A failure related to the prior malfunction of associated equipment.

FAILURE MODE, EFFECT, AND CRITICALITY ANALYSIS

1) Failure Mode Analysis — The study of a system and working interrelationships of the parts thereof under various anticipated conditions of operation (normal and abnormal) in order to determine probable location and mechanisms where and how failures will occur.

2) Failure Effect Analysis — The study of the potential failures that might occur in any part of a system in order to determine the probable effect of each on all other parts of the system and on probable mission success.

3) Failure Criticality Analysis — The study of the potential failures that might occur in any part of a system in relation to other parts of the system in order to determine the severity of effect of each failure in terms of a probable resultant safety hazard or unacceptable degradation of performance.

FAILURE RATE

The number of failures per unit time in a specified equipment.

FAILURE, WEAROUT

Those failures which occur as a result of deterioration processes or mechanical wear and whose probability of occurrence increases with time. Wearout failures are those failures that occur generally near the end of life of an item and are usually characterized by chemical or mechanical changes; hence, those failures which could have been prevented by a replacement policy based on the known wearout characteristics (and thus prevented by appropriate maintenance). (TR 58-111) Example: Motor brush wearout. Also see Degradation Failure under FAILURE CLASSIFICATION.

FAULT

An undesirable event.

FAULT LOCATION TIME

The time spent arriving at a decision as to which item caused the system to malfunction, including work time in portions of systems which are shown not to have been the cause of the malfunction.

FAULT TREE

A logic diagram representing the propagation path (location) and inhibiting factors related to system faults.

FAULT TREE ANALYSIS

A mathematical system applied to the evaluation of the probability that a specific fault lying within the structure of a fault tree will occur.

FREE TIME

Time during which operational use of the system is not required. This time may or may not be down time, depending on whether or not the system is in operable condition.

GAUSSIAN DISTRIBUTION

See NORMAL DISTRIBUTION.

HAZARD

The constitutional probability that a given item will fail between a time t and an increment Δt , given that it has survived at $T \geq t$.

HUMAN ENGINEERING

A branch of science which deals with quantitative measures of human capabilities and limitations and their application to machine design, such as master control panels, emergency-manual actuation devices, etc. The art or science of designing, building, or equipping a vehicle to the anthropometric, physiological, or psychological requirements of a person.

The function of matching the production operation to the human operator by taking into consideration all characteristics and limitations of both machines and human operators, in order to limit degradation of reliability to a minimum. (FBM-RAP)

HUMAN FACTORS

Facts about human behavior which affect the design of systems. As a discipline, its goal is to achieve an optimal man-machine system with an efficient man working in a safe and habitable environment. Such a man will be working with equipment designed to maximally use his capabilities and minimize his limitations, while reliably performing tasks that men can do better or more economically than machines.

Factors caused by limitations of the human operator, and which usually result in degradation of reliability. (FBM-RAP)

HUMAN-INITIATED FAILURE

See FAILURE CLASSIFICATION.

HYPOTHESIS

An unproved theory or postulate, tentatively accepted to explain certain facts.

IMPORTANCE FACTOR

The relative importance of the particular system to total availability. It is defined as the ratio of down time caused by the particular equipment failing to the total operating time of a plant.

INCIDENT

A programmatically significant, unusual, or unscheduled event affecting or potentially affecting personnel safety or the performance and safety of a reactor or test facility.

INDEPENDENT FAILURE

See FAILURE CLASSIFICATION.

INDUCED FAILURE

See FAILURE CLASSIFICATION.

INFANT MORTALITY

Failures occurring during the debugging phase or early portion of equipment life. See LIFE CHARACTERISTICS.

Premature catastrophic-type failures occurring at a rate substantially greater than that observed during life prior to wearout. Infant mortality may be reduced by stringent quality control and eliminated by appropriate screening. Or alternatively, an attribute of a product, characterized by a hazard which is positive at age zero and decreases for some period of time thereafter. (IRE)

INHERENT DESIGN RELIABILITY

See RELIABILITY, INHERENT DESIGN.

INHERENT EQUIPMENT RELIABILITY

See RELIABILITY, INHERENT EQUIPMENT.

INHERENT RELIABILITY

See RELIABILITY, INHERENT.

INSPECTION

The process of measuring, examining, testing, gaging, or otherwise comparing a product with the applicable requirements. Inspection by variables requires measurement and recording of product characteristics on a continuous scale.

The examination, including testing, of contract work, articles, and services to determine conformance to contract requirements. (NPC 200-2)

INSPECTION TEST

See TEST, INSPECTION.

INTEGRATED TEST

See TEST, INTEGRATED.

INTERFACE

The junction points or the points within or between systems or subsystems where matching or accommodation must be properly achieved in order to make their operation compatible with the successful operation of all other functional entities in the system.

LIFE, AVERAGE

See AVERAGE LIFE.

LIFE CHARACTERISTIC

Life as a function of failure rate. Usually, it is plotted showing three parts: (1) an infant mortality or debugging part, (2) a normal operating (constant λ) part, (3) a wearout portion; i.e., the relationship which holds between the failure rate of equipment and operating or test time.

When the design provides adequate stress safety factors, the predominant failure characteristic will be a randomness which is inherent in the part reliability capabilities. This random failure characteristic yields an average failure rate, for an equipment containing many parts, which is constant for a reasonable period of time. The length of this constant failure rate period depends on the incidence of wearout and constitutes the normal operating period which follows debugging. (TR 58-111)

LIFE REQUIREMENT

See SERVICE LIFE REQUIREMENT.

LIFE, SHELF

The length of time an item can be stored under specified conditions and meet specified requirements with a specified level of assurance. (IRE)

LIFE TEST

See TEST, LIFE.

LIFE, USEFUL

The total operating time between debugging and wearout. (TR 58-111)

LOGISTICS

In an operational sense, that part of the activity that provides for the buildup and support of an auxiliary program by providing for supplies, equipment, transportation, maintenance, construction, and operation of facilities, movement and evacuation of personnel, and other like services.

LOT

The term "lot" shall mean "inspection lot," i.e., an accumulation of equal units of a product from which a sample is drawn and inspected to determine compliance with the acceptability criteria. (TR 58-111)

LOT SIZE

A specific quantity of similar material or equal units from a common source. In inspection work, the quantity offered for inspection and acceptance at any one time. It may include a collection of raw material, parts, subassemblies inspected during production, or a consignment of finished products.

MAINTAINABILITY

The quality of the combined features of equipment, design, and installation which facilitates the accomplishment of inspection, test, service, repair, and overhaul with minimum time, skill, and resources in the planned maintenance environment. Quantitatively, it is the probability that, when specified maintenance or replacement action is taken, the system can be restored to a satisfactory operational condition in a given period of time. (AFBM 58-10)

The maintainability of an equipment in a specified maintenance environment is the probability that a failure will be repaired within a specified time after the failure occurs. (TR 58-111)

The quality of the combined features of equipment design and installation which facilitates the accomplishment of inspection, test, service, repair, and overhaul with a minimum of time, skill, and resources in the planned maintenance environment. (FBM-RAP)

Maintainability is a characteristic of design and installation which is expressed as the probability that an item will conform to specified conditions within a given period of time when maintenance action is performed in accordance with prescribed procedures and resources. (MIL-STD-778)

MAINTENANCE RATIO

The number of maintenance manhours of downtime (t_m) required to support each hour of operation (t_o), i.e., $M = t_m/t_o$. This figure reflects the frequency of failures of the system, the amount of time required to locate and replace the faulty part and to some extent the overall efficiency of the maintenance organization. This method of measurement is primarily valuable to operating agencies since under a given set of operating conditions, it provides a figure of merit for use in estimating maintenance manpower requirements. The numerical value for maintenance ratio may vary from a very poor rating of five or ten down to a very good rating of 0.25 or less. (TR 58-111)

MAINTENANCE, SCHEDULED

Service, repair, or overhaul action performed at predetermined intervals of time.

MAINTENANCE, UNSCHEDULED

Service, repair, or overhaul action performed outside scheduled maintenance due to the occurrence of a failure. May also be performed if suspicion of an incipient failure exists.

MALFUNCTION

A failure or degradation occurring during plant operation for which a corrective action procedure has been prepared or planned and which occurrences do not fall either under the category of routine scheduled maintenance or the definition of an incident. Malfunctions are separated into two classes, minor malfunctions and major malfunctions:

- 1) Minor Malfunction — An occurrence which under expected operating conditions would have no safety or programmatic significance.
- 2) Major Malfunction — An occurrence which under more severe (but normal) environmental or operational level conditions, or different scheduling conditions, would have been classed as an incident (i.e., occurring at low-power operation or discovered during scheduled maintenance or routine tests but having no present safety or programmatic significance).

MARGINAL TEST

See TEST, MARGINAL.

MATERIAL REVIEW BOARD

A committee charged with reviewing deviated material for the purpose of deciding its acceptability for incorporation in production hardware, without compromising reliability, quality, and capability.

MEAN

The mean (also expectation or average) of a random variable x with probability density function $f(x)$ is defined to be

$$E(x) = \int_{-\infty}^{\infty} x f(x) dx$$

If x is discrete, then its mean is

$$E(x) = \sum_k x_k \cdot \Pr(x = k) = \sum_k x_k p_k$$

where the summation is extended over the values which x assumes (usually integers). (TR 58-111) Also see AVERAGE and MEDIAN.

MEAN CYCLES BETWEEN FAILURE (MCBF)

Same as MTBF, substituting cycles for time (hours). A similar relationship exists between MCTF and MTTF.

The average number of cycles between successive failures; i.e., the total number of cycles completed under specified conditions divided by the number of failures (the mean-cycles-between-failures is the reciprocal of the failure rate in terms of cycles). Mean-cycles-between-failures implies that initial life testing has occurred to produce an accurate measure of the mean-cycles-between-failure expectancy of an item. (FBM-RAP)

MEAN TIME BETWEEN FAILURES (MTBF)

The total operating time accumulated by a population of identical equipment items, under comparable operational environments, divided by the number of failures occurring in the time of observation. The operating time must include the period count accumulated by items which did not fail, as well as the time accumulated by items which did fail.

The mean life or mean-time-between-failures is the arithmetical mean (average) of the operating time between failures. In the case of exponentially distributed time between failures, this ratio is the reciprocal of the failure rate. (MIL-R-27173)

MEAN TIME BETWEEN REPAIR (MTBR)

The total time between repair accumulated by a population of identical equipment items under comparable operational environments divided by the population.

MEAN TIME TO FAILURE (MTTF)

The TR 58-111 definition is regarded as a special case of MTBF applied to a single equipment item rather than to a population of items. The FBM

definition is best applied to aircraft or missiles, where a large number of systems are involved, and the prime interest is in the percentage of missions which will be successful. In nuclear reactors, where the emphasis is in assuring that each phase of operation will be successful and a much smaller population is involved, MTTF may take on a special significance, and may replace MTBF as a figure of merit. Reactor containment and engineered safeguards could fall in this category.

The average time to first failure of several equipments. Used to determine the apparent approach of the equipment life characteristic to its random failure rate. (FBM-RAP)

The measured operating time of a single piece of equipment divided by the total number of failures of the equipment during the measured period of time. This measurement is normally made during that period of time between the early life and wearout failures, and assumes that the equipment is repaired each time it fails. (TR 58-111)

The mean operating time to failure beyond which point the item becomes expendable. (MIL-STD-721)

MEAN TIME TO FIRST FAILURE (MTFF)

Same as MTTF. No distinction is made between MTTF and MTFF.

The average time to first failure of several equipments. Used to determine the apparent approach of the equipment life characteristic to its random failure rate. Usually accomplished during the manufacturing phase of a program. (TR 58-111)

MEAN TIME TO REPAIR (MTTR)

Same difference between MTBR and MTTR as between MTBF and MTTF.

MEDIAN

A point designated in a series of values which divides the series such that an equal number of values lie on each side; e.g., the series 1, 3, 5, 17, 39 has 5 as its median, as compared with its arithmetic mean of 13.

MINIMUM ACCEPTABLE RELIABILITY

See RELIABILITY, MINIMUM ACCEPTABLE.

MODE (Statistical)

A mode of a continuous random variable is a maximum of its frequency function. (TR 58-111)

MODE OF FAILURE

See FAILURE MODE.

MODULE

A combination of parts, components, and/or sub-assemblies contained in one package or so arranged that they are common to one area, which provides a complete function or functions to a system and/or subsystem in which they operate. (AFBM 58-10)

MONITORING POINTS

Points in the reliability program at which functions relative to development, design, and production of the equipment are monitored to determine adequacy of the effort in establishing and maintaining the required reliability. (FBM-RAP)

MOVING AVERAGE

The average of a number of consecutive measurements, recalculated after each measurement or after a given number of measurements, or within a given calendar time period. Earlier measurements are dropped at each recalculation. Widely used in reliability assessments to ensure elimination of early lower reliability data, so that current assessments are based on current equipment.

NONDESTRUCTIVE TEST

See TEST, NONDESTRUCTIVE.

NORMAL DISTRIBUTION

A random variable has a normal (also Gaussian) distribution with mean (m) and standard deviation (σ) if its frequency function (f) is such that

$$f(t) = \frac{1}{\sigma\sqrt{2\pi}} \exp \left[-\frac{(t - m)^2}{2\sigma^2} \right]$$

for all t.

(IRE)

NORMAL OPERATING PERIOD

That period of time during which the equipment failure rate remains essentially constant. Also see LIFE CHARACTERISTIC. (MIL-STD-721)

OPERATING AVAILABILITY

The percentage of time a unit was available for service, whether operated or not. Available hours in this definition include both service hours and reserve hours.

OPERATING CHARACTERISTIC

A basic functional trait of an item. The summary of all operating characteristics is usually called performance requirement.

The operating characteristic of an acceptance test is the function c such that if t is the actual value of the parameter being tested, then c(t) is the probability that the item will be accepted under the test. In quality control the parameters usually plotted are percent defective and the probability of acceptance. (TR 58-111)

OPERATING CHARACTERISTIC CURVE

An outline of the functional traits of an item, showing the interrelation between these traits under conditions of varying stress.

The operating characteristic curve of a sampling plan is the curve which shows the relationship between the quality of submitted inspection lots and the percentage of such inspection lots which may be expected to be accepted on the basis of that sampling plan. (TR 58-111)

OPERATING CYCLE

A complete sequence of operations required for normal function of an item of equipment; or, for test purposes, a sequence of operations specified in the test procedure. (FBM-RAP)

OPERATING TIME

The time period between turn-on and turn-off of a system, subsystem, component, or part during which time operation is as specified. Total operating time is the summation of all operating time periods. See AVAILABILITY. (MIL-STD-721)

OPERATIVE REDUNDANCY

See REDUNDANCY, OPERATIVE.

PARALLEL REDUNDANCY

See REDUNDANCY, PARALLEL.

PART

An article which is an element of an assembly or subassembly, and is of such construction that it is not practically or economically amenable to further disassembly for maintenance purposes. (In this handbook, a part is usually the smallest element of current interest for study.)

PDF

Abbreviation for Probability Density Function.

POISSON DISTRIBUTION

A discrete random variable x has a poisson distribution with mean $\lambda \geq 0$ if:

$$P(x = k) = \frac{\lambda^k}{k!} \cdot e^{-\lambda}$$

for $k = 0, k = 1, 2, \dots$ etc. (IRE)

POPULATION

The total accumulation of units from a common source; the total number of units from a process, such as a production process. Also used in the sense of a universe (or population) of observation. "Universe," "population," and "parent distribution" are synonymous terms. Statistical methods are based on the concept of a distribution of an exceedingly large number of observations, termed an infinite universe or population. An individual observation, the x of a sample, etc., may be thought of as one coming from a parent distribution or infinite population of like terms. (IRE)

PREDICTED RELIABILITY

See RELIABILITY, PREDICTED.

PREVENTIVE ACTION

See CORRECTIVE ACTION.

PREVENTIVE MAINTENANCE

A procedure of periodically checking and/or reconditioning a system to prevent or reduce the probability of failure or deterioration while in service. (MIL-STD-721)

Preventive maintenance is a procedure of inspecting, testing, and reconditioning a product at regular intervals according to specific instructions intended to prevent failures in service or to retard deterioration. (TR 58-111)
See MAINTENANCE, SCHEDULED.

PRIMARY FAILURE

See FAILURE CLASSIFICATION.

PROBABILITY

The likelihood of occurrence of a particular event. The ratio of the number of ways an event can actually occur to the total number of possibilities.

PROBABILITY LIMITS

Upper and lower limits assigned to an estimated value to indicate the range within which the true value is supposed to lie according to some statement of a probabilistic character. Examples: Control-chart limits, confidence limits. (IRE)
Also see CONFIDENCE LIMIT.

PROBLEM

Problem, when capitalized, is defined as an operation defect or nonconsistent performance which adversely affects operation or maintenance but is of insufficient magnitude to warrant corrective action.

PROCESS SPECIFICATION

See SPECIFICATION, PROCESS.

PRODUCER'S RELIABILITY RISK

The risk of the producer (usually standardized at 10%) that a reliability acceptance test will reject a product when it is actually equal to or better than a specified value of reliability. (TR 58-111)

PRODUCER'S RISK

Associated with an acceptance test, the producer's risk is defined to be the probability (usually called α) of rejecting an item or a lot which is, in fact, satisfactory. (TR 58-111)

PRODUCIBILITY

The degree of compatibility between design requirements and production capabilities. (FBM-RAP)

PRODUCT ASSURANCE

A broad program of activities directed toward assuring the delivery of a reliable, useful product. Product assurance is the top management-centered control program which establishes factory-oriented control people in the organized quality and reliability program for operation in the manufacturing process, in design engineering, safety planning and control, and other specially oriented groups for product evaluation following production and for field followup. These various control areas are directed through a suitable chain of command from the topmost management staff. Product assurance embraces the final performance of the product in the network and all the related characteristics such as reliability, maintainability, safety,

system integration, operability, value, and cost. Product assurance is a technical management operation which deals with all documentary, development, factory, and field stages in an integrated overall control program.

PROTOTYPE

A model suitable for complete evaluation of mechanical and electrical form, design, and performance. It shall be of final mechanical and electrical form, employ approved parts, and be completely representative of final equipment.

(IRE)

A model suitable for use in complete evaluation of its functional features, design, and performance.

(FBM-RAP)

QUALIFICATION TEST

See TEST, DESIGN QUALIFICATION

QUALIFIED PRODUCT

An item listed as tested and approved for inclusion in a Qualified Product List, which indicates the operational and environmental maximum stresses to which the product has been tested, and which is compatible with the requirements of Nuclear Power Stations.

QUALIFIED VENDOR

A vendor is judged a qualified vendor when he demonstrates to the customers or prospective customers to their satisfaction, that he possesses the facilities, the financial resources, the technical and managerial capabilities for performing the job under consideration within the available budget and schedule.

QUALITY

The quality of a device is a measure of its conformance to engineering specifications and workmanship standards.

QUALITY ASSURANCE

A planned and systematic pattern of actions necessary to provide adequate confidence that the end items will perform satisfactorily in actual operations.

(NPC 200-2)

QUALITY CONTROL

A factory-oriented operation for causing a process to manufacture a uniform product within specified limits of percent defective in accordance with the design requirements. (TR 58-111)

QUALITY ENGINEERING

A quality control function responsible for establishing quality control inspection and test requirements, setting up quality criteria, and interpreting quality data.

QUALITY VERIFICATION TEST

See TEST, QUALITY VERIFICATION.

RANDOM FAILURE

See FAILURE CLASSIFICATION. Also see LIFE CHARACTERISTIC.

RANDOMNESS

A non-deterministic chance for possible outcome.

RANDOM SAMPLE

A random sample is one in which each item in the lot has an equal chance of being selected in the sample.

(TR 58-111)

RANDOM VARIABLE

A quantity which may take one of a specified set of values with a probability, varying, in general, from value to value.

RECEIVING INSPECTION

Examination and testing in accordance with specified criteria, to determine conformance of parts or equipment to certain specified requirements as a prerequisite for acceptance.

REDUNDANCY

The existence in a system of more than one means of accomplishing a function of the system. All means of accomplishing this system function must fail, to produce a failure of the system.

REDUNDANCY, OPERATIVE

Operative redundancy exists when two or more items are connected in parallel, or in parallel-series redundancy, with all of the items working simultaneously, and where any one item is capable of performing the given task.

REDUNDANCY, PARALLEL

When two or more items, any one of which is capable of performing the given task, are connected in parallel, this is known as parallel redundancy. Parallel redundancy can be either operative or standby.

REDUNDANCY, PARALLEL-SERIES

When two or more items, each having parallel redundancy, are connected in series, this is known as parallel-series redundancy.

REDUNDANCY, STANDBY

Standby (or backup) redundancy is applied to a system where there is an alternate means of accomplishing a task, which is held in abeyance until a failure of the primary equipment is sensed and the standby equipment is actuated to take over the required task.

RELIABILITY

The probability that a device will perform its intended function for a specified period of time under the operating environment for which it was designed.

RELIABILITY ANALYSIS

Loosely, any of a large variety of analyses that may be performed in connection with reliability engineering considerations.

RELIABILITY APPORTIONMENT (Or RELIABILITY ALLOCATION)

Allocation or assignment of the system reliability requirement to subsystems and components in accordance with their complexity and other factors, in such fashion that if each component or subsystem meets its apportioned requirements, the system reliability requirement will be met.

Assignment of reliability figures of merit to the various parts or components of a product in order to arrive at an estimate of the reliability of the product.

RELIABILITY ASSURANCE

The exercise of positive and deliberate engineering measures to provide confidence that a specified reliability will be obtained.

(NAWEPs 00-65-502)

RELIABILITY DEMONSTRATION

Demonstration of the reliability of a product by analysis of available information and by performance of tests.

RELIABILITY ENGINEERING

A branch of engineering which takes as its field of interest all factors in any area which affect the product reliability. It seeks to ensure (through scientific, technical, and management planning from a system point of view) that all organizational functions support the common goal of delivering a reliable product. It also provides a specialized technical support to areas such as design, testing, etc.

Reliability engineering is a design adjunct which assists in establishing a product design with a high inherent reliability. (TR 58-111)

RELIABILITY GOAL (or Objective)

The product reliability which is desired to be achieved. The statement of the reliability goal is sometimes accompanied by a statement of the level of statistical confidence which is desired in any demonstration that the goal has been achieved.

The reliability goal is that reliability desired of the system. Preferred over "Target Reliability." (TR 58-111)

Reliability level established for a system, subsystem, or component (i.e., a desired numerical reliability value, or failure rate with a stated statistical confidence level) which, in combination with other factors such as design criteria, cost, available raw materials, etc., will optimize the system. (AFR 375-5)

RELIABILITY GROWTH

A measure of reliability increases or decreases between predetermined events of a program. Usually a reliability goal is set at the beginning of a program and a growth rate is planned to achieve this goal. Various monitoring schemes are used to compare achieved reliability at any one point in time to the planned reliability growth curve for control purposes.

RELIABILITY INDEX

Figures of merit, such as ratios, factors, etc., used to denote relative reliability. For example: (1) the number of failures per 100,000 operational cycles, (2) the number of failures per million hours of equipment operating time as may be appropriate to the equipment application, (3) the mean time between failure in equipment operating hours, etc.

RELIABILITY, INHERENT

The reliability potential present in the design, as determined prior to full-scale operation.

Reliability potential present in the design. (MIL-R-27542)

Inherent reliability is the probability of performing without failure a specified function under specified test conditions for a required period of time. (TR 58-111)

That reliability inherent in the design. (AFBM 58-10)

The actual reliability achieved during the design phase. (MIL-STD-721)

RELIABILITY, INHERENT DESIGN

The reliability level supposedly provided by the design. An ambiguous and misleading concept, since the "design" cannot be operated or tested, and "inherent design reliability" cannot in any way be measured.

RELIABILITY, INHERENT EQUIPMENT

Inherent equipment reliability is the probability of the equipment performing properly when operated under contractually stated operational conditions during the initial phases of full-scale operation in the manner intended.

Inherent equipment reliability is the probability of the equipment performing properly when operated under contractually stated operational conditions, utilizing supporting equipment and procedures in the manner intended. The reliability is measured by the failure rate of the equipment when operated under specified conditions for sufficient time to obtain a failure rate that is approximately constant. Usually there is an initially high failure rate period during which marginal parts are eliminated. Following this, there is an operating period during which the equipment exhibits a fairly constant failure rate. (MIL-STD-441)

RELIABILITY LIFE TEST

See TEST, RELIABILITY LIFE.

RELIABILITY, MAN-RATED

A term indicating that the reliability of an equipment is sufficient to meet or exceed the level of safety that is required.

RELIABILITY, MINIMUM ACCEPTABLE

Any agreed-upon or specified level of reliability which must be demonstrated as a minimum requirement. Not necessarily involved with acceptance of the product.

RELIABILITY, MISSION

Probability of successfully completing a mission in accordance with the predetermined functional and environmental mission profile. The term is mainly used in the aerospace industries.

RELIABILITY, OPERATIONAL

Operational reliability is the reliability demonstrated by an equipment under actual plant use and under full capacity operation of same.

RELIABILITY, PREDICTED

Predicted reliability is a computed value derived from analysis of failure modes, redundancy and other attributes expected to affect performance, and supported by past experience with similar items, synthesis of detail part failure rate data, and other quantitative data. When the value is derived from actual test of the item itself it is usually referred to as a reliability "assessment" rather than "prediction."

RELIABILITY PROGRAM

Activities and their definitions involving all elements of an organization, planned to help produce a reliable product.

RELIABILITY REQUIREMENT

A level of reliability expressed in an equipment specification as a design requirement.
(MIL-STD-721)

RELIABILITY RISK

See CONSUMER'S RELIABILITY RISK and PRODUCER'S RELIABILITY RISK.

RELIABILITY STRESS ANALYSIS

A technique somewhat similar to structural stress analysis, applied to equipment design to evaluate the influence of environmental, functional, and time stresses, as an aid to assuring design integrity or predicting reliability.

RELIABILITY TEST

See TEST, RELIABILITY.

REMEDIAL ENGINEERING

A reliability discipline involving the development of corrective action for known design deficiencies.

REQUIREMENT(S)

Quantitative and qualitative descriptions used to define a process of a commodity. See SPECIFICATION.

REPAIR TIME, ACTIVE

The time required to replace, repair, or adjust all items suspected to have been the cause of a malfunction, discounting any time lost because of nonavailability of spares, tools, logistic time, and/or final test time. (MIL-HDBK-472)
See DOWN TIME.

REPAIRABILITY

The probability that a failed system will be restored to operable condition within a specified active repair time.

RISK

The probability of making an incorrect decision.

SAFETY FACTOR

The margin of conservativeness inherent in the application of component parts is a function of all stresses. There is usually a limiting stress (or combination of stresses) at which the part failure rate goes to infinity or to an unacceptable extreme. From the catastrophic-failure viewpoint, the degrees to which application-stress conditions are backed off from such a limit constitutes a safety factor. From the performance-degradation viewpoint, a safety factor is represented by an adequate reserve of energy (as in the case of a battery), gain characteristic (transconductance), bandwidth, or other essential performance factor. Such factors may be designed as the inverse of the performance degradation characteristics of the components or parts involved and reflected into the overall system phenomena at practical environmental conditions. Other types of reliability safety factors are to be found in electronic-system designs in the area of maintenance, human engineering of control panels, etc. From the operations viewpoint, safety factors may be represented by stress reduction, minimum supply of cooling air, equipment redundancy, etc. Thus, it is necessary to recognize that there is a "trade-off" between different safety factors to achieve the optimum overall design. (TR 58-111)

SAMPLING PLAN

See ACCEPTANCE SAMPLING PLAN.

SCHEDULED MAINTENANCE

See MAINTENANCE, SCHEDULED.

SECONDARY FAILURE

See FAILURE CLASSIFICATION.

SEQUENTIAL TEST

See TEST, SEQUENTIAL.

SERVICEABILITY

A characteristic of an equipment design that makes it easy to service and repair in operation.
(MIL-STD-721)

Those properties of an equipment design that make it easy to service and repair in operation. Serviceability can be expressed as $S = 1/\bar{x}$ where $\bar{x}$ = mean-net-time-to-repair failures. (TR 58-111)

SERVICE LIFE REQUIREMENT

Specified requirement for useful life of the equipment. May include terms such as operating life, storage life, etc.

SERVICE READINESS

The condition of a complete electric power operating facility which has been demonstrated to have the required reliability for service operation, as determined from reduced or normal load test runs under simulated service conditions.
(Modified FBM-RAP)

SHELF LIFE

See LIFE, SHELF.

SIGMA LIMITS

The interval about the mean of a distribution expressed in units of standard deviation. Assuming a normal distribution, a one-sigma limit on each side of $\bar{x}$ would include 68.3% of the population, a two-sigma limit on each side of $\bar{x}$ would include about 95% of the population, and a three-sigma limit would include about 99% of the population of measurements. See STANDARD DEVIATION.

SIGNIFICANCE LEVEL

A significance level, associated with a test of statistical hypothesis, is a predetermined expected fraction of all cases of repetition of the test in which the hypothesis is rejected under the test even though it is true. (IRE)
Also see RISK.

SKEWNESS

Nonsymmetry in a frequency distribution.

SODIUM REACTIVITY

See COOLANT REACTIVITY COEFFICIENT.

SODIUM SYSTEM

The containment envelope associated with both the sodium and cover gas.

SODIUM VOIDING

The displacement, loss, or vaporization of sodium at a specific location in the reactor core.

SPECIFICATION

A detailed description of process and/or commodity characteristics and criteria which must be followed and used to conform with contractual requirements.

STANDARD

See ENGINEERING STANDARD.

STANDARD DEVIATION

The standard deviation (σ) is a statistical measure of dispersion. It is the positive square root of its variance, and may be expressed as

$$\sigma = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^n (x_i - \bar{x})^2}$$

STANDBY REDUNDANCY

See REDUNDANCY, STANDBY.

STATISTICAL ANALYSIS

The mathematical treatment and evaluation of statistical information. (IRE)

STATISTICAL DATA

An accumulation of numerical or qualitative data descriptive of a population or process. (IRE)

STATISTICAL INFERENCE

The making of statements or the process of drawing judgments about a population on the basis of random samples, in such a manner that the probability of making correct inferences is determinable under various alternative hypotheses about the population being sampled.

SUCCESS

The performance to specification requirements of any equipment within a specified period of time, number of cycles, or specified operational profile.

SYSTEM

A combination of parts, assemblies, and sets joined together to perform a specific operational function or functions. Examples: Piping system, refrigeration system, air conditioning system.
(TR 58-111)

A system is defined as any combination of complete operating equipment, components, accessories, or parts, interconnected or interrelated in such a manner as to perform a specific operational function or functions. (MIL-STD-441)

SYSTEM COMPATIBILITY

The ability of the equipments within a system to work together to perform the intended function(s) of the system. In a broader sense, system compatibility is the suitability of a system to provide the levels of plant performance, reliability and maintainability (availability and safety) required by the licensing agency.

SYSTEM EFFECTIVENESS

A measure as to how the system can successfully meet the operational demands of availability and safety within a given budget when operated under specified conditions.

SYSTEMS INTEGRATION

The management process by which the systems of a project — for example, the reactor, vessel, primary loop, secondary loop, and turbine generators, and their operational procedures — are made compatible, in order to achieve the purpose of the project. (Modified NPC 200-2)

TEST

Determination of the physical and/or functional properties of materials, parts, or equipment by the application of technical processes and procedures designed to eliminate, as far as possible, the element of human judgment in order to determine the true character of the article tested.

TEST, ACCEPTANCE

Tests to determine conformance to design or specifications as a basis for acceptance. They may include functional, environmental, or other tests, as necessary. (TR 58-111 and IRE)

A test designed to determine acceptability of a product by establishing whether or not the product complies with the technical provisions of the contract (specifications). (FBM-RAP)

TEST, DESIGN DEVELOPMENT

Test of bread-board or mockup with pre-prototype components or parts, constructed as a part of the design, research, and development process to verify design features or to obtain data needed for design evaluation, including reliability data.

TEST, DESIGN PROOF (DPT)

See TEST, DESIGN VERIFICATION.

TEST, DESIGN QUALIFICATION

A test to determine whether all specified criteria for the design of the product have been attained or exceeded the desired safety margin incorporated in said design. (FBM-RAP)

TEST, DESIGN VERIFICATION

Tests conducted on prototype or early production articles to demonstrate capability of functioning to selected specification limits during or after exposure to critical environments. See TEST, DESIGN QUALIFICATION.

TEST, DESTRUCTIVE

Any test which results in destruction or drastic deterioration of an article so that it is rendered unfit for repair or service. Usually conducted to explore limits of strength, resistance to environments, or life.

TEST, ENGINEERING EVALUATION

See TEST, DESIGN DEVELOPMENT.

TEST, ENVIRONMENTAL

Any test conducted under environmental conditions (usually under an environment other than normal room ambient).

A test performed under actual or simulated specified environmental conditions to determine ability of the product to function under those conditions.

(FBM-RAP)

TEST, FACTORIAL

A statistically designed pattern of tests planned to permit varying more than one factor at a time while determining the effect of the various factors in the performance and reliability of the test article. (Factors may be load parameters, environmental stresses, etc.)

TEST, INTEGRATED

Refers to Integrated Test Program in which the tests, which are required to meet a number of different test objectives such as design development goals, qualification test goals, reliability test goals, etc., are planned together to support and supplement each other in a manner that the required data will be acquired most economically.

TEST, LIFE

Any test conducted to evaluate the longevity of an article or change in characteristics as a function of time of operation. May be, but usually is not, conducted in the presence of environmental stresses.

TEST, MARGINAL

A procedure for system checking which indicates when some portion of the system has deteriorated to the point where there is a high probability of a resultant system failure during the next operating period. (An example might be operation of the system with coolant flow reduced or increased by a given percentage to determine whether the system will continue to perform satisfactorily at that reduced or increased flow.) Thus, marginal testing is a form of prediction testing. It tests equipment under more severe conditions than are normally present and thus functions by causing it to produce observable abnormalities. Alternatively, marginal testing is (1) the means of varying circuit or system parameters in such a way as to indicate potential operational failures in a system, and (2) the means of altering circuit or system performance to render intermittent faults continuous, thereby simplifying troubleshooting. (TR 58-111 and IRE)

A form of testing the system at the limits of the design parameters. (MIL-STD-721)

TEST, NONDESTRUCTIVE

Any test which leaves the test article in usable or repairable condition.

TEST, PRODUCTION ENVIRONMENTAL

Environmental tests conducted on all, or a sample (fraction), of the components to provide a continuous verification of environmental resistance or, if conducted on a 100% basis, to permit rejection of those articles which, because of workmanship, process, or material variations, do not meet the test criteria. Also sometimes employed as a shakedown or debugging operation, particularly when the environment is vibration,

to disclose poorly soldered joints, untightened nuts, and similar gross defects. Usually conducted under environmental stress somewhat lower than the design criteria to avoid any possibility that the test article will suffer deterioration.

TEST, QUALIFICATION

See TEST, DESIGN QUALIFICATION.

TEST, QUALITY VERIFICATION

Inspection tests performed on random samples of parts and components at periodic intervals during production to verify that production articles continue to meet previously established standards.

TEST, RELIABILITY

Tests and analyses in addition to other type tests which are designed to evaluate the level of reliability in a component, part, or system and the dependability or stability of this level with time and use under various environmental conditions. (TR 58-111)

TEST, RELIABILITY LIFE

Testing of a sample of an item under specified conditions for predetermined periods of time, or until a predetermined number of failures occur, for the purpose of estimating the mean time to first failure or mean time between failure to a specified confidence level (failure density distribution). (MIL-STD-721)

TEST, SEQUENTIAL

A sequential test of a statistical hypothesis is the measurement of a sequence of samples where it is decided at each step in the sequence to accept the hypothesis, to reject the hypothesis, or to take an additional sample. (TR 58-111)

TEST TO FAILURE

Testing conducted on one or more items until a predetermined number of failures have been observed. Failures are induced by increasing electrical, mechanical, and/or environmental stress levels, usually in contrast to life tests in which failures occur after extended exposure to predetermined stress levels. A life test can be considered a test to failure using age as the stress. (TR 58-111)

A process of submitting an item to stress levels within design limits until failure occurs. (Accelerated tests to failure result in subjecting an item to stress levels beyond design limits to induce failure.) (MIL-STD-721)

TESTING TO DESTRUCTION

See TEST TO FAILURE.

TRACEABILITY

The ability to trace the history, application, use, and location of an individual article or characteristic lot of articles through use of the recorded identification numbers.

TRADE-OFF

The procedure of trading a degree of one attribute to gain a degree of another attribute; e.g., a degree of reliability might be sacrificed to obtain a greater degree of performance under certain conditions, or vice versa. (FBM-RAP)

TRADE-OFF STUDY

Analysis of the factors involved in a trade-off situation to determine the relative values and establish the optimum compromise.

TRUNCATION

For a distribution, this means deletion of portions greater than a certain value and/or less than a certain value. Truncation of a sequential test means termination of the test prior to reaching a firm decision under the sequential test plan.

UNIT

See PART, COMPONENT, or SYSTEM

UNIVERSE

See POPULATION.

UNSATISFACTORY CONDITION

A general term used to describe any condition which can be regarded as unsatisfactory from the management, manufacturing, quality control, human factors, reliability, maintainability, design, or system effectiveness point of view.

UNSCHEDULED EVENT

Any failure, abnormality, or unsatisfactory condition which, when observed, leads to a partial or total shutdown of system operation at a time different from normal maintenance routine shutdown.

USEFUL LIFE

See LIFE, USEFUL.

VARIABLE

A quantity or characteristic that is not fixed. A continuous variable may assume any value within a defined range. A discrete variable may assume any one of a number of distinct or separate values.

VARIANCE

The variance of a random variable (x) with mean ($\bar{x}$) and of its distribution $f(x)$ is defined by the expression

$$V = \int_{-\infty}^{\infty} (x - \bar{x})^2 f(x) dx ,$$

when f is the frequency function of x . When x is discrete, then its variance is

$$V = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2 ,$$

where the summation is extended over the n values which x assumes. Variance is also the square of the standard deviation (σ).

VENDOR RATING

A general term denoting any one of many schemes designed to rate vendor performance.

VENDOR SURVEILLANCE

A management discipline used for control of vendor performance.

WEAROUT

End of useful life. The point in time at which maintenance or repair and continued use is not feasible or economical.

The point at which further operation is uneconomical. (TR 58-111)

WEAROUT FAILURE

See FAILURE, WEAROUT.

WEAROUT PERIOD

The wearout period of an equipment is that period of equipment life, following the normal operating period, during which the equipment failure rate increases above the constant rate.

(TR 58-111)

WORST CASE ANALYSIS

A reliability analysis technique in which in an analog (of a subsystem, for example) part performance characteristic values are systematically varied to extremes to analyze the effect of such variance or combination of variance on the subsystem performance. This provides data for specifying limits on the permissible drift of part performance characteristics, for example. Or, if drift rates are known, a reliability estimate may be derived. The analysis will also reveal whether the subsystem design is "tolerant" to variances in the parts.