GENERAL ELECTRIC INPUT FOR SAFETY ANALYSIS REPORT

VOLUME IV

GENERAL ELECTRIC

APPENDIX C - LOADING CRITERIA

TABLE OF CONTENTS

G.E.
Ref.

APPENDIX C

LOADING CRITERIA

(1) C.1 DEFINITIONS

Each structure, system, and component, is analyzed to determine its governing loading condition and load limiting criteria. Each structure, system, component, and parts thereof are classified in accordance with the definitions which follow.

(1) C.1.1 Class I

This class includes those structures, systems, components, and parts thereof, failure of which could lead to a release of radioactivity in excess of the guideline values in published regulations pertaining to accident considerations.

(1) C.1.2 Class IM

This class includes those structures, systems, components, and parts thereof, which are required to function after any accident up to and including the design basis accident.

(1) C.1.3 Class II

Structures, systems, components, and parts thereof, which are not included in Class I or Class IM are Class II and have no safety considerations. A Class II designated item shall not degrade the integrity of any item designated Class I or Class IM.

(1) C.2 General Classification of Systems, Structures, and Equipment

C.2.1 Class I

The following list establishes a general category of Class I items and is not intended to be all inclusive or exclusive:

Item

Reactor pressure vessel

Spent fuel storage

In-core flux monitor guide tubes

All piping and piping supports included in the nuclear system primary barrier

G.E.
Ref.

C.2.2 Class IM

The following list establishes a general category of Class IM items noting any exceptions and is not intended to be all inclusive or exclusive:

Item	Exception
Reactor pressure vessel support system	
Reactor core and control rods	
Reactor pressure vessel internals	Shroud head Steam separators, steam dryers Startup neutron sources
Lower portion of reactor pressure vessel	
Reactor recirculation system	Recirculating pump M-G sets
Standby gas treatment system	
Nuclear Safety Systems	Neutron monitoring system
Engineered Safeguards	Standby liquid control system test tank
Cooling systems for engineered safeguards	
Control room	

(2)

C.3 Loading Conditions and Safety Margins

The loading conditions established herein are expressed in generic terms and are related in a probabilistic manner to the simultaneous occurrence of several of the loads which are normally investigated for safety considerations. The related probabilistic definitions are then used to determine an appropriate minimum safety factor which is used to establish structural design safety margins, and functional design safety margins. The governing loading conditions are established and related to the classification previously defined.

C.3.1 Loading Conditions

The loading conditions, which are to be considered in addition to loads from normal conditions, are divided into three categories; upset conditions, emergency conditions, and faulted conditions. The conditions are defined as follows:

G.E. Ref.

C.3.1.1 Normal Conditions

Any condition in the course of operation of the plant under planned, anticipated conditions, in the absence of upset, emergency, or faulted conditions.

(3)

C.3.1.2 Upset Conditions

Any deviations from normal conditions anticipated to occur often enough that design should include a capability to withstand the conditions without operational impairment. The upset conditions include abnormal operational transients caused by a fault in a system component requiring its isolation from the system, transients due to loss of load or power, and any system upset not resulting in a forced outage. The upset conditions include the effect of the specified earthquake for which the system must remain operational or must regain its operational status.

(3)

C.3.1.3 Emergency Conditions

Any deviations from normal conditions which require shutdown for correction of the conditions or repair of damage in the system. The conditions have a low probability of occurrence but are included to provide assurance that no gross loss of structural integrity will result as a concomitant effect of any damage developed in the system.

(3)

C.3.1.4 Faulted Conditions

Those combinations of conditions associated with extremely low probability postulated events whose consequences are such that the integrity and operability of the nuclear system may be impaired to the extent where considerations of public health and safety are involved. Such considerations require compliance with safety criteria as may be specified by jurisdictional authorities. Among the faulted conditions may be a specified earthquake for which safe shutdown is required.

(2)

C.3.2 Safety Margins

In addition to the generic definitions in the preceding paragraphs, the meaning of these terms is expanded in quantitative probabilistic language. The purpose of this expansion is to clarify the classification of any hypothesized accident or sequence of loading events so that the appropriate structural safety margins are applied. Knowledge of the event probability is necessary to establish meaningful and adequate safety factors for structural design. The following table illustrates the quantitative event classifications:

GESSAR
AJ Levine

G.E.
Ref.

Generic Definition	P_{40}, 40 year event encounter probability
Upset (likely)	$1.0 > P_{40} \geq 10^{-1}$
Emergency (low probability)	$10^{-1} > P_{40} \geq 10^{-3}$
Faulted (extremely low probability)	$10^{-3} > P_{40} \geq 10^{-6}$

The event probabilities currently in use as governing accident or fault conditions are:

$$P_{40} \text{ (N and U and } A_D) = 10^{-1} \text{ to } 10^{-2}$$

$$P_{40} \text{ (N and } A_m) = 10^{-3}$$

$$P_{40} \text{ (N and R)} = 10^{-3}$$

$$P_{40} \text{ (N and } A_m \text{ and R and C)} \leq 1.5 \times 10^{-6}$$

where:

N = normal loads

U = upset loads excluding earthquake

A_D = design earthquake

A_m = maximum earthquake

R = any pipe rupture

C = core standby cooling thermal loads

These probabilities have been derived to establish the appropriate structural design safety margins for loading criteria. Some criteria are covered by the ASME III code designated herein as C_1. Standard criteria covered by other industry codes is designated herein as C_2. Other criteria have been established to cover the situation where no applicable standard criteria exist. These criteria are designated herein as Criteria F and a summary of these criteria are shown on the indicated tables:

Tab C.0.1	Deformation limit	Table C.0.1
Tab C.0.2	Primary stress limit	Table C.0.2
Tab C.0.3	Buckling stability limit	Table C.0.3
Tab C.0.4	Fatigue limit	Table C.0.4

G.E.
Ref.

(2) The term SF_{min} which appears in the tables is identical with the classical definition of a minimum safety factor on load or deflection. SF_{min} is related to the event probability by the following equation:

$$SF_{min} = \frac{9}{3 - \log_{10}P_{40}}$$

where:

$$10^{-1} > P_{40} \geq 10^{-6}$$

These expressions show the probabilistic significance of the classical safety factor concept as applied to reactor safety. The SF_{min} values corresponding to the current governing accident event probabilities are summarized as follows:

P_{40}	SF_{min}
10^{-1}	2.25
10^{-2}	1.80
10^{-3}	1.50
1.5×10^{-6}	1.02

The minimum safety factor decreases as the event probability diminishes and if the event is too improbable (incredible; $P_{40} \leq 10^{-6}$) then no safety factor is appropriate or required.

(1) The seismic design of Class I and Class IM equipment is based upon appropriate static on dynamic analyses which define the maximum seismic capability of General Electric supplied equipment. The dynamic analysis uses the response spectrum approach or time history analysis.

(2) C.3.3 Governing Loading Conditions and Criteria

The governing loading conditions are summarized as follows:

Governing Loading Conditions

(1) N and U and A_D	Class I and IM
(2) N and A_m	Class I and IM
(3) N and R	Class I and IM
(4) N and A_m and R and C	Class IM only

Using these conditions and the preceding definitions and criteria, and applying them to Class I and Class IM equipment the following table is established:

	Loading Conditions	Criteria
Reactor Pressure Vessel	(1)	C_1, F
	(2)	C_1, F
	(3)	C_1, F
	(4)	C_1, F
Internals	(1)	F
	(2)	F
	(3)	F
	(4)	F
Piping	(1)	C_2, F
	(2)	F
	(3)	F
Equipment and Valves	(1)	C_2, F
	(2)	F
	(3)	F
	(4)	F
Supports and Restraints	(1)	F
	(2)	F
	(3)	F
	(4)	F

where the criteria are:

C_1 = ASME III code

C_2 = Industry codes

F = General Electric criteria

Appendix C - Loading Criteria

List of Tables

GESSAR
AJ Levine

G.E.
Ref.

TABLE C.0.1

CRITERIA F - DEFORMATION LIMIT

Any One Of		General Limit
a. $\left[\dfrac{\text{(Permissible Deformation)}}{\text{(Analyzed deformation causing loss of function}^{(1)}\text{)}}\right]$	$\leq$	$\dfrac{.9}{SF_{min}}$
b. $\left[\dfrac{\text{(Permissible Deformation)}}{\text{(Experimental deformation causing loss of function)}}\right]$	$\leq$	$\dfrac{1.0}{SF_{min}}$

1. "Loss of Function" can only be defined quite generally until attention is focused on the component of interest. In cases of interest where deformation limits can affect the function of Class I structures, they will be specifically delineated. Examples where such limits apply are: Control rod drive alignment and clearances for proper insertion, core support deformation causing fuel disarrangement, excess leakage of any component, required pumps or valves failing to operate.

8/16/68

GESSAR
AJ Levine

G.E.
Ref.

TABLE C.0.3

CRITERIA F - BUCKLING STABILITY LIMIT

Any One Of		General Limit
a. $\left[\dfrac{\text{(Permissible Load)}}{\text{(ASME III normal event permissible load)}} \right]$	$\leq$	$\dfrac{2.25}{SF_{min}}$
b. $\left[\dfrac{\text{(Permissible Load)}}{\text{(Stability Analysis Load}^{(1)}\text{)}} \right]$	$\leq$	$\dfrac{.674}{SF_{min}}$
c. $\left[\dfrac{\text{(Permissible Load)}}{\text{(Instability Load from Test)}} \right]$	$\leq$	$\dfrac{1.0}{SF_{min}}$

(1) The ideal buckling analysis is often sensitive to otherwise minor deviations from ideal geometry and boundary conditions. These affects shall be accounted for in the analysis of the buckling stability loads. Examples of this are ovality in externally pressurized shells or eccentricity of column members.

8/16/68

GESSAR
AJ Levine

G.E.
Ref.

TABLE C.0.4

CRITERIA F - FATIGUE LIMIT

		General Limit
Summation of mean fatigue[1] damage usage including emergency and fault events with design and operation loads following Miner hypotheses ... either one.	a. Fatigue cycle usage from analysis	≤ .05
	b. Fatigue cycle usage from test	≤ 0.33

(1) Fatigue failure is defined here as a 25% area reduction for a load carrying member which is required to function or excess leakage causing loss of function whichever is more limiting. In the fatigue evaluation the methods of linear elastic stress analysis may be used when the $3S_m$ range limit of ASME III has been met. If $3S_m$ is not met account will be taken of (a) increases in local strain concentration, (b) strain ratcheting, (c) redistribution of strain due to elastic-plastic effects. The February, 1968 draft of the B31.7 piping code may be used where applicable or detailed elastic-plastic methods may be used. With elastic-plastic methods, strain hardening may be used not to exceed in stress for the same strain, the steady state cyclic strain hardening measured in a smooth low cycle fatigue specimen at the average temperature of interest.

(TEMPORARY FORM)

CONTROL NO: 12263

ACCEPTANCE REVIEW

FILE: Subj 7.4

FROM: General Electric Co. San Jose, Calif. 95125	DATE OF DOC 12-13-74	DATE REC'D 12-16-74	LTR X	MEMO	RPT	OTHER

TO: E.G. Case	ORIG	CC	OTHER	SENT AEC PDR YES SENT LOCAL PDR N/A

CLASS	UNCLASS	PROP INFO	INPUT	NO CYS REC'D	~~XXXXXXXXXX~~ PROJ.STN-538

DESCRIPTION: Ltr trans addtl info to complete ACCEPTANCE REVIEW of 251 GESSAR-NSSS

DIST; Per: Mr. Kane PM(L)

PLANT NAME: 251 GESSAR-NSSS

ENCLOSURES:
1. Amdt # 1)15) cys
2. Amdt # 2. (15) cys

NOTE ABOVE AMDT'S CONTAIN REVIES PAGES TO UPDATE ORIG. SUBMITTAL.....

Amd# 1-Rev. 12/19/74 G.J.B.
Amd# 2 Rev. 12/30/74 G.J.B.

FOR ACTION/INFORMATION

PROJECT MANAGER (L)
KANE W/ 1 set of encl's
~~XXXXXXXXXXXXXXXXXXXX~~
~~XXXXXXXXXXXXXX~~

PROJECT MANAGER (E)
N/A
1 Cys ENVIRO RPT & APPL
1 Cy SEC. 2 of PSAR/FSAR

BRAITMAN (A/T)
W/5 Cys Anti-Trust
W/3 Cys Application

INTERNAL DISTRIBUTION

~~XXXXXXXXXXXXXXXXXXXX~~
~~XXXXXXXXXXXX~~ Amdt's 1-2
DOCKET/SUBJECT FILE.....1 SET
AEC PDR.................1 SET

APPLICATION ONLY
LIC ASST (L) ~~H.Smith L/O~~
C. MILES (OIS)

QUALITY ASSURANCE, OPERATIONS AND FINANCE
VOLLMER W/SEC 13-14-17 FR BENAROYA
HOUSTON W/SEC 13-14 FR IPPOLITO
COLLINS W/SEC 13 FR NOVAK
B. HURT W/APPL ONLY

TECHNICAL REVIEW
PSAR/FSAR
KNIGHT
PAWLICKI
SHAO
NOVACK ~~LESS SEC 2 & 13~~
IPPOLITO ~~LESS SEC 13 & 14~~
LONG/LAINAS LESS SEC 4 & 15
BENAROYA LESS SEC 13, 14 & 17
ROSS ~~W/SEC 4 & 15 FR LONG~~

SECTION 17.0 (QA) ONLY
REG OPR (THORNBURG)...(2) CYS
SEND TO WILDA MULLINIX (RO)

TECHNICAL REVIEW
PSAR/FSAR & ENVIRO RPT
BENAROYA W/ENVIRO RPT
GRIMES LESS SEC 17
GAMMILL LESS SEC 17
KASTNER

ENVIRO RPT ONLY
SPANGLER
BALLARD

LETTERS ONLY
GIAMBUSSO
BOYD
MOORE
DEYOUNG
DENISE
SKOVHOLT
TEDESCO
MACCARY

LETTERS ONLY
STELLO
DENTON
OGC
MULLER
S. KARI
McDONALD
KENNEKE L/O
PANZARELLA L/O

LETTERS ONLY
L. REEDER (RO)
B/C (L)
B/C (E)
L/A (E)
N. DUBE W/INPUT

WIGGINTON, D. L/O

INTERNAL DISTRIBUTION

LOCAL PDR N/A

NATIONAL LABORATORY N/A (ENVIRO REPORT)

APPL, PSAR, FSAR, ENVIRO RPT & ANTI-TRUST