REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**319-8360**
SRP Section:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
Application Section:	**3.9.3**
Date of RAI Issue:	**11/24/2015**

Question No. 03.09.03-2

DCD Tier 2, Table 3.9-2 indicates that the load combination for Service Level C includes dynamic system loadings associated with the emergency condition. However, DCD Tier 2, Section 3.9.1 states that there are no transient events for the emergency condition. These two sections appear to be inconsistent. The staff requests that the applicant describe the specific dynamic system loads that are included in the load combination for Service Level C, and add a clarification note in Table 3.9-2, as applicable.

Response – (Rev. 3)

SRP 3.9.3 defines the design basis pipe break (DBPB) as those postulated pipe breaks other than a LOCA or MS/FWPB and the DBPB is identified as an emergency condition. This includes postulated pipe breaks in Class 1 branch lines that result in the loss of reactor coolant at a rate less than or equal to the capability of the reactor coolant makeup system.

For the APR1400 DC, make-up flow can compensate for the loss of coolant from a break with a 5.56 mm (7/32 in.) internal diameter as described in Subsection 9.3.4. In accordance with the guidance in SRP 3.6.2, postulated breaks in one-inch nominal diameter piping and smaller piping do not require the analysis of the dynamic system loadings from the ruptured pipe on components, component supports or core support structures. The DBPB condition also results in RCS temperature and pressure transient conditions and is thus conservatively included as a Level B service condition in the RCS design transients given in Table 3.9-1. Therefore, Level C service loadings including dynamic system loads are not used in any APR1400 analyses.

Postulated breaks in lines larger than 25.4 mm (1 in.) nominal diameter are considered in the pipe break analysis as described in Subsection 3.6.2, and are included in the scope of the branch line pipe break (BLPB), which are treated as a Level D condition. The BLPB scope includes those postulated pipe breaks in lines connected to the RCS that are not eliminated by LBB and that result in the loss of the reactor coolant at a rate in excess of the capability of the reactor coolant makeup system, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the RCS except those eliminated by LBB. The BLPB scope also includes main steam and main feedwater pipe breaks (MS/FWPB).

Based on the above, the DCD Tier 2 will be revised to delete Service Level C loads including the dynamic system loads.

In reviewing the associated tables and contained information, it was found that other changes were necessary. IRWST loads were omitted and will be added to DCD Tier 2, Table 3.9-10, Table 3.12-1, and Table 3.12-2. Wind and tornado loads will be deleted in DCD Tier 2, Table 3.9-6, Table 3.9-7, Table 3.9-10, and Table 3.12-2 because ASME Class 1, 2, and 3 components and component supports are designed within wind/tornado protected structures and are not directly exposed to wind or tornado loads. If the COL applicant finds it necessary to route ASME Class 1, 2 or 3 piping systems outside the protected structures, the wind and/or tornado load will need to be included in the plant design basis loads as a site-specific load (refer COL 3.12(2)).

In addition, loading due to components' internal operating and/or design pressure is not transferred to their associated supports. A note that internal operating and/or design pressure loading is applicable to pressure boundary components and not to their supports will be added to DCD Table 3.9-2. The term "IRWST loads" in DCD Tier 2 will be changed to "IRWST discharge loads" for clarity in terminology.

Impact on DCD

DCD Tier 2, Subsections 3.9.3.1, 3.9.4.3, 3.9.5.2, and 3.9.5.2.4, Tables 3.9-2, 3.9-6, 3.9-7, 3.9-10 through 12, 3.12-1, and 3.12-2 will be revised as indicated in the attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

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In addition, handling loads alone at cold shutdown conditions are used to design only the reactor vessel.

Level B Service Loadings

Normal operation (including deadweight) and IRWST discharge loads in conjunction with the upset transients are considered Level B service loadings.

The seismic cycles mentioned in Subsection 3.7.3 are applied in a fatigue analysis, considering the effects of reactor coolant environment in accordance with NRC RG 1.207.

Level C Service Loadings

~~Normal operation (including deadweight) and dynamic system loadings associated with the emergency condition are considered Level C service loadings~~.

Level D Service Loadings

SRP 3.9.3 defines the design basis pipe break (DBPB) as those postulated pipe breaks other than a LOCA or MS/FWPB and the DBPB is identified as an emergency condition. This includes postulated pipe breaks in Class 1 branch lines that result in the loss of reactor coolant at a rate less than or equal to the capability of the reactor coolant makeup system. Make-up flow can compensate for the loss of coolant from a break with a 5.56 mm (7/32 in.) internal diameter as described in Subsection 9.3.4. In accordance with the guidance in SRP 3.6.2, postulated breaks in one-inch nominal diameter piping and smaller piping do not require the analysis of dynamic system loading from a ruptured pipe on components, component supports or core support structures. The DBPB condition also results in RCS temperature and pressure transient conditions and is thus conservatively included as a Level B condition in the RCS design transients given in Table 3.9-1. Therefore, Level C service loadings are not used in any APR1400 analyses.

Postulated breaks in lines larger than 25.4 mm (1 in.) nominal diameter are considered in pipe break analysis as described in Subsection 3.6.2 and included in the BLPB scope, which are treated as Level D conditions. The BLPB scope includes those postulated pipe breaks in the lines connected to the RCS that are not eliminated by LBB and that result in the loss of the reactor coolant at a rate in excess of the capability of the reactor coolant makeup system, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the RCS except those eliminated by LBB evaluation. The BLPB scope also includes main steam and main feedwater pipe breaks (MS/FWPB).

2) Impulse load due to stepping of the CEDM

3) Mechanical base excitation loads

4) Loads produced by the thermal expansion of the reactor vessel closure head

d. ~~Design Basis Pipe Break (DBPB)~~ ← Deleted

~~The DBPB is defined as a postulated pipe break that results in the loss of reactor coolant at a rate less than or equal to the capability of the reactor coolant makeup system.~~

e. IRWST loads

f. BLPB loads

g. Seismic loads

The design and fabrication of the CEDM pressure boundary components fulfill the requirements of ASME Section III, Subsection NB. The pressure housings are capable of withstanding all the steady-state and transient operating conditions specified in Table 3.9-11 for a 60-year life. The design report for the ASME Code Class 1 components is to be prepared in accordance with ASME Section III.

Deformation of the CEDM under seismic conditions is evaluated to verify scramability as presented in Subsection 3.9.2.7.3.

The adequacy of the design of the CEDM pressure boundary and non-pressure boundary components has been verified by the life cycle tests as described in Subsection 3.9.4.4.

3.9.4.4 CEDM Operability Assurance Program

The APR1400 CEDM is essentially identical to the System 80 CEDM, which is presently operating at the Palo Verde Nuclear Generating Station, except for the material of the motor housing lower end fitting and thickness of the upper shroud tube. The material of the

f. Shock loads (including SSEs)

g. Anticipated transient loadings

h. Handling loads (not combined with other loads above)

i. ~~Appropriate design basis pipe break (DBPB), secondary~~ Secondary side break, and LOCA loads

j. IRWST discharge loads

3.9.5.2.1 Design Loadings

The following loading combination is considered as a design loading.

Normal operation loads in combination with IRWST discharge loads. Normal operation loads are defined as the following sustained loads resulting from the normal events:

a. Pressure difference

b. Temperature

c. Mechanical loads

1) Weight

2) Loads from flow impingement or flow of reactor coolant

3) Superimposed or reaction loads

3.9.5.2.2 Level A Service Loadings

The following loading combination is considered as Level A service loadings.

Normal operation loads in combination with specified system operating transient loads resulting from normal events.

3.9.5.2.3 Level B Service Loadings

The following separate loading combinations are considered as Level B service loadings.

a. Normal operation loads in combination with IRWST discharge loads and system operating transient loads from the upset events. The IRWST discharge loads are defined as the loads due to postulated discharge to in-containment refueling water storage tank.

b. Normal operation loads in combination with the system operating transient loads from the upset event (the loss of external load with turbine control system failure). Note that the loss of external load of the upset event, which is evaluated as if it occurs once during the plant lifetime, is the emergency event. This event is evaluated with this combination of loadings for conservatism.

3.9.5.2.4 Level C Service Loadings

~~Level C service loadings are derived from the combination of normal operation loads and the DBPB loads.~~

There are no Level C service loadings (Refer to Subsection 3.9.3.1).

~~The DBPB is defined as a postulated pipe break that results in the loss of reactor coolant at a rate less than or equal to the capability of the reactor coolant makeup system.~~

3.9.5.2.5 Level D Service Loadings

The following loading combination is considered as Level D service loadings.

a. Normal operation loads

b. Either the main steam/feed water pipe break (MS/FWPB) or LOCA loads (including asymmetric blowdown loads), whichever are greater

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Table 3.9-2

Loading Combinations for ASME Code Class 1, 2, and 3 Components(1) and Component Supports

superscript "(6)"

Condition	Design Loading(2) Combination
Design	PD + DW + IRWST
Level A (Normal)(3)	PO + DW
Level B (Upset)(3)	PO + DW + IRWST +DFL
Level C (Emergency)	~~PO + DW + DE~~ No Loads (5)
Level D (Faulted)	PO + DW + SRSS (SSE + (DF + IRWST)) SRSS(SSE + DF + IRWST) (4)

(1) For piping, see Tables 3.9-10, 3.12-1, and 3.12-2.

(2) Legend:

PD = design pressure

PO = operating pressure

DW = deadweight

SSE = safe shutdown earthquake

~~DE = dynamic system loadings associated with the emergency condition~~

DF = dynamic system loadings associated with pipe breaks (not eliminated by a leak-before-break analysis) , or POSRV actuation

IRWST = In-containment refueling water storage tank discharge loads

DFL = Dynamic fluid loads are occasional loads associated with hydraulic transients caused by events such as valve actuation (safety or relief valve discharge, rapid valve opening/closing), water hammer, or steam hammer.

(3) As required by the ASME Section III, other loads, such as thermal transient, and thermal gradient, require consideration in addition to the primary stress producing loads listed. SSE is considered in equipment fatigue evaluations in accordance with Subsection 3.7.3.1.

(4) Detailed loading combinations of ASME Code Class 1 components and component supports are described in Subsection 3.9.3.1.

(5) Refer to Subsection 3.9.3.1.

(6) Internal operating and/or design pressure loading is applicable to pressure boundary components and not to their supports.

Table 3.9-6

Stress Criteria for ASME Section III Class 2 and Class 3 Inactive Pumps

Plant Condition	Service Limits[(1)]	Loads	Stress Limits[(2)]	P_{max}[(3)]	Subsections[(5)]
Design	Design	Sustained loads: pressure, weight, other mechanical loads	$\sigma_m \leq 1.0$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.5$ S	-	ASME Section III NC/ND-3400
Normal	Level A	Sustained loads: pressure, weight, other mechanical loads	$\sigma_m \leq 1.0$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.5$ S	1.0	ASME Section III NC/ND-3400
Upset	Level B	Occupational loads: pressure, weight, thermal effects, dynamic fluid loads,[(4)] ~~wind~~[(6)]	$\sigma_m \leq 1.1$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.65$ S	1.1	ASME Section III NC/ND-3400
Emergency	Level C	~~Occupational loads: pressure, weight, thermal effects, dynamic system loads,~~[(7)] ~~tornado~~[(6)] no loads (Refer to Subsection 3.9.3.1)	$\sigma_m \leq 1.5$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.8$ S	1.2	ASME Section III NC/ND-3400
Faulted	Level D	Occupational loads: pressure, weight, thermal effects, dynamic fluid loads,[(4)] SSE inertia, pipe break	$\sigma_m \leq 2.0$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 2.4$ S	1.5	ASME Section III NC/ND-3400

(1) Service limits are taken from ASME Section III, NCA-2142.4.

(2) Stress limits are taken from ASME Section III, Subsections NC and ND, Table NC/ND-3416-1.

(3) The maximum pressure does not exceed the tabulated factors listed under Pmax times the design pressure.

(4) Dynamic fluid loads (DFL) are occasional loads such as safety and relief valve thrust, steam hammer, water hammer, or other loads associated with plant upset or faulted condition as applicable. Dynamic loads are combined by the SRSS method.

(5) SECY-93-087, Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, Paragraph 9, “Elimination of Operating Basis Earthquake,” Nuclear Regulatory Commission, July 21, 1993.

~~(6) Wind and tornado loads are not combined with earthquake loading.~~

~~(7) Dynamic system loadings associated with the emergency condition.~~

Table 3.9-7

Stress Criteria for ASME Section III Class 2 and Class 3 Active Pumps

Plant Condition	Service Limits[1]	Loads	Stress Limits[2]	P_{max}[3]	Subsections[5]
Design	Design	Sustained loads: pressure, weight, other mechanical loads	$\sigma_m \leq 1.0$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.5$ S	-	ASME Section III NC/ND-3400
Normal	Level A	Sustained loads: pressure, weight, other mechanical loads	$\sigma_m \leq 1.0$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.5$ S	1.0	ASME Section III NC/ND-3400
Upset	Level B	Occupational loads: pressure, weight, thermal effects, dynamic fluid loads,[4] ~~wind~~[(6)]	$\sigma_m \leq 1.1$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.65$ S	1.1	ASME Section III NC/ND-3400
Emergency	~~Level B~~ ~~Level C~~ Level B	~~Occupational loads: pressure, weight, thermal effects, dynamic system loads,[(7)] tornado[(6)]~~ no loads (Refer to Subsection 3.9.3.1)	$\sigma_m \leq 1.1$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.65$ S	1.1	ASME Section III NC/ND-3400
Faulted	~~Level B~~ ~~Level D~~ Level B	Occupational loads: pressure, weight, thermal effects, dynamic fluid loads,[4] SSE inertia, pipe break	$\sigma_m \leq 1.1$ S $(\sigma_m$ or $\sigma_L) + \sigma_b \leq 1.65$ S	1.1	ASME Section III NC/ND-3400

(1) Service limits are taken from ASME Section III NCA-2142.4.

(2) Stress limits are taken from ASME Section III, Subsections NC and ND, Table NC/ND-3416-1. However, the stress limits for service level C and D are more restrictive than the ASME Section III limits to provide reasonable assurance of pump operability.

(3) The maximum pressure does not exceed the tabulated factors listed under Pmax times the design pressure.

(4) Dynamic fluid loads (DFLs) are occasional loads such as safety and relief valve thrust, steam hammer, water hammer, or other loads associated with plant upset or faulted condition as applicable. Dynamic loads are combined by the SRSS method.

(5) SECY-93-087, Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, Paragraph 9, "Elimination of Operating Basis Earthquake," July 21, 1993.

~~(6) Wind and tornado loads are not combined with earthquake loading.~~

~~(7) Dynamic system loadings associated with the emergency condition.~~

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Table 3.9-10

Loading Conditions and Load Combinations Requirements
for ASME Section III Class 1, 2, and 3 Piping Supports

Service Level	Loading Combination
Level A	Weight Thermal(1) Friction
Level B	Weight Thermal(1) Dynamic fluid loads(2) ~~Wind~~
Level C	~~Weight~~ ~~Thermal(1)~~ ~~Dynamic system loads(3)~~ ~~Tornado~~
Level D	Weight Thermal(1) Dynamic fluid loads(2) SSE inertia SSE seismic movements Pipe break loads (4)

~~IRWST loads (3)~~ IRWST discharge loads(3)

no loads (Refer to Subsection 3.9.3.1)

~~IRWST loads (3)~~ IRWST discharge loads(3)

(1) Thermal conditions (including ambient temperature) to be combined to provide maximum load combinations.

(2) Dynamic fluid loads due to safety/relief valve thrust, steam hammer, and water hammer.

~~(3) Dynamic system loadings associated with the emergency condition.~~

(3) In-containment refueling water storage tank discharge loads.

(4) Pipe break loads include loads due to LOCA.

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Table 3.9-11

Stress Limits for CEDM Pressure Housings

Service Level	Stress Categories and Limits of Stress Intensities(1)
1. Design: design pressure, normal operating loads(2), ~~IRWST loads~~ IRWST discharge loads	NB-3221 and Figure NB-3221-1 including notes
2. Level A: normal operating loads, normal operating transients	NB-3222 and Figure NB-3222-1 including notes
3. Level B: normal operating loads, upset transients, ~~IRWST loads~~ IRWST discharge loads, fatigue loads due to SSE(3)	NB-3223 and Figure NB-3222-1 including notes
4. Level C: ~~operating pressure, normal operating loads, DBPB loads~~ no loads (Refer to Subsection 3.9.3.1)	NB-3224 and Figure NB-3224-1 including notes
5. Level D(4): operating pressure, normal operating loads, ~~IRWST loads~~ IRWST discharge loads, BLPB loads, SSE loads	Appendix F Article F-1000 Rules for evaluation of service conditions loading with level D service limits
6. Testing: testing plant transients	NB-3226

(1) References listed are taken from ASME Section III.

(2) "'Normal operating loads" is defined in Subsection 3.9.4.3.

(3) Fatigue loads due to SSE are applied in accordance with Subsection 3.9.2.2.3.

(4) SSE loads is combined with BLPB and IRWST by the SRSS method in accordance with the guidelines of NUREG-0484.

Table 3.9-12

Stress Limits for Reactor Internals Design and Service Loads

Stress Limit	Description
Design Limits	The reactor internals are designed to meet the design limits defined in ASME Section III, NG-3221, for design loadings. The reactor internals are safety Class 3 and seismic Category I in accordance with ANSI/ANS-51.1-1983. Core support structures are constructed in accordance with ASME Section III, NG-1100. The reactor internals other than core support structures meet the guidelines of ASME Section III, NG-3000 and are constructed so as not to adversely affect the integrity of the core support structures. Under Level D service loadings, the maximum stress intensity is obtained from principal stresses resulting from an SRSS combination of IRWST, BLPB, and SSE plus normal operating dynamic and static loading in accordance with NUREG-0484, Rev. 1. For other than Level D service loading conditions, maximum stress intensity are derived from an SRSS combination of dynamic loads in accordance with NUREG-0484, Rev. 1, or a more conservative summation of stress intensities.
Level A Service Limits	The reactor internals are designed to meet the Level A service limits defined in ASME Section III, NG-3222, for Level A service loadings.
Level B Service Limits	The reactor internals are designed to meet the Level B service limits defined in ASME Section III, NG-3223, for Level B service loadings.
Level C Service Limits	~~The reactor internals are designed to meet the Level C service limits defined in ASME Section III, NG-3224, for Level C service loadings.~~ There are no Level C service loadings. Refer to Subsection 3.9.3.1.
Level D Service Limits	The reactor internals are designed to meet the Level D service limits defined in ASME Section III, NG-3225, for elastic system analysis of Appendix F of ASME Section III using Level D service loadings. Maximum stress intensity is obtained from principal stresses resulting from an SRSS combination of IRWST, BLPB, and SSE loadings plus normal operation loads in accordance with NUREG-0484, Rev. 1.

Table 3.12-1 (1 of 4)

Loading Combinations and Acceptance Criteria for ASME Section III, Class 1 Piping

Service Condition	Service Level	Category	Loading	Acceptance Criteria [1]: Equation (NB-3650)	Acceptance Criteria [1]: Stress Limit
Design	-	Primary Stress	Design pressure, deadweight, steady-state flow load and dynamic fluid load [2] specified as level A	Eq. 9 NB-3652	$1.5\ S_m$
Normal /Upset	A/B	Primary plus Secondary Stress Intensity Range (S.I.R.)	Service pressure, steady-state flow load, dynamic fluid load [2], thermal expansion load [3], thermal expansion anchor motion load[3], cyclic thermal load [4], material discontinuity stress, earthquake inertial load [7] ~~, IRWST load~~ , IRWST discharge loads	Eq. 10 NB-3653.1	$3\ S_m$
		Peak S.I.R.	Service pressure, steady-state flow load, dynamic fluid load [2], thermal expansion load [3], thermal expansion anchor motion load [3], cyclic thermal load [4], material discontinuity stress, earthquake inertial load [7], ~~IRWST load,~~ , IRWST discharge loads thermal radial gradient stress (linear and nonlinear)	Eq. 11 NB-3653.2	
		Thermal S.I.R. [5]	Thermal expansion load [3], thermal expansion anchor motion load [3], cyclic thermal load [4]	Eq. 12 NB-3653.6(a)	$3\ S_m$
		Primary plus Secondary Membrane plus Bending S.I.R. [5]	Service pressure, steady-state flow load, dynamic fluid load [2], material discontinuity stress, earthquake inertial load [7] ~~, IRWST load~~ , IRWST discharge loads	Eq. 13 NB-3653.6(b)	$3\ S_m$
		Alternating Stress Intensity (S.I.) (Fatigue Usage) [6]	Service pressure, steady-state flow load, dynamic fluid load [2], thermal expansion load [3], thermal expansion anchor motion load[3], cyclic thermal load [4], material discontinuity stress, earthquake inertial load [7], ~~IRWST load,~~ , IRWST discharge loads thermal radial gradient stress (linear and nonlinear)	NB-3653.3 NB-3653.4 NB-3653.5 NB-3653.6(c)	
		Thermal Stress Ratchet	Linear thermal radial gradient	NB3653.7	

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Service Condition	Service Level	Category	Loading	Acceptance Criteria: Equation (NB-3650)	Acceptance Criteria: Stress Limit
Upset	B	Permissible Pressure	Maximum level B service pressure	NB-3654.1	1.1 Pa
		Primary Stress	Coincident level B service pressure, deadweight, steady-state flow load, dynamic fluid load (2)	NB-3654.2	Min (1.8 S_m, 1.5 S_y)
		Deformation Limits	As set forth in the design specification	NB-3653.7	
Emergency ~~(9)~~ (Deleted)	C	Permissible Pressure	~~Maximum level C service pressure~~	NB-3655.1	1.5 Pa
		Primary Stress	~~Coincident level C service pressure, deadweight, steady-state flow load, dynamic system load (15)~~ No loads. Refer to Subsection 3.9.3.1.	NB-3655.2	Min (2.25 S_m, 1.8 S_y)
		Deformation Limits	~~As set forth in the design specification~~	NB-3655.3	
Faulted	D	Permissible Pressure	Maximum level D service pressure	NB-3656(a)(1)	2 P_a
		Primary Stress (10)	Coincident level D service pressure, deadweight, steady-state flow load, dynamic fluid load (2), (11), earthquake inertial load (11), high-energy line break load (11) (loss-of-coolant accident or secondary side pipe rupture) ~~, IRWST load~~ , IRWST discharge loads	NB-3656(a)(2)	Min (3 S_m, 2 S_y)
		Secondary Stress (12)	Max [range of (bending moments due to thermal expansion load (3) plus thermal expansion anchor motion load (3) plus ½ earthquake anchor motion load) or range of earthquake anchor motion load]	NB-3656(b)(4)	6 S_m (13)
Pressure Testing (14)	-	Primary Membrane S.I.	Test pressure, deadweight	NB-3657 NB-3226(b)	0.9 S_y, 0.8 S_y
		Primary Membrane plus Bending S.I	Test pressure, deadweight	NB-3657 NB-3226(c)	1.35S_y, Min (2.15 S_y-1.2P_m)

Table 3.12-1 (3 of 4)

(1) Acceptance criteria are taken from the referenced section in Section III of the ASME Code or are as noted.

(2) Dynamic fluid loads are occasional loads associated with hydraulic transients caused by events such as valve actuation (safety or relief valve discharge, rapid valve opening/closing), water hammer, or steam hammer.

(3) Thermal expansion and thermal expansion anchor motion loads are not calculated for those operating conditions where the piping system does not exceed 65 °C (150 °F).

(4) Cyclic thermal load includes loads due to thermal stratification, and stresses due to high-cycle thermal striping and thermal penetration (i.e., thermal mixing).

(5) The thermal bending and primary plus secondary membrane plus bending stress intensity ranges (Equations 12 and 13) are only calculated for those load sets that do not meet the primary plus secondary stress intensity range (Equation 10) allowable.

(6) The cumulative fatigue usage factor is calculated by summing the Level A and Level B fatigue usage. If applicable, ~~fatigue usage from Level C and~~ pressure testing conditions is also included in the calculation of the cumulative usage factor (see Notes ~~9 and~~ 14).

(7) The earthquake inertial load considered in the Level B primary plus secondary stress intensity range, peak stress intensity range and alternating stress intensity calculations (Equations 10, 11, and 14) is taken as one-third of the peak SSE inertial load or as the peak SSE inertial load. If the earthquake inertial load is taken as the peak SSE inertial load, then 20 cycles of earthquake loading are considered. If the earthquake inertial load is taken as one-third of the peak SSE inertial load, then the number of cycles to be considered for earthquake loading is as described in Subsection 3.7.3.1.2 (the equivalent number of 20 full SSE cycles as derived in accordance with Appendix D of IEEE Standard 344-2004 (Reference 28)).

(8) The resultant moment calculated is the maximum of the resultant moment due to the full range of earthquake inertial load or the resultant moment due to the consideration of half of the range of earthquake inertial load with all other applicable loads.

~~(9) If a piping system is subjected to more than 25 emergency condition transient cycles that result in an alternating stress intensity (S_a) value greater than that for 106 cycles, as determined from the applicable fatigue design curves of Figures I-9.0 in Section III of the ASME Code, then those cycles in excess of 25 are included in the fatigue calculation that determines the cumulative usage factor. See Section NB-3113(b) in Section III of the ASME Code.~~

(10) The rules given in Appendix F of the ASME Code may be used in lieu of those given in NB-3656(a) and NB-3656(b) when evaluating Level D primary stress.

(11) Loads due to dynamic events other than high-energy line break (i.e., loss-of-coolant accident and secondary side pipe rupture) and SSE are combined considering the time phasing of the events (i.e., whether the loads are coincident in time). When the time phasing relationship can be established, dynamic loads may be combined by the square-root-sum-of-the-squares (SRSS) method, provided it is demonstrated that the non-exceedance criteria given in NUREG-0484 (Reference 17) are met. When the time phasing relationship cannot be established, or when the non-exceedance criteria in NUREG-0484 are not met, dynamic loads are combined by absolute sum. SSE and high-energy line break loads are always combined using the SRSS method.

Table 3.12-1 (4 of 4)

(12) This secondary stress check is only necessary if the stresses (including those due to earthquake inertial load) exceed the Equation 10 (primary plus secondary stress intensity range for the upset service condition) allowable stress. See Section NB-3656(b)(4) in Section III of the ASME Code.

(13) S_m = Allowable design stress intensity value from Part D of Section II of the ASME Code.

(14) If a piping system is subjected to more than 10 pressure test cycles that result in an alternating stress intensity (S_a) value greater than that for 106 cycles, as determined from the applicable fatigue design curves of Figures I-9.0 in Section III of the ASME Code, then those cycles in excess of 10 are included in the fatigue calculation that determines the cumulative usage factor. See Sections NB-3657 and NB-3226(e) in Section III of the ASME Code.

~~(15) Dynamic system loadings associated with the emergency condition.~~

Table 3.12-2

Loading Combinations for Acceptance Criteria for ASME Section III Class 2 and 3 Piping

Service Condition	Service Level	Loading	Acceptance Criteria(4)	
			Equation (NC/ND-3650)	Stress Limit
Design	-	Pressure, Weight, Other Sustained Mechanical Loads	Eq. 8 NC/ND-3652(3)	1.5 S_h (3)
Normal /Upset	A/B	Pressure, Weight, Other Sustained Mechanical Loads, Dynamic Fluid Loads (DFL)(1), ~~Wind (7)~~ ~~, IRWST load~~ , IRWST discharge loads	Eq.9 NC/ND-3653.1 (Level B Only) (6)	Min (1.8 S_h, 1.5 S_y)
		Thermal Expansion, Thermal Anchor Movement (TAM)	Eq.10 NC/ND-3653.2(a)(2)	S_A (2)
		Building Settlement	Eq. 10a NC/ND-3653.2(b)	$3S_c$
		Pressure, Weight, Other Sustained Mechanical Loads, Thermal Expansion, TAM	Eq. 11 NC/ND- 3653.2(c)(2)	$S_h + S_A$ (2)
Emergency	C	~~Pressure, Weight, DSL(9), Tornado(7)~~ No loads. Refer to Subsection 3.9.3.1.	Eq. 9 NC/ND-3654.2(a)(5)	Min(2.25 S_h,1.8 S_y)
Faulted	D	Pressure, Weight , DFL(1), SSE Inertia, Pipe Break(9) ~~, IRWST load~~ , IRWST discharge loads	Eq. 9 NC/ND-3655(a)(5)	Min(3 S_h, 2 S_y)
		Thermal Expansion, TAM, Seismic Anchor Motion (SAM)	NC/ND-3655(b)(4)	$6S_h$ (6) (8)

(1) Dynamic fluid loads (DFLs) are occasional loads such as safety/relief valve thrust, steam hammer, water hammer, or other loads associated with plant upset, emergency, or faulted conditions as applicable.

(2) Stresses are to meet the requirements of either Equation 10 or 11, not both.

(3) If, during operation, the system normally carries a medium other than water (air, gas, steam), sustained loads are to be checked for weight loads during hydrostatic testing as well as normal operation weight loads.

(4) ASME Code, Section III.

(5) When causal relationships can be established, dynamic loads may be combined by SRSS, provided it is demonstrated that the non-exceedance criteria given in NUREG-0484 are met. When the causal relationship cannot be established, or when the non-exceedance criteria given in NUREG-0484 are not met, dynamic loads are to be combined by absolute sum. SSE and high-energy line break loads are always combined using the SRSS method.

(6) OBE inertia and SAM loads are not included in the design of Class 2 and 3 piping (Reference 30).

(7) ~~Wind and tornado loads are not combined with earthquake loading.~~ Deleted

(8) ASME Code equations and paragraph numbers refer to the 2007 Edition through 2008 Addenda of the ASME Code.

~~(9) Dynamic system loadings (DSLs) associated with the emergency condition.~~

(9) Pipe break loads include loads due to LOCA.