CVCS CHARGING AND LETDOWN FLOW

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 1

CVCS CHARGING FLOW
CVCS LETDOWN FLOW
CVCS BORATION FLOW {31}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	06/19/95	ALL	Congdon	Wild	Greene
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PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

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Cognizant Engineer (Signature) Date: 11/11/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 4/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 1 - APPLICATION 1

{311}
System Subject Parameter(s): CVCS Charging Flow or CVCS Letdown Flow

Value: [letdown flow greater than charging flow]

Use: U54
To consider parameters in the decision making process.

Cat: C03

Engineering Limit(s):

None

Summary:

"Letdown flow greater than charging flow" is a comparative value. There are no engineering limits associated with the comparison of parameters.

Instrument uncertainties can not be meaningfully applied in cases where no engineering limit or operational limit is included for verification or comparison. This application is used to evaluate system performance and conditions for decision making purposes only. Decisions to implement strategies to reduce or remove indicated RCS voiding are not going to made solely on the presence of this indication.

Basis for Engineering Limit(s):

"Letdown flow greater than charging flow" is a comparative determination. There are no engineering limits associated with the comparison of parameters.

The intent of comparing charging flow to Letdown flow is to determine if voiding is taking place in the RCS, after attempting to depressurize and observing that RCS pressure fails to decrease as expected. Letdown flow greater than charging flow may be indicative of void formation.

This instrument application is not safety related. It is one of five (when indication of impeded RCS pressure trend is included) that are listed in applicable EPG steps as available indicators of RCS voiding. As a result, decisions to implement strategies to reduce or remove indicated RCS voiding are not going to made solely on the presence of this indication.

Uncertainties Application Assessment:

Instrument uncertainties can not be meaningfully applied in cases where no engineering limit or operational limit is included for verification or comparison. This application is used to evaluate system performance and conditions for decision making purposes only. Decisions to implement strategies to reduce or remove indicated RCS voiding are not going to made solely on the presence of this indication.

Usually, when the operator is instructed to trend an indication, the indication is used in conjunction with other parameters to corroborate a condition or a safety function. Such is the case in this application. The operator is not required to perform a safety related action on the trending of a single parameter by itself in the EPGs.

Where the trending of a parameter is combined with an operating limit, e.g. pressurizer level > 100" and increasing, the operational limit should be evaluated independently to determine the engineering limit and the impact of applying instrument uncertainties.

This application was category two (C02) in CEOG task 776, CE-NPSD-925, revision 00. As a result of a more extensive review of this application it has been changed to category three (C03).

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 1 - APPLICATION 2

{312}|
System Subject Parameter: CVCS Boration Flow

Value: [nominal capacity of one charging pump], (operational limit 40 gpm)

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Lower = the nominal capacity of one charging pump, nominally 44gpm

Summary:

The engineering limit is the minimum positive indication of boration flow into the RCS which corresponds to the nominal RCS makeup flowrate supplied by one charging pump. This operational value is used to identify an abnormal boration system lineup. Reactor shutdown can be assured by the minimum boration rate (assuming one more than one CEA is not fully inserted). However, confirmation of successful achievement of the reactivity control safety function is directly determined by a decreasing reactor power trend.

Instrument uncertainties need not to be applied for this application. In this case, there is no specific analytical limit.

Basis for Engineering Limit(s):

Since this instrument application pertains to boration using CVCS, as monitored by the charging header flowmeter, the engineering limit is the minimum positive indication of boration flow into the RCS which corresponds to the nominal RCS makeup flowrate supplied by one charging pump. The charging pumps are positive displacement pumps, and therefore they can not be throttled. The entire discharge flow of at least one charging pump is assumed to be going to the RCS, via the normal charging line and the 4 RCP seal injection lines. The charging header flow meter monitors the total charging flow to the RCS.

The CEN-152, revision 03 operational limit (≥40 gpm) is a "nominal" operational minimum value. This value is based on the design capacity of one charging pump, which was 44 gpm for the EPG reference plant. Using engineering judgement, the CEN-152 authors subtracted 4 gpm from the rated capacity of one pump, to account for pump internal loses and instrument inaccuracies to arrive at the 40 gpm value. The also took into consideration the possibility that some charging pump flow was being diverted to Reactor Coolant Pump seal injection in the design of some CE NSSS units.

This operational value is used to identify an abnormal boration system lineup. Reactor shutdown can be assured by the minimum boration rate. However, confirmation of successful achievement of the reactivity control safety function is directly determined by a decreasing reactor power trend.

In the determination of the required combination of boration flow rate and boron concentration of the makeup water, there is no unique minimum boration flow requirement that must be satisfied (ref 1).

Uncertainties Application Assessment:

Since there is no specific analytical limit in this case, instrument uncertainties can not be applied. When determining the plant specific operational limit, reasonable pump internal loses and inefficiencies should be accounted for.

The ultimate goal is to derive a reasonable minimum operational value, that will provide the operator with a valid indication of an abnormal system line up that should be promptly investigated and corrected.

If plant-specific control room alarm and annunciator systems include a charging pump discharge low flow alarm, consideration should be given to the comparison between the setpoint used for this EPG/EOP instrument application and the charging pump discharge low flow alarm setpoint.

Potential Margin Loss Options:

Not applicable.

References:

1) NUREG 1432, Revision 01 Section 3.1.1 (Analog) and NUREG-1432, Revision 01, Section 3.1.1 (Digital).

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

Review Criteria (page 2 of 2)	OK	N/A
11. When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12. Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13. Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14. Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures	✓	
15. Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16. Is the document legible and reproducible?	✓	
17. Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL KRAMARCHYK / Paul Kramarchyk / 11/12/96

Independent Reviewer: Name/Signature/Date

PRESSURIZER LEVEL

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2

PRESSURIZER LEVEL {32}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	06/19/95	ALL	Congdon	Wild	Greene
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PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
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Paul Kramarchyk [signature] 11/11/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 1

{321}
System Subject Parameter: Pressurizer Level

Value: [expected post-trip band], nominally 35 - 245 inches

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Upper = the highest level which will assure that there is still sufficient steam space to ensure pressure control using Pressurizer sprays

Lower = the lowest measurable level which can be accepted before the pressurizer is drained

Summary:

Pressurizer level within the [expected post-trip band], nominally 35 - 245 inches indicates adequate RCS inventory control via a saturated bubble in the Pressurizer. This operational band is intended to ensure the continued operability of the Pressurizer. The [minimum level for inventory control], nominally 35 inches, corresponds to the lowest level which can be accepted before the pressurizer is drained. The [maximum level for inventory control], nominally 245 inches, corresponds to the highest level which will still provide sufficient steam space for normal pressure control.

This application is a nominal operational guideline, possessing a low degree of nuclear safety significance, relative to its use in the EOPs. Engineering judgment is used to establish both the upper and the lower engineering limits. Therefore, instrument uncertainties need not be applied.

Basis for Engineering Limit(s):

The upper engineering limit is based on engineering judgment. The chosen limit is intended to: 1) avoid water-solid conditions, 2) provide sufficient steam space to ensure pressure control using sprays, and 3) bound the highest pressurizer levels observed in best estimate analysis.

The [maximum level for inventory control], nominally 245 inches, which is approximately ([70%]) of a typical Combustion Engineering Pressurizer's range (0 - 350)"), was chosen by the authors of CEN-152 as an upper limit for Pressurizer level to account for some instrument and process fluid uncertainties. The upper limit was established to avoid filling the Pressurizer to water-solid conditions and bounded the highest level observed in the best estimate analysis. CEN-152 authors used engineering judgment to establish the corresponding engineering limit at [78%]. Instrument uncertainties, assumed to be ± 8%, were conservatively applied to the engineering limit, yielding the upper operational limit of [70%]. [70%] is also a "nominal" setpoint for the Pressurizer high level alarm.

The [minimum level for inventory control], nominally 35 inches, which is approximately ([10%]) of a typical Combustion Engineering Pressurizer's range, was chosen as the lower limit to account for some instrument and process fluid uncertainties. The lower limit is based on the lowest indication that with confidence reflects an actual Pressurizer level. The authors of CEN-152 used engineering judgment to establish the corresponding engineering limit at [2%]. Instrument uncertainties, assumed to be ± 8%, were conservatively applied to the engineering limit, yielding the lower operational limit of [10%].

Pressurizer level within the [expected post-trip band], nominally 35 - 245 inches defines an acceptable transient control band following a reactor trip. Ultimately, level should be restored to the [normal control band]. Level in the transient band is indicative of RCS inventory control via a saturated bubble in the Pressurizer. It provides the operator with information to support the continued operability of the Pressurizer. [35"] corresponds to the lowest level which can be accepted before the pressurizer is considered drained. [245"] corresponds to the highest level judged to provide sufficient steam space to ensure pressure control using Pressurizer sprays without immediately bringing the plant to a water-solid condition. In the EPGs, the RCS is not considered water-solid if there is evidence of a steam void anywhere in the RCS, i.e. in the pressurizer, the reactor vessel head, or in the steam generator tubes.

This instrument application is used to verify that charging, and/or SIS pumps, and letdown are maintaining or restoring Pressurizer level to an acceptable pressurizer level control band following an uncomplicated trip and to direct event re-diagnosis if it is not.

This application possesses a low degree of nuclear safety significance, relative to its use in the EOPs. As stated previously, the authors of CEN-152 used engineering judgment to establish both the upper and the lower engineering limits.

They did not perform a calculation to determine the exact pressurizer level at which sprays are no longer effective for controlling RCS pressure. The lower engineering limit is defined as the theoretical minimum detectable level at which it is possible to observe a change in pressurizer level, either rising or lowering.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied for the following reasons:

1) The safety significance associated with both limits is low because neither is intended to protect a design limit,
2) These operational guidelines are nominal values, they are not calculated or analytical values. They were established using engineering judgment,
3) In the EPGs, RCS temperature and pressure instrumentation is used to corroborate the upper limit on pressurizer level to determine the effectiveness of pressurizer sprays and the onset of water-solid conditions,
4) In the EPGs, RVLMS and subcooled margin are used to corroborate the lower limit on pressurizer level to ensure inventory control and core covery.

Originally, CEN-152 used engineering judgment to establish the upper engineering limit. The authors did not perform a calculation to determine the exact pressurizer level at which sprays are no longer effective for controlling RCS pressure. The importance of the upper limit was based by operational concerns associated with the effectiveness of sprays, and the desire to avoid water-solid conditions.

Water-solid operations were not directly addressed in CEN-152, revision 03. Revision 04 made changes to the EPGs to include guidance to recognize, control and recover from water-solid operations. The new guidance uses RCS temperature and pressure response to back up pressurizer level. Therefore, the importance of pressurizer level in determining whether or not the RCS is water-solid has been lessened.

From a safety significant point of view, it has been shown that instrument uncertainties need not be applied. However, from an operational view, it may be desirable to apply some margin to ensure that the operational limits capture the intent of the application. Once again, the intent is to indicate adequate RCS inventory control via a saturated bubble in the Pressurizer. The lower indicated operational limit should correspond to the lowest level which can be accepted before the pressurizer is drained. The upper indicated operational limit should correspond to the highest level which will assure that there is still sufficient steam space for normal pressure control.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 2

{322}
System Subject Parameter: Pressurizer Level

Value: [maximum level for inventory control], nominally 245 IN

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: 03

Engineering Limit(s):

Upper = the highest level which will assure that there is still sufficient steam space to ensure pressure control using Pressurizer sprays.

Summary:

A pressurizer level of [maximum level for inventory control] corresponds to the highest level which will assure that there is still sufficient steam space for normal pressure control. The intent of this application is to establish pre-requisite conditions prior to cycling the PORVs /presurizer vents for RCS pressure control and avoid relieving water through the PORVs/vents.

This application is a nominal operational guideline, possessing a low degree of nuclear safety significance, relative to its use in the EOPs. Engineering judgment is used to establish the upper engineering limit. Therefore, instrument uncertainties need not be applied.

Basis for Engineering Limit(s):

The upper engineering limit is based on engineering judgement. The chosen limit is intended to: 1) avoid water-solid conditions, 2) provide sufficient steam space to ensure pressure control using sprays, and 3) bound the highest pressurizer levels observed in best estimate analysis.

The upper operational limit of [245"], which is approximately ([70%]) of a typical Combustion Engineering Pressurizer's range (0 - 350)"), was chosen by the authors of CEN-152 as an upper limit for Pressurizer level to account for some instrument and process fluid uncertainties. The upper limit was established to avoid filling the Pressurizer to water-solid conditions and bounded the highest level observed in the best estimate analysis. CEN-152 authors used engineering judgement to establish the corresponding engineering limit at [78%]. Instrument uncertainties, assumed to be ± 8%, were conservatively applied to the engineering limit, yielding the upper operational limit of [70%]. [70%] is also a "nominal" setpoint for the Pressurizer high level alarm.

[245"] corresponds to the highest level which will assure that there is still sufficient steam space to ensure pressure control using Pressurizer sprays without immediately bringing the plant to a water-solid condition.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied for the following reasons:

1) The safety significance associated with the limit is low because it is not intended to protect a design limit,
2) This operational guideline is a nominal value, it is not a calculated or analytical value. It was established using engineering judgement.
3) In the EPGs, RCS temperature and pressure instrumentation is used to corroborate the upper limit on pressurizer level to determine the effectiveness of pressurizer sprays and the onset of water-solid conditions

Originally, CEN-152 used engineering judgement to establish the upper engineering limit. The authors did not perform a calculation to determine the exact pressurizer level at which sprays are no longer effective for controlling RCS pressure. The importance of the upper limit was based by operational concerns associated with the effectiveness of sprays, and the desire to avoid water-solid conditions.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 3

{323}
System Subject Parameter: Pressurizer Level

Value: [minimum level for inventory control], nominally 35 inches

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Lower = the lowest measurable level which can be accepted before the pressurizer is drained.

Summary:

The engineering limit is based on the lowest indication that, with confidence, reflects an actual pressurizer level of subcooled fluid. This operational limit is intended to ensure the continued operability of the pressurizer. The engineering limit corresponds to the lowest level which can be accepted before the pressurizer is drained.

Instrument uncertainties need not be applied because the safety significance associated with this limit is low due to the fact that in the EPGs pressurizer level is backed up by RVLMS when evaluating the adequacy of inventory control.

Basis for Engineering Limit(s):

The lower operational limit of [35"], which is approximately ([10%]) of a typical Combustion Engineering Pressurizer's range, was chosen as the lower limit to account for some instrument and process fluid uncertainties. The lower limit is based on the lowest indication that with confidence reflects an actual Pressurizer level. The authors of CEN-152 used engineering judgment to establish the corresponding engineering limit at [2%]. Instrument uncertainties, assumed to be ± 8%, were conservatively applied to the engineering limit, yielding the lower operational limit of [10%].

This operational limit is intended to ensure the continued operability of the pressurizer. The engineering limit corresponds to the lowest level which can be accepted before the pressurizer is drained.

This instrument application appears in the Inventory Control safety function acceptance criteria of ESDE, SGTR and SBO to initiate back up verifications and contingency actions in the event of low pressurizer level. It also appears in other locations throughout the ORG and FRG instructions to define the lower end of the [expected post-trip band].

Uncertainties Application Assessment:

Instrument uncertainties need not be applied for the following reasons:

1) The safety significance associated with this limit is low because it is not intended to protect a design limit,
2) Engineering judgment is used to establish the limit, it is not a calculated or analytical value,
3) In the EPGs, RCS temperature and pressure instrumentation is used to corroborate the upper limit on pressurizer level to determine the effectiveness of pressurizer sprays and the onset of water-solid conditions,
4) In the EPGs, RVLMS and subcooled margin are used to corroborate the lower limit on pressurizer level to ensure inventory control and core covery.

From a safety significant point of view, it has been shown that instrument uncertainties need not be applied. However, from an operational view, it may be desirable to apply some margin to ensure that the operational limits capture the intent of the application. Once again, the intent is to indicate adequate RCS inventory control via a saturated bubble in the Pressurizer. The lower indicated operational limit should correspond to the lowest level which can be accepted before the pressurizer is drained. The upper indicated operational limit should correspond to the highest level which will assure that there is still sufficient steam space for normal pressure control.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 4

{324}
System Subject Parameter: Pressurizer Level

Value: [normal PLCS program band], nominally 120 - 220 inches

Use: U11
To verify that parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = the maximum programmed level as generated by the Pressurizer Level Control System (PLCS)

Lower = the minimum programmed level as generated by the Pressurizer Level Control System (PLCS)

Summary:

The engineering limits are based on the pressurizer level control program generated by the Pressurizer Level Control System (PLCS). These limits define the bounds of the "normal" or expected post-trip Pressurizer level response. If an uncomplicated reactor trip has occurred and the automatic Pressurizer Level Control system is functioning properly, the level should be returning to this range.

It is not necessary to add additional instrument uncertainties to those which have been addressed when developing the Pressurizer Level Control System (PLCS) upper and lower program limits.

Basis for Engineering Limit(s):

The engineering limits are based on the pressurizer level control program generated by the Pressurizer Level Control System (PLCS).

The upper engineering limit for the maximum programmed level is the technical specification maximum Pressurizer level limit. During normal operation (Modes 1, 2, and 3), Pressurizer operability is defined, in part, by Pressurizer water level remaining < [60]% (ref 1).

{This volume is typically equivalent to 50% of the Pressurizer volume, e.g. 900 cubic feet for a 1800 cubic foot pressurizer.} The maximum water level limit permits pressure control equipment to function as designed. The limit preserves the steam space during normal operation, thus, both sprays and heaters can operate to maintain the design operating pressure. The level limit also prevents filling the pressurizer to water-solid conditions during anticipated design basis transients, thus ensuring that pressure relief devices, (PORVs or pressurizer safety valves) are able to control pressure by steam-relief rather than water-relief.

In MODES 1, 2, and 3, the LCO requirement for a steam bubble is reflected implicitly in the accident analyses. All analyses performed from a critical reactor condition assume the existence of a steam bubble and saturated conditions in the pressurizer. In making this assumption, the analyses neglect the small fraction of noncondensible gases normally present (ref 2).

The lower engineering limit for the minimum programmed level is based on keeping the pressurizer heaters covered with water, and thus preserving the normal means of RCS pressure control following a reactor trip. The pressurizer heaters maintain RCS pressure to keep the reactor coolant subcooled. Inability to control RCS pressure during natural circulation flow could result in loss of single phase flow and decreased capability to remove core decay heat.

These operational limits define the bounds of the "normal" or expected post-trip Pressurizer level response. If an uncomplicated reactor trip has occurred and the automatic Pressurizer Level Control system is functioning properly, the level should be trending to this range . These operational limits are also used to direct the operator to take manual control of charging and letdown to control pressurizer level in the event that automatic controls are not maintaining/restoring level to the expected range.

This instrument application does not directly substantially impact a safety function.

Uncertainties Application Assessment:

It is not necessary to add additional instrument uncertainties to those which may have been included in development of the Pressurizer Level Control System (PLCS) upper and lower program limits.

Instrument uncertainties need not be applied to normal control bands. The associated instruments do not require a high degree of accuracy to verify that a parameter is within the normal control band and to verify that the PLCS is functioning properly. There are other checks within the EOPs that monitor this parameter when it is outside the normal control band. These checks are used to ensure adequate RCS inventory control via a saturated bubble in the Pressurizer.

Potential Margin Loss Options:

Not applicable.

References:

1. NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.9, page 3.4-18

2. NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.9 Bases, page 3.4-38

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 5

{325}
System Subject Parameter: Pressurizer Level

Value: [RCP restart level control band], nominally 100 - 200 inches

Use: U36
To verify the operability of non-safety related equipment such as RCPs, whose failure to operate is not likely to impact a safety function.

Cat: C03

Engineering Limit(s):

Upper = the maximum level allowed by technical specifications for RCP restart.

Lower = the minimum level required to maintain Pressurizer heaters covered.

Summary:

The upper engineering limit is based on technical specification RCP restart requirements, which ensure following RCP restart, that there is still sufficient steam space to ensure pressure control using Pressurizer sprays, and preclude a large pressure surge in the RCS.

The lower engineering limit is based on keeping the pressurizer heaters covered to preserve normal means of RCS pressure control following RCP restart.

Instrument uncertainties, in addition to those applied in the technical specification value, need not be applied to arrive at an upper operational limit. Heater availability is an operational concern and not a safety concern. Therefore instrument uncertainties need not be applied to arrive at the lower operational limit.

Basis for Engineering Limit(s):

Establishing pressurizer level within the required restart level band provides a minimum level to help mitigate the effects of RCS void collapse during RCP restart, and a maximum level to keep a pressurizer steam space available for RCS pressure control.

The CEN-152 authors used engineering judgment to establish the upper limit of [200"]. They did not perform a calculation to determine the exact pressurizer level which would help ensure that the pressurizer would not go solid on RCP restart following an ESDE.

The upper engineering limit is based on TS RCP restart requirements which will ensure that there is still sufficient steam space to ensure pressure control using Pressurizer sprays, and preclude a large pressure surge in the RCS following restart. [LCO 3.4.6] (ref.2) prohibits RCP restart with T cold less than [285°F], unless pressurizer lever in less than [60%], or secondary side water temperature in each steam generator is less than [100°F] above each of the RCS cold leg temperatures. Satisfying either of the above conditions will preclude a large pressure surge in the RCS when the RCP is started.

The lower engineering limit is based on keeping the pressurizer heaters covered to preserve normal means of RCS pressure control following RCP restart. The pressurizer heaters maintain RCS pressure to keep the reactor coolant subcooled. Inability to control RCS pressure during natural circulation flow could result in loss of single phase flow.

Following reactor Coolant Pump (RCP) restart, the operator is directed to operate charging (and/or HPSI) pumps, and letdown to restore and maintain pressurizer level [RCP restart level control band , nominally 100 to 200"], to ensure that pressurizer heaters remain covered and at the same time minimize the amount of water added to the RCS to avoid water-solid operation, which could increase the potential for PTS. Greater than 100" is used in all other EPGs, without the maximum limit.

Uncertainties Application Assessment:

Instrument uncertainties, in addition to those applied in the technical specification value, need not be applied to arrive at an upper operational limit.
The lower engineering limit is based on keeping the pressurizer heaters covered to preserve normal means of RCS pressure control. Heater availability is an operational concern and not a safety concern. Therefore instrument uncertainties need not be applied.

However, from an operational point of view, it may be desirable to apply some margin to the lower engineering limit to ensure that the lower operational limit is consistent with the low level heater cutoff setpoint.

Potential Margin Loss Options:

Not applicable

References:

1) NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.9 Bases, page 3.4-38

2) NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.6 Bases, page 3.4-26

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 2 - APPLICATION 6

{326}
System Subject Parameter: Pressurizer Level

Value: [heater cutoff setpoint], nominally 100 inches

Use: To verify plant parameters are in the normal or expected post trip range

Cat: C03

Engineering Limit(s):

Lower = the minimum level required to maintain Pressurizer heaters covered.

Summary:

The engineering limit is based on keeping the pressurizer heaters covered to preserve a normal means of RCS pressure control following a reactor trip.

This instrument application is used throughout the EPGs to ensure inventory control and a normal means of pressure control by ensuring the heaters remain covered.

Instrument uncertainties need not be applied because pressurizer heaters are not necessary for event recovery. Typical safety analyses presented in the FSAR do not take credit for pressurizer heater operation. The SIS system is designed to restore inventory and pressure control in the absence of a means of normal pressure control.

Basis for Engineering Limit(s):

The engineering limit is based on keeping the pressurizer heaters covered to preserve the normal means of RCS pressure control following a reactor trip. The pressurizer heaters are used to maintain RCS pressure, and keep the reactor coolant subcooled. Inability to control RCS pressure during natural circulation flow could result in loss of single phase flow.

This instrument application is used throughout the EPGs to maintain normal pressure control by ensuring that pressurizer heaters remain covered, prior to entry into Shutdown Cooling, prior to throttling or stopping HPSI, and after restarting RCPs.

Although the heaters are not specifically used in the accident analysis, they help maintain subcooling in the long term.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied because pressurizer heaters are not necessary for event recovery. Typical safety analyses presented in the FSAR do not take credit for pressurizer heater operation. The SIS system is designed to restore inventory and pressure control in the absence of normal pressure control. If the heaters are unavailable and pressurizer level rises to greater than the heater cutoff, the operator would still throttle HPSI.

The plant specific engineering limit is defined by the elevation at the top of the highest heater element in the Pressurizer. To arrive at the plant specific operational limit, it may be desirable to include sufficient operational margin to arrive at an easy to read value. The operational limit should be established sufficiently greater than the low level heater cut-off setpoint to accommodate a reasonable amount of undershoot following initiation of corrective action by the operator to restore level at the operational limit. Engineering judgment and empirical data obtained from observation of simulator exercises should be considered in making this determination.

Potential Margin Loss Options:

Not applicable

References:

1) NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.9 Bases, page 3.4-38

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures — n. a. PK	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK / [signature] / 11/11/95
Independent Reviewer: Name/Signature/Date

REACTOR VESSEL
LEVEL MONITORING

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 3

REACTOR VESSEL LEVEL MONITORING {33}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	06/19/95	ALL	Congdon	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Greene	Whipple
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/11/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 3 - APPLICATION 1

{331}
System Subject Parameter: RCS RX VESSEL LEVEL

Value: [top of the hot leg nozzles]

U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: C03\

Engineering Limit(s):

Lower = the top of the hot leg nozzles.

Summary:

The engineering limit of "above the top of the hot leg nozzles" helps to ensure (along with subcooled margin being greater than the minimum required), that pressurizer level is a good indication of inventory control.

It does not make since to apply RVLMS instrument uncertainties, because they are negligible and therefore will have no significant impact on execution of the EOPs.

Basis for Engineering Limit(s):

The intent of the engineering/operational limit is to ensure that adequate RCS inventory control has been established. It ensures that pressurizer level is an accurate representation (along with greater than [minimum required RCS subcooling]) of inventory control.

The Reactor Vessel Level Monitoring System (RVLMS) provides an indication of level based on which sensors are covered with water. The level indication changes only when a sensor becomes uncovered. Variations of level between sensors may not be detected by the RVLMS.

The engineering limit of "above the top of the hot leg nozzles" helps to ensure (along with subcooled margin being greater than the minimum required), that pressurizer level is a good indication of inventory control. Therefore, the safety function acceptance criteria and the performance of the success paths in the Functional Recovery are satisfied.

This indication is taken in conjunction with a pressurizer level above the heaters, subcooling greater than the minimum required, and at least one steam generator available for heat removal, to provide the entire Stop/Throttle criteria. Satisfying all criteria, provides assurance that the RCS is stabilized, and that once HPSI is throttled or terminated, or O-T-C is terminated, forced or natural circulation can be used to remove heat through at least one steam generator.

Uncertainties Application Assessment:

RVLMS indication possesses a high degree of nuclear safety significance, relative to its use in the EOPs, because RVLMS is the last indication of inventory control in the core. However, instrument uncertainties need not be applied, because they are negligible and therefore will not significantly impact execution of the this EOP application. This opinion is the consensus of the I & C working group. No controlled documentation in support of this opinion is provided. Each plant should verify that instrument uncertainties associated with their RVLMS are indeed insignificant.

Potential Margin Loss Options:

Not Applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 3 - APPLICATION 2

{332}
System Subject Parameter: RCS RX VESSEL LEVEL

Value: [top of active fuel region]

U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: C03\

Engineering Limit(s):

Lower = the top of the active fuel region.

Summary:

The engineering limit of "the top of the active fuel region" helps to ensure that the core remains covered with water.

It does not make since to apply RVLMS instrument uncertainties, because they are negligible and therefore will have no significant impact on execution of the EOPs.

Basis for Engineering Limit(s):

The engineering/operational limit represents the elevation that will ensure that the active fuel region of the reactor vessel is completely covered with water.

The Reactor Vessel Level Monitoring System (RVLMS) provides an indication of level based on which sensors are covered with water. The level indication changes only when a sensor becomes uncovered. Variations of level between sensors may not be detected by the RVLMS. The engineering limit of "the top of the active fuel region" helps ensure that the core remains covered with water. Therefore, the safety function acceptance criteria and the performance of the success paths in the Functional Recovery are satisfied.

This instrument application appears throughout the EPGs as Inventory Control Safety Function Acceptance Criteria. It also appears in inventory control verification steps in Loss of Off-Site Power and Station Black-out. To ensure that the integrity of the fuel cladding is maintained, the core must remain covered. This requirement is reflected in the acceptance criteria for the Inventory Control Safety Function Status Checks provided in the EPGs. In conjunction with indication that the level is above the active core region, the EPGs require that inventory control has stabilized or is being restored.

Uncertainties Application Assessment:

RVLMS indication possesses a high degree of nuclear safety significance, relative to its use in the EOPs, because RVLMS is the last indication of inventory control in the core. However, instrument uncertainties need not be applied, because they are negligible and therefore will not significantly impact execution of the this EOP application. This is the consensus opinion of the I & C working group. No controlled documentation in support of this opinion is provided. Each plant should verify that instrument uncertainties associated with their RVLMS are indeed insignificant.

Potential Margin Loss Options:

Not Applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 3 - APPLICATION 3

{333}
System Subject Parameter: RCS RX VESSEL LEVEL

Value: [full]

U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: C03\

Engineering Limit(s):

Lower = the top of the Reactor Vessel Head.

Summary:

The intent of the engineering/operational limit is to detect voiding in the Plenum or Head, when the RCS fails to depresssurize as expected. The engineering limit is the highest elevation in the interior Reactor Vessel Head area.

It does not make since to apply RVLMS instrument uncertainties, because they are negligible and will have no significant impact on execution of the EOPs.

Basis for Engineering Limit(s):

The engineering limit is the highest elevation in the interior Reactor Vessel Head.

The intent of the operational limit is to detect voiding in the Reactor Vessel Head when the attempts are made to depressurize the RCS and system pressure fails to respond as expected. Detection of a level less than 100% in the Plenum or Head, is an indication of void formation.

This instrument application appears in the Heat Removal SFSCs of RTR and the FRG. It also appears in void detection and elimination contingency actions in LOCA, SGTR, ESDE, LOAF, LOOP, and the FRG.

The Reactor Vessel Level Monitoring System (RVLMS) uses several sensors to monitor the area between the fuel alignment plate and the top of the head, to provide discrete water level indications. The Heated Junction Thermocouple System (HJTCS) is designed to detect voids in the reactor vessel head. The HJTCS provides discrete level indications based on the number of sensors covered by water. If the highest sensor is covered, the indicated level will be 100%. However, it is possible for a void to exist with the highest sensor covered since the highest sensor is usually located [X] inches below the top of the reactor vessel head. The exact elevation of the sensors is plant specific. Consequently, there is no way of determining if the reactor vessel head is completely free of voids.

Another item that must be taken into consideration is the RCS and RVLMS response for various RCP operating configurations. Due to upper guide structure design, there are mechanical restrictions to flow above the fuel alignment plate which could bias the RVLMS response when RCPs are operating. The RCP operating configuration also has different effects on the various RVLMS designs. When RCPs are operating, the quality of the pumped fluid has an effect on the RVLMS response and this also has to be taken into account.

The safety significance of a void above the highest HJTCS sensor is negligible. Therefore, an RVLMS indication of 100% reactor vessel level is sufficient for these applications.

This application possesses a moderate degree of nuclear safety significance, relative to its use in the EOPs. The RVLMS is not the sole indicator of voids in the RCS. Other empirical observations (e.g. pressurizer level increase while spraying down) are used to detect voids. RVLMS is simply used as a corroborative for void determination. If the RVLMS show no voiding, but voids exist, these other indicators will demonstrate that fact.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied in this case. RVLMS uncertainties are negligible and therefore will not significantly impact execution of this EOP application.
This is the consensus opinion of the I & C working group. No controlled documentation in support of this opinion is provided. Each plant should verify that instrument uncertainties associated with their RVLMS are indeed insignificant.

Potential Margin Loss Options:

None

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

Review Criteria (page 1 of 2)		OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
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15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK / [signature] / 11/11/96

Independent Reviewer: Name/Signature/Date

HPSI PUMP FLOW

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 4

ECCS-SI HPSI PUMP FLOW {34}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	06/19/95	ALL	Congdon	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Greene	Whipple
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/12/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 4 - APPLICATION 1

{341}
System Subject Parameter: ECCS-SI HPSI PUMP FLOW

Value: [minimum required HPSI pump flowrate], nominally 30 gpm

Use: U09
To monitor operability or operation of safety related Systems, Structures, and Components (SSCs), that could impact the accomplishment of a safety function, if impaired.

Cat: C02

Engineering Limit(s):

Lower = the minimum required HPSI pump flowrate.

Summary:

The engineering limit is based on the minimum required flowrate through a HPSI pump that will avoid pump damage during continuous minimum flow operation.

The intent of the operational limit is to ensure that the HPSI pump is secured when the flowrate through the pump decreases to less than the minimum required for continuous minimum flow operation. This will ensure continued operability and availability of the HPSI pumps by avoiding over heating and subsequent pump damage.

Engineering judgment may be used when evaluating the appropriateness of including instrument uncertainties.

Basis for Engineering Limit(s):

The engineering limit is based on the minimum required flowrate through a HPSI pump that will avoid pump damage during continuous minimum flow operation.

The intent of the operational limit is to ensure that the HPSI pump is secured when the flowrate through the pump decreases to less than the minimum required for continuous minimum flow operation. This will ensure continued operability and availability of the HPSI pumps by avoiding over heating and subsequent pump damage. This instrument application appears in LOCA and the FRG. The CEN-152, revision 03 authors did not include instrument inaccuracies in the EPG value, i.e. [30 gpm]

Uncertainties Application Assessment:

This application has a high degree of safety significance. However, the negative impact of including instrument uncertainty must be considered before doing so. It may not be in the best interest of the equipment that is being protected to apply instrument uncertainties. It could result in a minimum flow value that is well above the required minimum flow, due to the large uncertainties associated with the HPSI header flow instruments at low flows.

If instrument uncertainties were to be applied, the resulting inflated flow requirement may only be managed by ensuring only one HPSI pump is in operation to maximize the flow through the one pump. This situation could pose a problem for the operator because, if the flow is less than required, and inventory control requirements are satisfied, the operator would have to turn the pump off to satisfy the minimum flow requirement. This could lead to a situation where the pump would be have to be cycled on and off many times during the event mitigation to comply with the minimum flow requirement. This would not be desirable due to the greater negative impact of cycling the HPSI pump on and off as opposed to running the pump with less than the minimum required flow.

Therefore, engineering judgment may be used when evaluating the appropriateness of including instrument uncertainties.

Typical SIS installations do not have remote indication of HPSI pump flow in the Control Room. System and pump flow is determined using Hot and Cold Leg SI injection nozzle flow instruments. There are four Cold Leg injection flowmeters [and two Hot Leg injection flow meters.] The accuracy of these flowmeters at low flowrates [less than 75 gpm], is typically not adequate to determine the minimum indicated flow rate that provides reliable pump performance, i.e. [30 gpm] or more. Therefore, the minimum operational limit used in the EOPs must be the minimum flow rate that provides a reliable indication.

To determine HPSI pump flow, the operator must add the individual hot and cold leg injection flowrates (greater than minimum reliable indicated flowrate) and divide by the number of HPSI pumps in operation. The result is the flowrate through one HPSI pump (assuming the recirc paths to the RWT are isolated). If the calculated total flowrate/per pump is greater than the minimum reliable indicated flowrate, the minimum flowrate requirement for the pump is considered satisfied.

For simplicity, and to avoid confusing the operator, all HPSI pump minimum flow applications (category one and category two) should use the same operational value throughout the EPGs. This approach is conservative by nature and preferred from a human factors perspective.

Potential Margin Loss Options:

1. Install permanent pump flow indication for each HPSI pump.
2. Install low pump flow alarms on each HPSI pump.
3. Install Cold and Hot Leg injection flow meters that have the required accuracy at the low flows necessary to check minimum flow requirements.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 4 - APPLICATION 2

{342}
System Subject Parameter: ECCS-SI HPSI PUMP FLOW

Value: [nominal capacity of one charging pump], (operational limit 40 gpm)

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Lower = the nominal capacity of one charging pump, nominally 44gpm

Summary:

The engineering limit is the minimum acceptable boration flowrate, which is the nominal capacity of one charging pump. This operational limit is used to identify an abnormal boration system lineup. Boration in accordance with technical specification required actions will eventually shutdown the reactor. Confirmation of successful achievement of the reactivity control safety function is directly determined by a decreasing reactor power trend.

Since there is no specific analytical limit in this case, instrument uncertainties can not be applied.

Since this instrument application pertains to boration using ECCS, i.e. HPSI pumps, as monitored by the SI line flowmeters, the minimum acceptable boration flowrate, is the minimum required HPSI pump flowrate.

Basis for Engineering Limit(s):

The engineering limit is the minimum acceptable boration flowrate, which is the nominal capacity of one charging pump. This operational limit is used to identify an abnormal boration system lineup. Boration in accordance with technical specification required actions will eventually shutdown the reactor. Confirmation of successful achievement of the reactivity control safety function is directly determined by a decreasing reactor power trend.

Since this instrument application pertains to boration using ECCS, i.e. HPSI pumps, as monitored by the SI line flowmeters, the minimum acceptable boration flowrate, is the minimum required charging pump flowrate.

The CEN-152, revision 03 operational limit ($\geq$40 gpm) is a "nominal" operational minimum value. This value is based on the design capacity of one charging pump, as was described in the CVCS applications. The same value is used in RC-3 (boration using SIS) for simplicity. This operational value is used to identify an abnormal boration system lineup. HPSI flow is being used in place of charging flow. In the determination of the required combination of boration flow rate and boron concentration of the makeup water, there is no unique minimum boration flow requirement that must be satisfied (ref 1).

Uncertainties Application Assessment:

Since there is no specific analytical limit in this case, instrument uncertainties can not be applied.

The ultimate goal is to derive a reasonable minimum operational value, that will provide the operator a valid indication of an abnormal system line up that should be promptly investigated and corrected. The selected value should not send the operator in search of a problem when there is none.

Potential Margin Loss Options:

Not applicable

References:

1) NUREG 1432, Revision 01 Section 3.1.1 (Analog) and NUREG-1432, Revision 01, Section 3.1.1 (Digital).

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 4 - APPLICATION 3

{343}
System Subject Parameter: ECCS-SI HPSI PUMP FLOW

Value: [SI flow delivery curves]
Use: U70
To verify charging or SI flow is in agreement with "nominal design values" included in the EOPs.

Cat: C03

Engineering Limit(s):

Lower = the minimum Safety Injection flow for a given RCS pressure .

Summary:

The engineering limit is based on minimum expected HPSI flow for a given RCS pressure. The SI flow curves were developed to provide the operator with a tool for use in making prompt evaluations of Safety Injection System operation.

Instrument uncertainties need not be added to the engineering limit (required system design flowrate) to develop the EOP [SI flow delivery curves].

Basis for Engineering Limit(s):

The engineering limit is based on minimum expected SI flow for a given RCS pressure.

The SI flow curves were developed to provide the operator with a tool for use in making prompt evaluations of Safety Injection System operation. In order to minimize the total number of curves (thus minimizing potential confusion) numerous plant operating configurations were reviewed and only the worst case, i.e. minimum flows for single and two trains of SIS operation were included in the EPGs.

The curves help the operator verify that Safety Injection System (SIS) is operating properly. Indication of flow, confirms that HPSI pumps are operating and that the valve line up is correct. Adequate SIS flow ensures RCS Inventory Control and Core Heat Removal safety function are satisfied.

The EPG curves do not display expected or required SIS flow rates during simultaneous SIS hot/cold leg injection. This is a controlled evolution and not considered to be part of the EPG curve.

This instrument application appears in the SFSCs and instructions that ensure inventory control is achieved. It is used to aid the operator in evaluating SIS system performance and to prompt the operator to investigate possible causes of degraded system flow if it is below the expected value.

No instrument or process uncertainties were accounted for when developing the EPG curves (e.g., the RCS pressure values were not adjusted to account for the pressurizer elevation head when the RCS pressure versus SIS flow was plotted). The authors assumed that since the SI system design was determined and verified through the accident analyses, as long as the system performs as required by the accident analyses, core damage will not occur.

Uncertainties Application Assessment:

Instrument uncertainties need not be added to the engineering limit (required system design flowrate) to develop the EOP SIS minimum flow curves.

As stated previously, the curves are utilized to make a prompt determination of SIS operation. Flow significantly below the curve may indicate equipment misoperation or improper lineup. However, sufficient SIS flow is determined by the ability of the system, in conjunction with operator actions, to fulfill the RCS inventory control and heat removal safety functions.

Adding additional uncertainty to the engineering limit (required system design flowrate) could have the effect of requiring the operator to obtain a system flowrate that is beyond the design capability of the Safety Injection System (SIS) pump. Since this would be wasting the operator's time and may not be achievable, this practice is not recommended.

If instrument uncertainty results in the indicated SIS flowrate being not equal to the design flowrate, it would not necessarily mean that the flow rate is inadequate. The ultimate adequacy of SIS flowrate is determined by the status of the Reactivity Control, RCS Inventory Control and Core Heat Removal safety functions. If these safety function become jeopardized, the operator will be alerted to the situation by trends and alarms associated with reactor power, RCS temperature and pressure, and take appropriate contingency action per the EOPs.

Potential Margin Loss Options:

Not applicable

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?		
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:____

PAUL KRAMARCHYK Paul B. Kramarchyk 11/12/96

Independent Reviewer: Name/Signature/Date

REFUELING
WATER TANK
LEVEL

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 5

ECCS-SI RWT LEVEL {35}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	06/19/95	ALL	Congdon	Wild	Greene
00	03/29/96	ALL	Congdon	Greene	Whipple
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/6/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 3 - DOCUMENT 5 - APPLICATION 1

{351}
System Subject Parameter: ECCS-SI RWT LEVEL

Value: [RAS setpoint], nominally 10%

Use: U13
To verify automatic actuation of the ESFAS due to its setpoint being exceeded, or to indicated directly to the operator to manually actuate the safety systems associated with those setpoints since they failed to automatically actuate.

Cat: C03

Engineering Limit(s):

Upper = the upper Technical Specification ALLOWABLE TRIP setpoint for the Recirculation Actuation Signal (RAS).

Lower = the lower Technical Specification ALLOWABLE TRIP setpoint for the Recirculation Actuation Signal (RAS).

Summary:

The basis for the engineering limit is the same as the basis for the technical specification allowable setpoint for RAS. The operational limit is the same as the engineering limit.

The intent of the application is to prompt the operator to verify that RAS occurred automatically or to manually initiate RAS if it did not.

This instrument application is the ESFAS actuation setpoint. Since the intent is to verify Recirculation Actuation at setpoint, it serves no useful purpose to add additional uncertainties to those already applied to establish the RAS setpoint (C01).

Basis for Engineering Limit(s):

The bases for the engineering limit is the same as the bases for the technical specification allowable setpoint for RAS. The operational limit is the same as the engineering limit.

The upper allowable value for this trip is set low enough to ensure RAS does not initiate before sufficient water is transferred to the containment sump (ref. 1). Premature recirculation could damage or disable the recirculation system if recirculation begins before the sump has enough water to prevent air entrainment in the suction.

The lower allowable value is high enough to transfer suction to the containment sump prior to emptying the RWT and to prevent air entrainment during the transfer. Switchover from RWT to the Containment sump must occur before the RWT empties to prevent damage to the ECCS pumps and a loss of core cooling capability. For similar reasons, switchover must not occur before there is sufficient water in the Containment sump to support pump suction.

Allowable Values specified in the accompanying LCO, are conservatively adjusted with respect to the analytical limits. The actual trip setpoint entered into the bistable is normally more conservative than that specified by the allowable value to account for changes in random measurement errors detectable by a CHANNEL FUNCTIONAL TEST. If the measured setpoint does not exceed the Allowable Value, the bistable is considered OPERABLE.

This application appears in LOCA and FRG. It is used to direct the operator to verify RAS initiation. The intent of the application is to prompt the operator to verify that the suction valve from the Containment Sump opens automatically or to manually initiate RAS if it did not open as required.

This application is also used in LOCA and FRG to monitor RWT level and to direct the operator to make up to the RWT as necessary from all available sources to ensure that level remains greater than the RAS setpoint, if the LOCA is outside of containment and cannot be isolated.

The authors of CEN-152 assumed that the instrument inaccuracy considerations that have previously been discussed in this section were taken into consideration in the development of this ESFAS actuation setpoint.

Uncertainties Application Assessment:

This instrument application is a ESFAS actuation setpoint. Since the intent is to verify Recirculation Actuation occurs at setpoint, it serves no useful purpose to add additional uncertainties to those already applied to establish the RAS setpoint.

Additional instrument uncertainties are not applied because we do not want the operator to initiate any safety signal too early. Such action may further complicate an event. Also, we expect the safety systems to automatically initiate when designed, and the design setpoint already accounts for instrument uncertainties. Therefore, this should only be a manual backup in case the automatic setpoint does not initiate.

In addition, failure of the ESFAS systems to automatically actuate (as would be the case if manual actuation was required) is considered to be outside design bases space. Therefore, it is not possible to accurately calculate and apply instrument uncertainties in a meaningful manner in this operational space.

Finally, no additional instrument uncertainties need to be added to the ESFAS setpoint because doing so would unnecessarily complicate the EOPs by creating a second number to be used in the EOPs for RAS verification. This would place an unjustified burden on the operator.

Potential Margin Loss Options:

Not applicable

References:

1. CEOG STS, revision 01, LCO 3.3.4 Bases, pages 3.3.65 - 66

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) — n.a. pk - All Required Signatures	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK / Paul B. Kramarchyk / 11/11/96
Independent Reviewer: Name/Signature/Date

RCS AVERAGE TEMPERATURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1

RCS AVERAGE TEMPERATURE {41}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	07/17/95	ALL	Congdon	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Greene	Whipple
01	1/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1 - APPLICATION 1

Application 1 deleted by revision 01.

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1 - APPLICATION 2

{412}
System Subject Parameter: RCS AVE TEMP

Value: [minimum expected post-trip temperature], nominally 525°F

Use: U22 To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = The saturation temperature corresponding to the minimum expected normal post-trip SG pressure (35 psi below the normal setpoint for the TBVs/SBCS).

Lower = The saturation temperature corresponding to the Main Steam Isolation System (MSIS) setpoint

Summary:

The upper engineering limit is based on the lowest expected post-trip steam generator pressure (35 psi below the normal setpoint for the TBVs/SBCS, nominally 885 psia). The lower engineering limit is based on the low steam generator pressure setpoint for MSIS in technical specifications. The operational limit and engineering limit are intended to mitigate or prevent excessive RCS heat removal resulting from a malfunction of the TBVs, ADVs, or MSSVs.

Instrument uncertainties need not be applied in this application because it is backed up by the [MSIS] which is designed to protect the core in overcooling events, independent of operator action.

Basis for Engineering Limit(s):

The basis for the upper engineering limit is the saturation temperature corresponding to the minimum expected post-trip steam generator pressure. The basis for the lower limit is the same as the bases for the TS low SG pressure setpoint for MSIS.

This application is used to provide early recognition and mitigation of an over-cooling event. In this application, the operator is directed to ensure feed flow is not excessive, ensure TBVs/ADVs/MSSVs are closed if SG pressure is less than [minimum expected post-trip value], and ensure MSIS is initiated if SG pressure is less than [MSIS setpoint].

Less than [minimum expected post-trip temperature] was chosen as an operational limit for this application because it will facilitate early recognition of excess RCS heat removal following a reactor trip. It is assumed that if T_{ave} decreases to less than[minimum expected post-trip temperature] , an abnormality may exist that should be investigated and corrected.

This operational limit is a corroborative that corresponds to the lower end of the SG pressure [expected post-trip band], nominally 850 - 920 psia. It was chosen to avoid premature operator intervention, but allow maximum time for the operator to identify and correct the problem prior to reaching the MSIS setpoint. This instrument application is consistent with the philosophy to back up expected automatic control system response, i.e. TBS, with manual operator actions.

The safety significance of this application is low. Tavg indication is corroborated by Thot and Tcold instruments, as well as by SG pressure indication. In addition, this application is backed up by MSIS which is designed to protect the core in severe overcooling events.

CEN-152 revision 03 did not include instrument uncertainties in the [525°F] EPG operational limit.

Uncertainties Application Assessment:

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable for the following reasons:

1) In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board.

2) The lack of absolute accuracy of the T_{ave} instrumentation in this case will not prevent the operator from accomplishing the intended function of this instrument application.

3) There is significant redundant and corroborative instrumentation available to the operator to address the intent of this instrument application.

4) The instrument application is backed up by the MSIS which are designed to protect the core in overcooling events, independent of operator action.

The plant specific operational limit should be less than the no-load SBCS control program band and less than the typical T_{ave} trend following an uncomplicated reactor trip. The selected value should be far enough below the SBCS control program corresponding temperature to avoid unnecessary operator intervention, while still high enough to give the operator time to find and correct a problem prior to a MSIS actuation if possible.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1 - APPLICATION 3

{413}
System Subject Parameter: RCS AVE TEMP

Value: [maximum expected post-trip temperature], nominally 535°F

Use: U22
To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = The saturation temperature corresponding to 35 psi above the normal setpoint for the TBVs (SBCS).

Summary:

The engineering and operational limits are based on a the upper end of a 10°F post-trip RCS temperature control band, nominally [525 - 535°F] which was established based on engineering judgment (including, but not centered on the no-load temperature).

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable.

Basis for Engineering Limit(s):

The engineering and operational limits are based on a the upper end of a 10°F post-trip RCS temperature control band, nominally [525 - 535°F] which was established based on engineering judgment (including, but not centered on the no-load temperature).

The intent of this application is to assist the operator in detecting a malfunction of the TBVs(SBCS) or MSSVs, to provide early recognition of a decrease in RCS heat removal, as soon as possible after a trip. In this contingency action, the operator is directed to ensure feed is controlling or restoring level to at least one SG, and to ensure TBS/SBCS or the ADVs are controlling T_{ave} within the [expected post-trip band], nominally 525 to 535 °F.

It is assumed that if T_{ave} increases to greater than [535°F], the normal control systems are malfunctioning and should be investigated and corrected. This operational limit corresponds to the upper end of the SBCS SG pressure [expected post-trip band], nominally 850 - 920 psia. It was chosen to avoid premature operator intervention, but allow maximum time for the operator to identify and correct the problem prior to lifting the MSSVs. This instrument application is consistent with the philosophy to back up expected automatic control system response, i.e. TBS/SBCS, with manual operator actions.

The safety significance of this application is low. RCS Tavg is corroborated by the use of Thot and Tcold temperature indication, in addition to SG pressure indication. In addition, this application is backed up by MSSVs which are designed to ensure heat removal in the event that normal heat removal systems fail to control RCS temperature.

The authors of CEN-152, revision 03 did not include instrument uncertainties in the [535°F] EPG operational limit.

Uncertainties Application Assessment:

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable for the following reasons:

1) In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board.

2) The lack of absolute accuracy of the T_{ave} instrumentation in this case will not prevent the operator from accomplishing the intended function of this instrument application.

3) There is significant redundant and corroborative instrumentation available to the operator to address the intent of this instrument application.

The plant specific operational limit should be greater than the no-load SBCS control program band and greater than the typical T_{ave} trend following an uncomplicated reactor trip. The selected value should be far enough above the SBCS control program corresponding temperature to avoid unnecessary operator intervention, while still low enough to give the operator time to find and correct a problem prior to lifting the MSSVs.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1 - APPLICATION 4

{414}
System Subject Parameter: RCS AVE TEMP

Value: [expected post-trip band], nominally 525°F to 535°F

Use: U11 To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = Saturation temperature corresponding to 35 psi above the normal setpoint for the TBVs (SBCS).

Lower = Saturation temperature corresponding to 35 psi below the normal setpoint for the TBVs (SBCS).

Summary:

The engineering limits are based on the normal control band for TBVs (SBCS), 885 psia +/- 35 psi.

The high and low operational limits are intended to define the normal post-trip SG pressure band, and thereby assist the operator in detecting and responding to a malfunction with the TBVs or steam bypass control system (SBCS) as soon as possible.

Explicit instrument uncertainties need not be applied or specifically accounted for in determining the appropriate plant specific operational limits.

Basis for Engineering Limit(s):

The engineering limits are based on the [normal control band for TBVs (SBCS) 885 psia +/- 35 psi]. This application is used in standard post trip actions (SPTAs) as part of the criteria for acceptable reactor coolant system (RCS) heat removal, i.e. at least one steam generator (SG) has level in the [normal control band] or being restored by feedwater, average RCS temperature is within the [expected post-trip band], nominally 525°F to 535°F, and SG pressure is within the [expected post-trip band], nominally 850 - 920 psia. The high and low operational limits are intended to define the normal post-trip SG pressure band, and thereby assist the operator in detecting and responding to a malfunction with the TBVs or steam bypass control system (SBCS) as soon as possible.

The TBVs/SBCS is designed to remove decay heat and sensible heat following a reactor trip without overcooling the RCS. The upper and lower operational limits for this instrument application are based on saturation temperatures corresponding to the TBVs/SBCS [program control band 885 psia +/- 35 psi].

Uncertainties Application Assessment:

Explicit instrument uncertainties need not be applied or specifically accounted for in determining the plant specific operational limits.

This instrument application does not directly impact a safety function. Therefore, it does not require a high degree of accuracy. An allowance for instrument inaccuracies is included, by definition, in the engineering limits.

This application is used to verify normal RCS heat removal following an uncomplicated reactor trip and is corroborated by SG pressure being controlled in the expected range (normal control band). It is used by the operator to verify that the TBVs/SBCS are functioning properly.

In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board. Therefore, it is apparent that there is adequate redundancy and corroborative instrumentation for the operator to address the intent of this application.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152) ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 1 - APPLICATION 5

{415}
System Subject Parameter: RCS AVE TEMP

Value: [minimum RCS temperature defining a PTS event], nominally 500°F

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Lower limit = The minimum RCS temperature used as defining criteria for a pressurized thermal shock transient.

Summary:

The engineering limit is based on engineering judgment. The operational limit of < 500°F is taken from the CEN-152 definition for a pressurized thermal shock (PTS) transient.

Instrument uncertainties need not be applied in this application, since the engineering limit is an approximate value arrived at via engineering judgment, and there is no explicit design limit to protect against.

Basis for Engineering Limit(s):

The engineering limit is based on engineering judgment.

The operational limit of < 500°F is taken from the CEN-152 definition for a pressurized thermal shock transient. As per CEN-152, rev 03, a pressurized thermal shock transient is defined as an overcooling transient which causes RCS temperature to go below 500°F.

The intent of the operational limit is to provide the operator with an easy to use criterion for transitioning to use of the [200°F] Post Accident PTS P-T curve.

This instrument application is found in Note #1 at the bottom of all Post Accident Pressure-Temperature Limit Figures in CEN-152

When the EPGs were first developed, CEN-152, rev 01 used a more detailed set of criteria to determine that a pressurized thermal shock transient had occurred, requiring the operator to limit subcooling to 200°F thereafter. At that time the criterion was, 1) >100°F/hour cooldown rate, and 2) >100°F total cooldown, and 3) >10 minutes duration (to allow for reactor vessel response). In the course of the EPG simulator validation and training that followed, operators recommended that the criterion be simplified, pointing out that the operator can easily recognize a major uncontrolled cooldown event, without verifying all the previous criteria, which may be difficult and time consuming to do. Therefore, using engineering judgment the EPG authors changed the criterion to "anytime the RCS has experienced an uncontrolled cooldown which causes RCS temperature to go below 500°F.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied in this application, since the engineering limit is an approximate value arrived at via engineering judgment, and there is no explicit design limit to protect against.

In the context of the use of this application in the EPGs, the engineering limit is supplemented with additional criteria to meet the intent of the limit ("anytime the RCS has experienced *an uncontrolled cooldown* which causes RCS temperature to go below 500°F)

Potential Margin Loss Options:

Not Applicable

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:____________________

PAUL KRAMARCHYK / Paul Kramarchyk / 11/12/96

Independent Reviewer: Name/Signature/Date

CORE EXIT TEMPERATURE

1 ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 2

AVERAGE CET TEMPERATURE {42}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	07/21/95	ALL	Kramarchyk	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Kramarchyk	Greene
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk — Signature — 11/11/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

Cognizant Engineering Supervisor (Signature) Date 11/13/96

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 2 - APPLICATION 1

{421}
System Subject Parameter: REP CET TEMP

Value: [not superheated]

Use: U22
To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = 0°F superheat

Summary:

The engineering limit is based on the saturation temperature of the RCS.

The intent of the engineering limit is to provide an indication that can be used by the operator to assess the status of adequate core heat removal and corroborate core covered and core uncovered with the aid of RVLMS.

Instrument uncertainties need not be applied. Due to the way representative CET (REPCET) temperature is calculated, there is no meaningful way to apply the uncertainties to the individual CETs, and the uncertainties associated with the REPCET derivation, have already been addressed by the design of the system.

Basis for Engineering Limit(s):

The engineering limit is based on the saturation temperature of the RCS.

The intent of the engineering limit is to provide an indication that can be used by the operator to assess the status of adequate core heat removal and corroborate core covered and core uncovered with the aid of RVLMS. A superheated core indicates that core uncovery is occurring, and that core heat removal is inadequate.

For cases when pressurizer level is below the lower limit, RVLMS indication that the core is covered, in conjunction with subcooled CET temperatures, indicate that RCS inventory is sufficient to support adequate core cooling and prevent core damage. This application is used in the LOCA, SBO, and FRG Safety Function Status Checks (SFSC) to evaluate the effectiveness of core heat removal and RCS inventory control. The operator uses the ICC display, SMM or SPDS to perform the assessment.

All CEOG plants have a Subcooled Margin Monitor (SMM), Inadequate Core Cooling (ICC) display/cabinet, and/or a Safety Parameters Display System (SPDS). Using the SMM, ICC Display or SPDS, saturation margin may be calculated using [Representative] CET temperature (REPCET). The value of REPCET is a statistical combination of the CET inputs representing a value greater than 95% of all of the valid CET inputs, with a 95% confidence interval. The inputs are validated and REPCET is statistically chosen from the remaining inputs. Overall Instrument uncertainty associated with REPCET will be very small (typically <1%).

Uncertainties Application Assessment:

Additional instrument uncertainties need not be applied. Due to the way [representative] CET (REPCET) temperature is calculated, there is no meaningful way to apply the uncertainties to the individual CETs, and the uncertainties associated with the REPCET derivation, have already been addressed by the design of the system. The overall uncertainty associated with REPCET, using the method described above will be very small (<0.1%) (ref. 1).

In addition, category 03 is appropriate because of the dynamics associated with applying this limit under accident conditions. If core uncovery does occur, uncertainties associated with this indication will be masked by the rapidly increasing core exit temperatures. Consequently, the absolute value which is indicative of superheated conditions is less significant than the rapidly increasing trend.

Potential Margin Loss Options:

Not applicable

References:

1) CE NPSD-928-P, Subcooled Margin Monitoring System Possible Solutions to Margin Loss (CEOG Task 782), February 1994, page 9.

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 2 - APPLICATION 2

{422}
System Subject Parameter: REP CET TEMP

Value: [no abnormal difference] between T hot and REPCET, nominally (± 10°F)

Use: U34
To determine if operator actions associated with safety related equipment are necessary to support a safety function.

Cat: C02

Engineering Limit(s):

Upper = No difference between T hot and representative CET.

Summary:

The engineering limit is based on engineering judgment. The intent of the engineering limit is to provide an operational value that enables the operators to assess the status of single phase liquid natural circulation flow in at least one RCS loop.

Engineering judgment (category 02) may be used to determine the operational limit when accounting for instrument uncertainties, system characteristics and process affects. It is necessary to estimate the uncertainties to know what the expected band should be.

Basis for Engineering Limit(s):

The engineering limit is based on engineering judgment. When single phase natural circulation flow is established in at least one loop, the RCS should indicate....no abnormal differences between [operating loop] T_{hot} RTDs and core exit thermocouples. [Operating loop] T_{hot} RTD temperature should be consistent with the core exit thermocouples. Adequate natural circulation flow ensures that core exit thermocouple temperature will be approximately equal to the [operating loop] hot leg RTD temperature.

The intent of the engineering limit is to provide an approximate operational value that can be used, in conjunction with other indications, to assess the status of single phase liquid natural circulation flow in at least one RCS loop. Under single phase natural circulation flow, core exit thermocouple temperatures should be consistent with the operating loop hot leg temperature.

Approximate agreement between hot leg temperature and CET is corroborative evidence that there is fluid communication (flow) between the core and at least one hot leg. Engineering judgment was used to determine that an "abnormal difference" between T hot and CETs could be any difference greater than [10°F].

"No abnormal differences between T hot RTDs and core exit thermocouples" is used throughout CEN-152 as one of four criteria to verify single phase liquid natural circulation flow is established in at least one loop. The complete list of criteria is as follows:

a. Loop delta-T (Thot - Tcold) less than normal full power delta-T,
b. Hot and cold leg temperatures constant or lowering,
c. RCS subcooling at least [minimum RCS subcooling] based on [representative]CET temperature
d. No abnormal differences between T_H RTDs and core exit thermocouples.

This application possesses a moderate degree of nuclear safety significance. A lack of absolute instrument accuracy will not inhibit accomplishment of the intended function.

Uncertainties Application Assessment:

Engineering judgment (category 02) may be used to determine the operational limit when accounting for instrument uncertainties, system characteristics and process affects. It is necessary to estimate the uncertainties to know what the expected band should be.

The use of engineering judgment is acceptable to meet the intent of this instrument application for the following reasons:

1) The engineering limit is an approximate value, and there is no explicit design limit to protect against.

2) This application is used in corroboration with several other criteria to satisfy the intent of the step, i.e. verify natural circulation flow is established.

3) The operator should be trained to recognize the indicated delta-T that is "normal" for a wide spectrum of operating histories and RCS flow conditions. Also, operator training should address plant conditions that may affect the actual delta-T, such as reverse flow in the non-operating loop. The intent of applying operational margin to that which is normal or expected is to prevent the operator from being directed to the contingency actions when there is not a problem with natural circulation flow.

Potential Margin Loss Options:

Make the acceptable band larger.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 2 - APPLICATION 3

{423}
System Subject Parameter: REP CET TEMP

Value: [saturation temperature corresponding to PSV/PORV lift pressure], nominally 600°F

Use: U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: CO3

Engineering Limit(s):

Upper = The saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%), [or PORVs].

Summary:

The engineering limit is based on the saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%), [or PORVs]. This yields a corresponding saturation temperature of approximately 664°F.

The intent of the engineering limit is to establish a maximum operational [representative]CET temperature that provides indication that the core and the Steam Generators (SGs) are effectively coupled, and that the SGs are adequately removing decay heat. If [representative]CET temperature is greater than the engineering limit, then the SGs are not adequately removing decay heat, since being in excess of this value would indicate that the core was producing more heat than is being removed by the SGs.

Due to the way representative CET temperature is calculated, there is no meaningful way to apply instrument uncertainties to the individual CETs. The uncertainties associated with the [representative]CET derivation are addressed in the design of the system. The overall uncertainty associated with [representative]CET as described in the bases section is typically very small (<0.1%) (ref. 1).

Basis for Engineering Limit(s):

The engineering limit is based on the saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%), [or PORVs]. This yields a corresponding saturation temperature of approximately 664°F.

This temperature limit is basically a steady state limit. It is recognized that RCS pressure can be ≥2500 psia ±3%, with [representative]CET temperature being less than 668°F, if the plant is in a transient condition (e.g., rising pressurizer level squeezing the pressurizer steam bubble). However, if the main steam safety valves are adequately removing RCS heat, and at least one steam generator has adequate inventory and feed, the core exit temperature should never exceed 664°F (assuming ±3% tolerance for the primary code safety valves).

The CEN-152, revision 03 operational limit was based on the design secondary system pressure saturation temperature and the maximum expected core delta-T for adequate natural circulation flow.

In the EPG reference plant, the design secondary system pressure was [1100] psia. The corresponding saturation temperature is 556.3°F. The [600]°F operational limit was arrived at by adding [43.7]°F to the steam generator design saturation temperature to account for CET inaccuracy and maximum expected core delta-T.

During the course of conducting this project, it was determined the operational limit justification of this instrument application in reference 1 could be improved. The intent of the engineering limit should be to provide indication that the core is being adequately cooled by the Steam Generators (SGs). Therefore, if [representative]CET temperature is greater than the engineering limit, it can be assumed that the SGs are not adequately removing decay heat, since being in excess of this value would indicate that the core was producing more heat than is being removed by the SGs.

This application is used in the LOAF, SGTR, and ESDE Safety Function Status Check as an acceptance criteria for core heat removal.

All CEOG plants have a Subcooled Margin Monitor (SMM), Inadequate Core Cooling (ICC) display/cabinet, and/or a Safety Parameters Display System (SPDS). Using the SMM, ICC Display or SPDS, saturation margin may be calculated using Representative CET temperature (REPCET). The value of REPCET is a statistical combination of the CET inputs representing a value greater than 95% of all of the valid CET inputs, with a 95% confidence interval. The inputs are validated and REPCET is statistically chosen from the remaining inputs. Overall Instrument uncertainty associated with REPCET will be very small (typically <1%).

Uncertainties Application Assessment:

Due to the way representative CET (REPCET) temperature is calculated, there is no meaningful way to apply instrument uncertainties to the individual CETs. The uncertainties associated with the REPCET derivation is addressed in the design of the system. The overall uncertainty associated with REPCET as described in the bases section is typically very small (<0.1%) (ref.1).

The plant specific engineering limit is determined as described in the bases section.

The plant specific operational limit is arrived at by subtracting process uncertainties and any additional margin needed to arrive at an easily read and remembered operating limit. The resulting operational limit should also be greater than saturation temperature corresponding to secondary system design pressure ([1100] psia, [556.3]°F). An operational value between these two bounding conditions will satisfy the intent of the application.

Potential Margin Loss Options:

Not applicable

References:

1) CE NPSD-928-P, Subcooled Margin Monitoring System Possible Solutions to Margin Loss (CEOG Task 782), February 1994, page 9.

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures — n.a. pk	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK , [signature] , 11/11/96
Independent Reviewer: Name/Signature/Date

RCS COLD LEG
TEMPERATURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3

RCS COLD LEG TEMPERATURE {43}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	07/17/95	ALL	Congdon	Kramarchyk	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
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01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature] Date: 11/11/96
Cognizant Engineer (Signature)

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 1

{431}
System Subject Parameter: RCS COLD LEG TEMP

Value: [LTOP enabling criteria], nominally 275°F

Use: U20
To determine when to activate a safety related SSC for which no automatic initiation is provided in support of a safety function, safe shutdown, cooldown or depressurization.

Cat: C03

Engineering Limit(s):

Lower = The technical specification LCO value for placing low temperature overpressure protection (LTOP) in service.

Summary:

The engineering limit is based on the LTOP enabling temperature found in technical specifications. This operational limit is intended to protect against subjecting the RCS pressure boundary to low temperature brittle fracture conditions.

It is not necessary to apply additional instrument uncertainties to the plant-specific engineering limit when determining the appropriate plant-specific operational limit.

Basis for Engineering Limit(s):

The engineering limit is based on the LTOP enabling temperature found in technical specifications. Technical Specifications (ref. 1) require at least one overpressure protection system operable whenever cold leg temperature is less than or equal to [285°F]. The pressurizer safety valves provide overpressure protection above [285]°F.

The actual temperature at which the pressure in the P/T limit curve falls below the pressurizer safety valve setpoint increases as the reactor vessel material toughness decreases due to neutron embrittlement.

Each time the P/T limit curves are revised, the LTOP System will be re-evaluated to ensure its functional requirements can still be satisfied using the installed overpressure protection method. This operational limit is intended to ensure that low temperature overpressurization protection (LTOP) is lined up at the required cold leg temperature to protect against subjecting the RCS pressure boundary to low temperature brittle fracture.

This instrument application is used in cooldown/depressurization instructions of the Optimal and Functional Recovery Procedures. Instrument uncertainties were not included in the EPG value. The EPG value is a restatement of the reference plant tech spec value.

This instrument application is used to ensure operation within RCS pressure and temperature limits designed to protect against brittle fracture. Protection of the RCS pressure boundary has a high degree of nuclear safety significance. This conclusion is based on the high priority assigned to protection of fission product barriers in 10 CFR 50 App. G, fracture Toughness Requirements.

Uncertainties Application Assessment:

Because this instrument application possesses a high degree of nuclear safety significance, instrument uncertainties must be accounted for. However, in this particular application, it is not necessary to apply *additional* instrument uncertainties to the technical specification value for use in the EOPs. Uncertainties are typically accounted for and applied as appropriate in developing the corresponding plant-specific Technical Specification LCO requirement. This assumption should be verified on a plant specific bases.

Potential Margin Loss Options:

Not applicable

References:

1. NUREG-1432, Revision 1, 04/07/95, Section B 3.4.12, Bases for Low Temperature Overpressure Protection (LTOP) System, Pages B 3.4-56 through 3.4-65.

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 2

{432}
System Subject Parameter: RCS COLD LEG TEMP

Value: [post accident PT limits] and [Lowest service line temperature]

Use: U25
To verify operation within the design limits to prevent damage to safety related SSCs.

Cat: C01

Engineering Limit(s):

None

Summary:

Not applicable

Basis for Engineering Limit(s):

The bases for P/T curves is addressed in Module 5, RCS Subcooling and Pressurizer Pressure application 5.

Uncertainties Application Assessment:

Instrument uncertainty issues is addressed in Module 5, RCS Subcooling.

Potential Margin Loss Options:

None

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 3

{433}
System Subject Parameter: RCS COLD LEG TEMP

Value: SDM Calculation

Use: U12
To determine the value of a core physics parameter.

Cat: C03

Engineering Limit(s):

None

Summary:

This instrument application is used to ensure that the technical specification Shutdown Margin requirement is satisfied for the current or projected RCS temperature based on the most recent boron sample.

Additional instrument uncertainties need not be applied for this EOP application, because category 01 instrument uncertainties should be accounted for in the Shutdown Margin calculation.

Basis for Engineering Limit(s):

This instrument application is used to ensure the technical specification Shutdown Margin requirement is satisfied for the current or projected RCS temperature based on last boron sample. Typically, it appears in the EOPs well after the event mitigation, and prior to commencing a controlled cooldown.

In the EOPs, the primary focus is to maintain the reactor shutdown, as opposed to maintaining the required technical specification shutdown margin. The primary indications used by the operator to verify reactivity control are: reactor power level and trend, negative SUR, and CEA position indication showing that all CEAs are fully inserted. The initial transient would be over with by the time the operator is directed to verify SDM. Core reactivity, i.e. SDM, may to less negative than the required TS value, but core reactivity should remain negative and the reactor should remain shutdown if the reactivity control SFSC acceptance criteria are satisfied. The T_{cold} limit is per plant specific Surveillance Procedures for calculating the required SDM Boron Concentration.

The limiting temperature is a function of the current boron concentration, the method used to calculate SDM, and the current plant physics condition.

Uncertainties Application Assessment:

Additional instrument uncertainties need not be applied for this EOP application, because category 01 instrument uncertainties should be accounted for in the Shutdown Margin calculation.

The Hot Shutdown Margin (SDM) LCO is verified by Technical Specifications (TS) surveillance procedures, to ensure that if an Excess Steam Demand Event occurs, there will be acceptable consequences. Category 01 instrument uncertainty treatment is required for this use in technical specifications. In technical specifications, this instrument application possesses a high degree of nuclear safety significance because it is used to ensure positive reactivity control following DBA and subsequent reactor shutdown. Explicit T_{cold} instrument uncertainties should be known and accounted for in the Shutdown Margin calculation. Plant physics curves that rely on real-time RCS temperature as a coordinate should be adjusted for instrument uncertainties.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 4

{434}
System Subject Parameter: RCS COLD LEG TEMP

Value: [typical feedwater required for sensible heat removal curve]

Use: U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

None

Summary:

There is no engineering limit associated with this application.

Instrument uncertainties need not be applied to analytically derived curves when generating plant specific feedwater vs. T_{cold} sensible heat removal curves.

Basis for Engineering Limit(s):

CEN-152 Figures 13-14 and 13-15 are examples of the types of figures that could be used in determining how much condensate is required while a plant is being cooled by auxiliary feedwater.

Figure 13-14 represents the amount of condensate required in removing decay heat for a specific duration of time before the shutdown cooling system must be used due to the remaining condensate inventory being inadequate. Each curve reflects a different time after shutdown (in hours). Curves representing intermediate time segments may be added.

Figure 13-15 provides the operator with an indication of how much condensate is required to remove system sensible heat while cooling down the plant to a desired cold leg temperature from an initial cold leg temperature.

Figure 13-14 and Figure 13-15 must be used together to calculate the condensate inventory required for decay heat and sensible heat removal for a given cooldown. The intent of condensate inventory information, whether it is presented in graphical, nomograph, or other forms, is to enable the operating staff to determine whether sufficient inventory exists for the planned actions. It should give the operator information in a timely manner such that, if a cooldown is required, enough condensate will be available to accomplish the task. In the event that enough condensate does not exist for a cooldown to shutdown cooling entry conditions, the operator(s) can plan accordingly to maximize the time to establish alternate sources of condensate. Instrument uncertainties were not taken into consideration in generating these curves. The curves were arrived at analytically.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied to analytically derived curves when generating plant specific feedwater vs. T_{cold} sensible heat removal curves. When using the sensible heat removal curves, the operator is actually comparing one temperature to another in order to estimate the amount of feedwater that will be required. This is essentially a delta comparison process. Therefore, instrument uncertainties will not negatively impact the desired result. It is assumed that the instrument uncertainties are the same throughout the full range of indication.

Potential Margin Loss Options:

Margin loss is not an issue for this particular application.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 5

{435}
System Subject Parameter: RCS COLD LEG TEMP

Value: [minimum expected post-trip temperature], nominally 525°F

Use: U22 To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = The saturation temperature corresponding to the minimum expected normal post-trip SG pressure (35psi below the normal setpoint for the TBVs/SBCS).

Lower = The saturation temperature corresponding to the Main Steam Isolation System (MSIS) setpoint

Summary:

The upper engineering limit is based on the lowest expected post-trip steam generator pressure (35 psi below the normal setpoint for the TBVs/SBCS, nominally 885 psia). The lower engineering limit is based on the low steam generator pressure setpoint for MSIS in technical specifications. The operational limit and engineering limit are intended to mitigate or prevent excessive RCS heat removal resulting from a malfunction of the TBVs, ADVs, or MSSVs.

Instrument uncertainties need not be applied in this application because it is backed up by the [MSIS] which is designed to protect the core in overcooling events, independent of operator action.

Basis for Engineering Limit(s):

The basis for the upper engineering limit is the saturation temperature corresponding to the minimum expected post-trip steam generator pressure. The basis for the lower limit is the same as the bases for the TS low SG pressure setpoint for MSIS.

This application is used to provide early recognition and mitigation of an over-cooling event. In this application, the operator is directed to ensure feed flow is not excessive, ensure TBVs/ADVs/MSSVs are closed if SG pressure is less than [minimum expected post-trip value], and ensure MSIS is initiated if SG pressure is less than [MSIS setpoint].

Less than [minimum expected post-trip temperature] was chosen as an operational limit for this application because it will facilitate early recognition of excess RCS heat removal following a reactor trip. It is assumed that if T_{ave} decreases to less than[minimum expected post-trip temperature] , an abnormality may exist that should be investigated and corrected.

This operational limit is a corroborative that corresponds to the lower end of the SG pressure [expected post-trip band], nominally 850 - 920 psia. It was chosen to avoid premature operator intervention, but allow maximum time for the operator to identify and correct the problem prior to reaching the MSIS setpoint. This instrument application is consistent with the philosophy to back up expected automatic control system response, i.e. TBS, with manual operator actions.

The safety significance of this application is low. Tavg indication is corroborated by Thot and Tcold instruments, as well as by SG pressure indication. In addition, this application is backed up by MSIS which is designed to protect the core in severe overcooling events.

CEN-152 revision 03 did not include instrument uncertainties in the [525°F] EPG operational limit.

Uncertainties Application Assessment:

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable for the following reasons:

1) In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board.

2) The lack of absolute accuracy of the T_{ave} instrumentation in this case will not prevent the operator from accomplishing the intended function of this instrument application.

3) There is significant redundant and corroborative instrumentation available to the operator to address the intent of this instrument application.

4) The instrument application is backed up by the MSIS which are designed to protect the core in overcooling events, independent of operator action.

The plant specific operational limit should be less than the no-load SBCS control program band and less than the typical T cold trend following an uncomplicated reactor trip. The selected value should be far enough below the SBCS control program corresponding temperature to avoid unnecessary operator intervention, while still high enough to give the operator time to find and correct a problem prior to a MSIS actuation if possible.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 6

{436}
System Subject Parameter: RCS COLD LEG TEMP

Value: [maximum expected post-trip temperature], nominally 535°F

Use: U22
To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = The saturation temperature corresponding to 35 psi above the normal setpoint for the TBVs (SBCS).

Summary:

The engineering and operational limits are based on a the upper end of a 10°F post-trip RCS temperature control band, nominally [525 - 535°F] which was established based on engineering judgment (including, but not centered on the no-load temperature).

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable.

Basis for Engineering Limit(s):

The engineering and operational limits are based on a the upper end of a 10°F post-trip RCS temperature control band, nominally [525 - 535°F] which was established based on engineering judgment (including, but not centered on the no-load temperature).

The intent of this application is to assist the operator in detecting a malfunction of the TBVs(SBCS) or MSSVs, to provide early recognition of a decrease in RCS heat removal, as soon as possible after a trip. In this contingency action, the operator is directed to ensure feed is controlling or restoring level to at least one SG, and to ensure TBS/SBCS or the ADVs are controlling T cold within the [expected post-trip band], nominally 525 to 535 °F.

It is assumed that if T cold increases to greater than [535°F], the normal control systems are malfunctioning and should be investigated and corrected. This operational limit corresponds to the upper end of the SBCS SG pressure [expected post-trip band], nominally 850 - 920 psia. It was chosen to avoid premature operator intervention, but allow maximum time for the operator to identify and correct the problem prior to lifting the MSSVs. This instrument application is consistent with the philosophy to back up expected automatic control system response, i.e. TBS/SBCS, with manual operator actions.

The safety significance of this application is low. RCS cold is corroborated by the use of Thot and T ave temperature indication, in addition to SG pressure indication. In addition, this application is backed up by MSSVs which are designed to ensure heat removal in the event that normal heat removal systems fail to control RCS temperature.

The authors of CEN-152, revision 03 did not include instrument uncertainties in the [535°F] EPG operational limit.

Uncertainties Application Assessment:

It is not necessary to include instrument uncertainties when deriving the plant specific operational limit for this application. Category 03 treatment is acceptable for the following reasons:

1) In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board.

2) The lack of absolute accuracy of the T_{ave} instrumentation in this case will not prevent the operator from accomplishing the intended function of this instrument application.

3) There is significant redundant and corroborative instrumentation available to the operator to address the intent of this instrument application.

The plant specific operational limit should be greater than the no-load SBCS control program band and greater than the typical T cold trend following an uncomplicated reactor trip. The selected value should be far enough above the SBCS control program corresponding temperature to avoid unnecessary operator intervention, while still low enough to give the operator time to find and correct a problem prior to lifting the MSSVs.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 3 - APPLICATION 7

{437}
System Subject Parameter: RCS COLD LEG TEMP

Value: [expected post-trip band], nominally 525°F to 535°F

Use: U11 To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = Saturation temperature corresponding to 35 psi above the normal setpoint for the TBVs (SBCS).

Lower = Saturation temperature corresponding to 35 psi below the normal setpoint for the TBVs (SBCS).

Summary:

The engineering limits are based on the normal control band for TBVs (SBCS), 885 psia +/- 35 psi.

The high and low operational limits are intended to define the normal post-trip SG pressure band, and thereby assist the operator in detecting and responding to a malfunction with the TBVs or steam bypass control system (SBCS) as soon as possible.

Explicit instrument uncertainties need not be applied or specifically accounted for in determining the appropriate plant specific operational limits.

Basis for Engineering Limit(s):

The engineering limits are based on the [normal control band for TBVs (SBCS) 885 psia +/- 35 psi].
This application is used in standard post trip actions (SPTAs) as part of the criteria for acceptable reactor coolant system (RCS) heat removal, i.e. at least one steam generator (SG) has level in the [normal control band] or being restored by feedwater, average RCS temperature is within the [expected post-trip band], nominally 525°F to 535°F, and SG pressure is within the [expected

post-trip band], nominally 850 - 920 psia. The high and low operational limits are intended to define the normal post-trip SG pressure band, and thereby assist the operator in detecting and responding to a malfunction with the TBVs or steam bypass control system (SBCS) as soon as possible. The TBVs/SBCS is designed to remove decay heat and sensible heat following a reactor trip without overcooling the RCS. The upper and lower operational limits for this instrument application are based on saturation temperatures corresponding to the TBVs/SBCS [program control band 885 psia +/- 35 psi].

Uncertainties Application Assessment:

Explicit instrument uncertainties need not be applied or specifically accounted for in determining the plant specific operational limits.

This instrument application does not directly impact a safety function. Therefore, it does not require a high degree of accuracy. An allowance for instrument inaccuracies is included, by definition, in the engineering limits.

This application is used to verify normal RCS heat removal following an uncomplicated reactor trip and is corroborated by SG pressure being controlled in the expected range (normal control band). It is used by the operator to verify that the TBVs/SBCS are functioning properly.

In automatic, the SBCS controls on RCS average temperature and SG pressure signals respectively to control RCS heat removal. To monitor proper SBCS operation, the operator refers to T_{ave}, T_{cold}, T_{hot}, and SG pressure indicators on the main control board. Therefore, it is apparent that there is adequate redundancy and corroborative instrumentation for the operator to address the intent of this application.

Potential Margin Loss Options:

Not applicable

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

Review Criteria (page 2 of 2)		OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B KRAMARCHYK, Paul B. Kramarchyk, 11/12/96

Independent Reviewer: Name/Signature/Date

RCS HOT LEG
TEMPERATURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4

RCS HOT LEG TEMPERATURE {44}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	07/17/95	ALL	Congdon	Kramarchyk	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Kramarchyk	Greene
01	11/15/96	ALL	Congdon	Krama4rchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/11/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4 - APPLICATION 1

{441}
System Subject Parameter: RCS HOT LEG TEMP

Value: [not superheated] or [less than superherated]

Use: U22
To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = 0 °F superheat

Summary:

The engineering limit is based on the saturation temperature of the RCS.

The intent of the engineering limit is to provide an indication that can be used by the operator to assess the status of adequate core heat removal and corroborate <u>core covered</u> and <u>core uncovered</u> with the aid of RVLMS.

Instrument uncertainties in addition to those already accounted for in the Shutdown Margin Monitor (SMM), Inadequate Core Cooling (ICC) display and Safety Parameter Display System (SPDS) need not be applied. The main contributor to the saturation margin error is the pressurizer pressure input. The RTD input uncertainty contributes very little.

Basis for Engineering Limit(s):

The engineering limit is based on the saturation temperature of the RCS.

The intent of the engineering limit is to provide an indication that can be used by the operator to assess the status of adequate core heat removal and corroborate <u>core covered</u> and <u>core uncovered</u> with the aid of RVLMS. Superheated hot leg temperature indicate that core uncovery has occurred and that core heat removal is no longer sufficient to prevent core damage.

For cases when pressurizer level is below the lower limit, RVLMS indication that the core is covered, in conjunction with subcooled hot leg temperature, provide indication that RCS inventory is sufficient to support adequate core cooling and prevent core damage. This application is used in the LOCA, SBO, and FRG Safety Function Status Checks (SFSC) to evaluate the effectiveness of core heat removal and RCS inventory control. The operator uses the ICC display, SMM or SPDS to perform the assessment.

Uncertainties Application Assessment:

Instrument uncertainties, in addition to those already accounted for in the SMM, ICC display and SPDS need not be applied. The main contributor to error in the saturation margin is the pressurizer pressure input. The RTD input uncertainty contributes very little (ref. 1).

In addition, category 03 is appropriate because of the dynamics associated with applying this limit under accident conditions. If core uncovery does occur, uncertainties associated with this indication will be masked by the rapidly increasing core exit temperatures and hot leg temperature. Consequently, the absolute value which is indicative of superheated conditions is less significant than the rapidly increasing trend.

RCS Loop Temperatures less than superheat conditions can be used as a corroborative or backup to assess core heat removal capability. Although the use of RCS loop temperatures are not the preferred method, they may be used to provide secondary evidence that the core is covered. For example, multiple RCS loop temperatures indicating subcooled conditions is at least consistent with complete core covery. Since RCS loop temperatures are not a direct measure of core temperature, they should not be used as the only parameter for determining core heat removal capability.

Potential Margin Loss Options:

Not applicable

References:

1) CE NPSD-928-P, Subcooled Margin Monitoring System Possible Solutions to Margin Loss (CEOG Task 782), February 1994, page 9.

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4 - APPLICATION 2

System Subject Parameter: RCS HOT LEG TEMP

Value: [no abnormal difference] between hot leg RTDs and average CET, nominally(±10°F)

Use: U34
To determine if operator actions associated with safety related equipment are necessary to support a safety function.

Cat: C02

Engineering Limit(s):

No difference between T hot and representative CET.

Summary:

The engineering limit is based on engineering judgement. The intent of the engineering limit is to provide an operational value that enables the operators to assess the status of single phase liquid natural circulation flow in at least one RCS loop.

Engineering judgement (category 02) may be used to determine the operational limit when accounting for instrument uncertainties, system characteristics and process affects. It is necessary to estimate the uncertainties to know what the expected band should be.

Basis for Engineering Limit(s):

The engineering limit is based on engineering judgement. When single phase natural circulation flow is established in at least one loop, the RCS should indicate....no abnormal differences between [operating loop] T_{hot} RTDs and core exit thermocouples. [Operating loop] T_{hot} RTD temperature should be consistent with the core exit thermocouples. Adequate natural circulation flow ensures that core exit thermocouple temperature will be approximately equal to the [operating loop] hot leg RTD temperature.

The intent of the engineering limit is to provide an approximate operational value that can be used, in conjunction with other indications, to assess the status of single phase liquid natural circulation flow in at least one RCS loop. Under single phase natural circulation flow, core exit thermocouple temperatures should be consistent with the operating loop hot leg temperature. Engineering judgement was used to determine that an "abnormal difference" between T hot and CETs could be any difference greater than [10°F].

Approximate agreement between hot leg temperature and [representative] CET is corroborative evidence that there is fluid communication (flow) between the core and at least one hot leg. Engineering judgement was used to determine that an "abnormal difference" between T hot and CETs could be any difference greater than [10°F].

"No abnormal differences between T hot RTDs and core exit thermocouples" is used throughout CEN-152 (ref. 1) as one of four criteria to verify single phase liquid natural circulation flow is established in at least one loop. The complete list of criteria is as follows:

a. Loop delta-T (Thot - Tcold) less than normal full power delta-T,
b. Hot and cold leg temperatures constant or lowering,
c. RCS subcooling at least [minimum RCS subcooling] based on [representative CET temperature
d. No abnormal differences between T hot RTDs and core exit thermocouples.

This application possesses a moderate degree of nuclear safety significance. A lack of absolute instrument accuracy will not inhibit accomplishment of the intended function.

Uncertainties Application Assessment:

Engineering judgement (category 02) may be used to determine the operational limit when accounting for instrument uncertainties, system characteristics and process affects. It is necessary to estimate the uncertainties to know what the expected band should be.

The use of engineering judgement is acceptable to meet the intent of this instrument application for the following reasons:

1) The engineering limit is an approximate value, and there is no explicit design limit to protect against.

2) This application is used in corroboration with several other criteria to satisfy the intent of the step, i.e. verify natural circulation flow is established.

3) The operator should be trained to recognize the indicated delta-T that is "normal" for a wide spectrum of operating histories and RCS flow conditions. Also, operator training should address plant conditions that may affect the actual delta-T, such as reverse flow in the non-operating loop. The intent of applying operational margin to that which is normal or expected is to prevent the operator from being directed to the contingency actions when there is not a problem with natural circulation flow.

Potential Margin Loss Options:

Make the acceptable band larger.

References:

1) CEN-152 rev. 3, Loss of Coolant Accident, step #29 bases, pages 5-104 through 5-106.

EMERGENCY PROCEDURE GUIDELINE (CEN-152) ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4 - APPLICATION 3

{443}
System Subject Parameter: RCS HOT LEG TEMP

Value: [MSSV lift prevent temperature], nominally 525°F

Use: U05
To verify or ensure RCS and Core Heat Removal Safety Function Acceptance Criteria are satisfied.

Cat: C01

Use: U27
To prevent or mitigate off-site exposure to the public.

Cat: C01

Engineering Limit(s):

Upper = the saturation temperature for the lowest lifting main steam safety valve (MSSV), including lift tolerance.

Summary:

The bases for the engineering limit is the lift setpoint of the lowest MSSV.

The intent of this instrument application is to prevent inadvertent lifting a MSSV on the ruptured steam generator after it has been isolated.

An explicit plant specific instrument uncertainty calculation (C01) should be performed for the RCS hot leg temperature instrumentation used by the operator to perform this application.

Basis for Engineering Limit(s):

The bases for the engineering limit is the lift setpoint of the lowest lifting MSSV.

The lowest lifting Main Steam Safety Valve (MSSV) setpoint for the reference plant is [1000] psia, with a tolerance of [± 1% (10 psi)]. Therefore, this safety valve may open at a steam generator pressure of [990] psia. The saturation temperature at [990] psia is approximately [540]°F. In order to prevent the steam generator pressure from exceeding the MSSV setpoint, the temperature in the steam generator must remain less than [540]°F. Assuming the hot leg temperature is equal to the steam generator saturation temperature, the hot leg temperature must also remain below [540]°F.

The operational limit used in CEN-152, revision 03 is not based solely on the lift setpoint of the MSSV. The resultant heatup that is expected to take place due to transferring from two steam generators of cooling to one steam generator of cooling must also be accounted for. Following steam generator isolation, the hot leg temperature in both loops is expected to rise due to the increased heat removal load on the unisolated steam generator. Best estimate analyses have shown this rise may be as much as [15]°F. To ensure that the MSSVs do not open following this temperature rise, the hot leg temperature prior to isolation must be reduced by this amount. Therefore, hot leg temperature prior to steam generator isolation which will ensure the MSSVs do not open after the subsequent increase in hot leg temperature after isolation, is [540°F-15] or [525]°F.

The intent of this instrument application is to prevent inadvertent lifting a MSSV on the ruptured steam generator after it has been isolated. Reducing RCS temperature prior to isolation is one of the actions necessary to prevent inadvertently opening a direct release path to the environment after steam generator isolation.

This instrument application is used in SGTR and in Heat Removal success paths of the FRG. In SGTR, the steam generator with higher activity, higher radiation levels, or increasing water level should be isolated. Reducing RCS temperature to below the saturation temperature associated with the lowest pressure setpoint of the MSSVs is one of the actions required to prevent inadvertent opening the isolated SG MSSV, which is a direct path to the environment. SG isolation is an attempt to re-establish the containment isolation safety function.

However, should the pressure in the isolated SG approach the lift setpoint for the isolated SG MSSVs, it is more desirable from the perspective of positive operator control that the ADVs open first. This is accomplished by raising the automatic ADV lift setpoint to [950 psia], manually opening the ADV at [950] psia and increasing, or locally opening the ADV at [950 psia]. To minimize release of radioactivity to the environment, opening the affected SG ADVs should be minimized.

This instrument application relates to preventing and minimizing uncontrolled and unmonitored releases to the environment, therefore minimizing off-site exposure to the public during certain accidents. This instrument application helps ensure that the assumptions in accident analysis associated with off-site exposure during design basis events (DBEs) are not exceeded. Instrumentation used to mitigate off-site exposure to the public has a high priority in 10 CFR 50 Appendix A criteria. Therefore, this instrument application is considered to have a high degree of nuclear safety significance.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for the RCS hot leg temperature instrumentation used by the operator to perform this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

The application of instrument uncertainties is important to carrying out the intent of this particular instrument application due to its relationship to off-site exposure to the public as described in the bases section.

The plant specific engineering limit is derived as described in the bases section. The plant specific operational limit is arrived at by subtracting plant specific T_{hot} instrument uncertainties, plus 15°F operational margin from the plant specific engineering limit to account for the subsequent rise in temperature following SG isolation.

This application exists in SGTR and in the Functional Recovery Procedure. Consequently, harsh containment instrument uncertainties need to be included for the FRG instrument application.

Potential Margin Loss Options:

If when plant specific instrument uncertainties are applied to the plant specific engineering limit the resultant margin between the engineering limit and the operational limit is not acceptable, the following options may be considered:

1. T hot in the affected loop will be approximately equal to the affected SG temperature. Therefore, SG pressure will be approximately equal to the saturation temperature associated with T hot.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4 - APPLICATION 4

System Subject Parameter: RCS HOT LEG TEMP

Value: [saturation temperature corresponding to PSV/PORV lift pressure], nominally 600°F

Use: U22
To provide corroborative information related to the accomplishment of a safety function.

Cat:: C03

Engineering Limit(s):

Upper = The saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%) [or PORVs].

Summary:

The engineering limit is based on the saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%) [or PORVs]. This yields a corresponding saturation temperature of approximately 664°F.

The intent of the engineering limit is to establish a maximum operational T hot temperature that provides indication that the core and the Steam Generators (SGs) are effectively coupled, and that the SGs are adequately removing decay heat. If T hot is greater than the engineering limit, then the SGs are not adequately removing decay heat, since being in excess of this value would indicate that the core was producing more heat than the SG safety valves could remove.

An explicit plant specific instrument uncertainty calculation (C01) should be performed for the RCS hot leg temperature instrumentation used by the operator to perform this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

Basis for Engineering Limit(s):

The engineering limit is based on the saturation temperature corresponding to the lift setpoint of the primary code safety valves (typically 2500 psia, ±3%) [or PORVs]. This yields a corresponding saturation temperature of approximately 664°F.

This temperature limit is basically a steady state limit. It is recognized that RCS pressure can be ≥2500 psia ±3%, with T hot being less than 668°F, if the plant is in a transient condition (e.g., rising pressurizer level squeezing the pressurizer steam bubble). However, if the main steam safety valves are adequately removing RCS heat, and at least one steam generator has adequate inventory and feed, the core exit temperature should never exceed 664°F (assuming ±3% tolerance for the primary code safety valves).

The CEN-152, revision 03 operational limit was based on the design secondary system pressure saturation temperature and the maximum expected core delta-T for adequate natural circulation flow.

In the EPG reference plant, the design secondary system pressure was [1100] psia. The corresponding saturation temperature is 556.3°F. The [600]°F operational limit was arrived at by adding [43.7]°F to the steam generator design saturation temperature to account for instrument inaccuracy and maximum expected core delta-T (ref. 1).

During the course of conducting this project, it was determined the operational limit justification of this instrument application in reference 1 could be improved. The intent of the engineering limit should be to provide indication that the core is being adequately cooled by the Steam Generators (SGs). Therefore, if T hot is greater than the engineering limit, it can be assumed that the SGs are not adequately removing decay heat, since being in excess of this value would indicate that the core was producing more heat than is being removed by the SGs.

The T hot RTD temperature value of 600°F is used in the LOAF, SGTR, and ESDE Safety Function Status Check as acceptance criteria for core heat removal.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for the RCS hot leg temperature instrumentation used by the operator to perform this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

The plant specific engineering limit is determined as described in the bases section. The plant specific operational limit is arrived at by subtracting instrument uncertainties and process uncertainties, plus any additional margin needed to arrive at an easily read and remembered operating limit. The resulting operational limit should also be greater than saturation temperature corresponding to secondary system design pressure ([1100] psia, [556.3]°F in reference 1).

Adjusting the engineering limit for instrument uncertainties is necessary to meet the intent of the limit for the following reasons:

1) The engineering limit does not include instrument uncertainty.

2) The engineering limit is based on an explicit design value which is being used to evaluate adequate core heat removal via a SG.

3) The application of instrument uncertainties in the non-conservative direction (high side) is necessary to create an unambiguous bounding upper limit, above which the operator can be certain that heat removal via that SG is lost.

Potential Margin Loss Options:

None

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 4 - APPLICATION 5

{445}
System Subject Parameter: RCS HOT LEG TEMP

Value: [shutdown cooling entry temperature]. nominally 300°F

Use: U20
To determine when to activate a safety related SSC for which no automatic initiation is provided in support of a safety function, safe shutdown, cooldown or depressurization.

Cat: C01

Engineering Limit(s):

Upper = Shutdown Cooling System design temperature.

Summary:

The upper engineering limit is based on the design temperature of the shutdown cooling system.

This instrument application is intended to ensure hot leg temperature is less than the system design temperature prior to attempting to align the SCS suction to the RCS.

An explicit plant specific instrument uncertainty calculation (C01) should be performed for hot leg temperature instrumentation used by the operator to perform this application.

Basis for Engineering Limit(s):

The upper engineering limit is based on the design temperature of the shutdown cooling system components [300]°F.

During post accident conditions, the shutdown cooling system may be placed in operation when hot leg temperature is less than [300]°F. It should be noted that this temperature limit does not include considerations for instrument error. Additionally, if the shutdown cooling system is unable to maintain the temperature in the hot leg below the design limit, then the shutdown cooling success path must be terminated and another success path chosen.

This instrument application is intended to protect SCS components from high temperature. This application is used in SCS entry criteria throughout the EPGs. Due to its relationship to safe shutdown and cooldown of the plant it is considered to have a moderate degree of nuclear safety significance.

Harsh containment instrument uncertainties should be considered for the FRG instrument application.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed on hot leg temperature instrumentation used by the operator to perform this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

Adjusting the engineering limit for instrument uncertainties is necessary to meet the intent of the limit for the following reasons:

1) The engineering limit is based on an explicit design value which is being used to ensure that the SCS is protected from high temperature conditions.

3) The application of instrument uncertainties in the conservative direction (low side) is necessary to create an unambiguous bounding lower limit, below which the operator can be certain that SCS design temperature will not be exceeded.

3) The indirect relationship of this application to maintaining RCS pressure boundary integrity and control of RCS inventory.

Potential Margin Loss Options:

Not applicable

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

Review Criteria (page 1 of 2)		OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures - na. PK	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK / [signature] / 11/11/96

Independent Reviewer: Name/Signature/Date

RCS DELTA
TEMPERATURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 5

RCS LOOP DELTA-T {45}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	07/17/95	ALL	Kramarchyk	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Greene	Whipple
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/12/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 5 - APPLICATION 1

{451}
System Subject Parameter: RCS LOOP DELTA-T

Value: [normal full poser delta-T], nominally 50°F

Use: U22
To provide corroborative information for the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Upper = Less than normal full power delta-T.

Summary:

The engineering limit is based on engineering judgement. The intent of the engineering limit is to provide a value that enables the operators to assess the status of single phase liquid natural circulation flow in at least one RCS loop.

The engineering limit need not be adjusted for instrument uncertainties when determining the plant specific operational value.

Basis for Engineering Limit(s):

The engineering limit is based on engineering judgement. The intent of the engineering limit is to provide a value that enables the operators to assess the status of single phase liquid natural circulation flow in at least one RCS loop.

Under single phase natural circulation flow, the operating loop delta-T should be less than the normal full power delta-T. A loop delta-T less than the full power delta-T ensures that the [power/flow] ratio is within the nominal thermal hydraulic parameters for the RCS (i.e., the power to flow ratio is equal or greater than that for full power operation).

"Less than normal full power delta-T" is used throughout CEN-152 as one of four criteria to verify that single phase liquid natural circulation flow is established in at least one loop. The complete criteria are as follows:

a. Loop delta-T (Thot - Tcold) less than normal full power delta-T,
b. Hot and cold leg temperatures constant or decreasing,
c. RCS subcooling greater than the [minimum required] based on average CET temperature,
d. No abnormal differences between T_H RTDs and core exit thermocouples.

Uncertainties Application Assessment:

The engineering limit need not be adjusted for instrument uncertainties when determining the plant specific operational value.

Adjusting the engineering limit for instrument uncertainties is unnecessary to meet the intent of the limit for the following reasons:

1) The engineering limit is a nominal value based on engineering judgement, and there is no explicit design limit to protect against.
2) In the context of the EPG's, the engineering limit is supplemented with additional criteria to meet the intent of the limit (see natural circulation criteria (b), (c), and (d) in the bases section above).
3) The application of instrument uncertainties may create an acceptance criterion that is misleading or impossible to meet: if instrument uncertainties are subtracted from the engineering limit (conservatively lowering the delta-T limit), the operator may believe there is a problem with natural circulation flow when there is none, and take action which would delay the onset of stable natural circulation.

Potential Margin Loss Options:

Not applicable

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 4 - DOCUMENT 5 - APPLICATION 2

{452}
System Subject Parameter: RCS LOOP DELTA-T

Value: [maximum expected delta-T shutdown with forced circulation], nominally 10°F

Use: U14
To determine if operator actions associated with non-safety related equipment are necessary to provide indirect support of a safety function.

Cat: C02

Engineering Limit(s):

Upper = RCS loop delta-T associated with operation of one RCP.

Summary:

The engineering limit is based on best estimate analysis of the maximum delta-T expected with minimum forced circulation (only 1 RCP operating) and maximum decay heat. Post-trip core heat removal with forced flow is dependent on circulating subcooled fluid through the core to remove decay heat.

Engineering judgement may be used to account for instrument uncertainties in this application. Due to the nature of this application, there is no unacceptable margin loss.

Basis for Engineering Limit(s):

The engineering limit is based on best estimate analysis of the maximum delta-T expected with minimum forced circulation (only 1 RCP operating) and maximum decay heat. Post-trip core heat removal with forced flow is dependent on circulating subcooled fluid through the core to remove decay heat. The authors of CEN-152 used a "nominal" operational value of [10°F]. This value was arrived at by using an engineering limit of [2-3°F], plus [7-8°F] to account for instrument uncertainties.

The intent of the operational limit is to provide a "nominal" value that is easy to use, and that will conclusively verify that at least one RCP is successfully circulating fluid through the core/RCS (i.e., no sheared shaft) for core heat removal.

This instrument application is used assess the status of core heat removal.

Uncertainties Application Assessment:

Engineering judgement may be used to account for instrument uncertainties in this application. Due to the nature of this application, there is no unacceptable margin loss.

The safety significance associated with this application is low for the following reasons:

1) The engineering limit is a best estimate value under a specific set of assumed conditions. It is not a limiting value intended to protect an explicit design limit. In addition, the resultant operational limit is a "nominal" value.

2) In the context of the EPG, the operational limit is supplemented by additional criterion to aid the operator in evaluating the adequacy of core heat removal. For example, RCS temperature trends and subcooling can be used to corroborate core delta-T, when evaluating core heat removal.

Potential Margin Loss Options:

Not applicable

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

Review Criteria (page 1 of 2)		OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures – n.a. PK	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. Kramarchyk / [signature] / 11/12/96
Independent Reviewer: Name/Signature/Date

RCS SUBCOOLING

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 1

RCS SUBCOOLING {51}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	08/31/95	ALL	Max	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Kramarchyk	Greene
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph.R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 1 - APPLICATION 1

{511}
System Subject Parameter: RCS SUBCOOLING

Value:
[minimum RCS subcooling], nominally 20°F

Use: U03
To verify or ensure Inventory Control Safety Function Acceptance Criteria are satisfied.

Cat: C01

Use: U04
To verify or ensure Pressure Control Safety Function Acceptance Criteria are satisfied.

Cat: C01

Use: U05
To verify or ensure RCS and Core heat Removal Safety Function Acceptance Criteria are satisfied.

Cat: C01

Use: U16
To evaluate whether or not automatic control of safety equipment should/may be overridden to regain manual control of affected equipment.

Cat: C02

Use: U19
To provide indirect support for the accomplishment of a safety function.

Cat: C02

Use: U34
To determine if operator actions associated with safety related equipment are necessary to support a safety function.

Cat: C02

Use: U14
To determine if operator actions associated with non-safety related equipment are necessary to provide indirect support of a safety function.

Cat: C02

Engineering Limit(s):

Lower = greater than 0°F subcooling .

Summary:

The engineering limit is based on avoiding saturated conditions (e.g. subcooling = 0°F) in the reactor coolant system, by ensuring some margin to saturation always exists. The lower engineering limit does not include instrument uncertainties, process uncertainties, or operational margin.

An explicit plant specific instrument uncertainty calculation (C01) should be performed on pressurizer pressure and the various temperature instrumentation used by the operator when implementing these instrument applications.

Basis for Engineering Limit(s):

The engineering limit is based on avoiding saturated conditions (e.g. subcooling = 0°F) in the reactor coolant system, by ensuring some margin to saturation always exists. The lower engineering limit does not include instrument uncertainties, process uncertainties, or operational margin.

The lower operational limit on subcooling used in CEN-152, revision 03 was nominally 20°F. The numerical value of this limit is based on engineering judgement. Conceptually, a lower limit on reactor coolant subcooling is used for three different purposes in the EPGs. The manner, specific region, and inputs for determining coolant subcooling to be used depend to a large extent on the specific purpose intended. Coolant subcooling is used in the following ways in the EPGs:

(1) It is one of several parameters (all of which must be satisfied) used to verify adequate core cooling.

(2) It is one of several parameters (any of which may exist) used to determine when and where voiding is occurring in the reactor cooling system.

(3) It is the primary parameter used to validate pressurizer level indication as representative of RCS inventory. That is, if the RCS is subcooled throughout (except for the upper RV head and using all available indications), then pressurizer level provides a usable indication of acceptable RCS inventory.

In addition to the purpose for which the subcooling is to be used, another factor in determining which subcooling input to use (i.e., temperature input) is the mode of RCS core heat removal being employed.

There are five modes of core heat removal addressed in the emergency procedure guidelines. They are:

(1) Forced circulation using RCPs
(2) Natural Circulation (single phase)
(3) Once through cooling ([feed and bleed using PORVs], or SIS flow through the core and out a break)
(4) Reflux cooling (two phase)
(5) Shutdown Cooling System operation

For Core Cooling and Pressurizer level validation, with forced flow, loop T_{hot} is used in the determination of subcooling. For Core Cooling and Pressurizer level validation, on natural circulation, a representative CET temperature is used in the determination of subcooling. For Void detection, the lowest subcooling value calculated is used. In all cases, all other subcooling values are consulted for corroboration, and/or confirmation of expected trends (reference 1).

All CEOG plants have a Subcooled Margin Monitor (SMM) or Safety Parameter Display System (SPDS) designed in part to provide on-line indication of subcooled margin. In addition, P-T curves are contained in the EPGs for used by the operator to back up SMM or SPDS.

The importance of maintaining the RCS fluid in a subcooled single phase liquid state to facilitate adequate core cooling gives this application a high degree of nuclear safety significance.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed on pressurizer pressure and the various temperature instrumentation used by the operator to monitor RCS subcooling during post-accident conditions. The derived values of uncertainty should be conservatively applied to the associated engineering limit when developing plant specific post-accident RCS minimum subcooling P-T curve.

An in depth assessment of the nature and impact of instrument uncertainties on Subcooled Margin was done by CEOG Task 782 and documented in CE NPSD-928-P, February 1994 (Reference 2). Refer directly to CE NPSD-928-P for the associated uncertainty assessment.

In general, when verifying subcooling is adequate to ensure core heat removal, to be conservative, the operator should use the highest expected RCS temperature for existing conditions as input to the subcooling monitor or calculation. Higher temperature correlates to lower subcooling.

When developing the minimum subcooling operating curve, instrument uncertainties should be uniformly applied to the lower engineering limit (0°F curve) in the positive direction. This will result in shifting the curve to the left. The EPGs consistently refer to a [minimum RCS subcooling] margin, without explicitly identifying how much of the [minimum RCS subcooling is operational margin, and how much (if any) is representative of instrument uncertainty. In practice, each utility must select a combination of margin and instrument uncertainty to define the acceptable degree of subcooling. Adding operational margin is, in general, conservative, but only up to a point. The maximum amount of margin may be identified through the use of engineering judgement. If failure to meet the required subcooling during well defined events causes unnecessary abandonment of the optimal recovery procedure and transfer to the functional recovery procedure, the operational margin may be excessive and should be lowered.

Coolant temperature and pressure (i,e, subcooling) may vary with the actual location in the system. Therefore, adequate subcooling at one location could be accompanied by a saturated conditions elsewhere. One example of a system configuration where this would be true is, when a SG is isolated and it is hotter than the rest of the RCS. Operator training should make the operator aware of such conditions and possible variations. It is not necessary to add additional margin to account for these variances in the operational limit. Additionally, there are corroborative indications of when subcooling is lost. If uncertainties should result in indication of adequate subcooling when in reality subcooling has been lost, RVLMS will alert the operator to the situation. The operator will have time to initiate corrective action, because loss of subcooling does not immediately lead to inadequate core cooling.

Harsh containment instrument uncertainties need to be included for the LOCA, ESDE, and FRG subcooling instrument applications.

Potential Margin Loss Options:

The potential for margin loss, and the options for addressing the loss, have been evaluated in detail in Reference 2. The options identified include:

- Use of other indications to compensate for the known effects of the environmental conditions
- Use of other parameter to corroborate (including RVLMS)
- Use of "best estimate" errors rather than the conventional harsh errors
- Use of transmitters less sensitive to the environmental conditions
- Establishment of smaller uncertainties based on additional testing
- Use of multiple instrument loops for indication over specified ranges

References:

1. CEN-152, Section 13, Derivation of RCS Pressure-Temperature Limit Curves

2. CE NPSD-928-P, "Subcooled Margin Monitoring System Possible Solutions to Margin Loss," CEOG Task 782, February, 1994

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 1 - APPLICATION 3

{513}
System Subject Parameter: RCS SUBCOOLING

Value: [minimum RCS subcooling for PTS], nominally 200°F

Use: U04
To verify or ensure Pressure Control Safety Function Acceptance Criteria are satisfied.

Cat: C01

Engineering Limit(s):

Upper = the plant specific limiting value on subcooling that will significantly reduce the possibility of pressurized thermal shock, [nominally 200°F].

Summary:

The potential for pressurized thermal shock is reduced if the RCS temperature and pressure are maintained within acceptable limits. A convenient way to define the acceptable combinations of low temperature and high pressure is to define an upper limit on coolant subcooling.

The generic [200°F] subcooling limit currently used in CEN-152 was not based on specific calculations, but was a best estimate judgement when CEN-152 was initially being developed in the early 1980s. Analyses were not performed to confirm that maintaining subcooling below 200°F would entirely eliminate the possibility of pressurized thermal shock.

An explicit plant specific instrument uncertainty calculation (C01) should be performed on RCS pressurizer pressure and the various temperature instrumentation used by the operator to perform this application.

The CEOG is currently sponsoring a project which will produce a clear technical basis for an upper (PTS) limit on subcooling and provide additional guidance to the operator. When the project is completed, the results will be incorporated into this document and a revision issued.

Basis for Engineering Limit(s):

The generic [200°F] subcooling limit currently used in CEN-152 was not based on specific calculations, but was a best estimate judgement when CEN-152 was initially being developed in the early 1980s. Analyses were not performed to confirm that maintaining subcooling below 200°F would entirely eliminate the possibility of pressurized thermal shock. 200°F was judged to provide a sufficient operating band in order not to interfere with the operator's ability to control the plant and still protect the plant.

The purpose of this limit is to establish the maximum post-accident limit on subcooling to significantly reduce the possibility of pressurized thermal shock following a pressurized thermal shock (PTS) transient. The limit only applies to plants where PTS is an issue. It is the responsibility of each plant make this determination.

A pressurized thermal shock (PTS) transient, as defined by the authors of the EPGs, is an overcooling transient which causes RCS temperature to go below 500°F. The 200°F subcooling line on the Post-Accident PT curves was included to provide an upper limit on subcooling following an overcooling transient as described above.

The upper limit was selected with the understanding that, due to the inability of an operator to control the initial cooldown transient in some cases, it was conceivable that the upper limit would be violated during the first part of the transient. However, inspection of excess steam demand event (ESDE) analyses performed for a generic CE plant, show that this is typically not the case.

The thermal stress imposed on the vessel during an overcooling transient, when combined with the stress due to the RCS pressure, could result in crack initiation within the reactor vessel. The degree to which any reactor vessel may be affected by PTS will vary depending on the vessel age, vessel composition, neutron embrittlement, and other factors. Therefore, the upper engineering limit for PTS is plant specific and will vary over core life. The limit only applies to plants where PTS is an issue. Where it is an issue, the plant should perform the appropriate analysis to determine the upper engineering limit for PTS or to verify the acceptability of using the generic EPG value of 200°F.

10 CFR 50 Appendix G provide requirements associated with RT_{NDT} shift and the Reactor Coolant System (RCS) Pressure-Temperature (P-T) limits. This regulation requires that P-T limits be established in accordance with ASME Boiler and Pressure Vessel Code Section III Appendix G in addition to supplemental requirements. The combined requirements provide a prescriptive method for establishing P-T limits applicable to normal operation. In addition 10 CFR 50.61 establishes limits for the adjusted (irradiated RT_{NDT} for reactor vessel beltline welds and plate materials. These limits, commonly referred to as RT_{PTS} values, are 270°F for plates, forgings and Axial welds, and 300°F for circumferential welds at the vessel inner surface. These limits have been imposed to provide protection against pressurized thermal shock events.

If the vessel is expected to exceed the RT_{PTS} values, the owner/licensee has the options of performing a probabilistic fracture mechanics analysis to demonstrate acceptable risk levels or to perform a thermal anneal of the reactor vessel. Guidance for highly embrittled vessels is provided by Regulatory Guide 1.154 for performing probabilistic fracture mechanics analysis while 10 CFR 50.66 and a draft thermal annealing regulatory guide address thermal annealing. *The CEOG is currently sponsoring a project which will produce a clear technical basis for an upper (PTS) limit on subcooling and provide additional guidance to the operator. When the project is completed, the results will be incorporated into this document and a revision issued.*

The importance of maintaining the integrity of the RCS pressure boundary gives this application a high degree of nuclear safety significance.

Uncertainties Application Assessment:

If a plant specific analysis is done to determine the Engineering limit for PTS as described above, C01 uncertainties should be applied when developing the operational limiting values. If the generic EPG value of 200°F is used, each plant should perform the necessary analysis to determine their plant specific limit in order to validate use of the nominal value.

Potential Margin Loss Options:

The potential for margin loss, and the options for addressing the loss, has been evaluated in detail in Reference 2. The options identified include:

- Use of other indications to compensate for the known effects of the environmental conditions
- Use of "best estimate" errors rather than the conventional harsh errors
- Use of transmitters less sensitive to the environmental conditions
- Establishment of smaller uncertainties based on additional testing
- Use of multiple instrument loops for indication over specified ranges

References:

1. CE letter SE-82-345, "Reactor Vessel Pressurized Thermal Shock," CE Owner's Group Task 464

2. CE NPSD-928-P, "Subcooled Margin Monitoring System Possible Solutions to Margin Loss," CEOG Task 782, February, 1994

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 1 - APPLICATION 4

{514}
System Subject Parameter: RCS SUBCOOLING

Value: 20 °F - 50 °F

Use: U19
To provide indirect support for the accomplishment of a safety function.

Cat: C01 (lower limit)
C02 (upper limit)

Engineering Limit(s):

Lower = greater than 0°F subcooling

Upper = 30°F above the minimum subcooling limit

Summary:

The lower engineering limit ensures that the RCS is sufficiently subcooled to maintain single-phase natural circulation. The upper limit provides an (arbitrary) operating band, 30°F above the minimum subcooling limit.

An explicit plant specific instrument uncertainty calculation (C01) should be performed on pressurizer pressure and the various temperature instrumentation used by the operator to monitor RCS subcooling during post-accident conditions. The derived value of uncertainty should be conservatively applied to the lower engineering limit when developing plant specific lower limit on RCS subcooling. Engineering judgement (C02) may be used to select the upper limit engineering for the operating band.

Basis for Engineering Limit(s):

<u>Lower limit</u>

The lower engineering limit is based on avoiding saturated conditions (e.g. subcooling = 0°F) in the reactor coolant system, by ensuring some margin to saturation always exists. The lower engineering limit does not include instrument uncertainties, process uncertainties, or operational margin. The lower operational limit on subcooling currently contained in the CE Emergency Procedure Guidelines is nominally 20°F. The numerical value of this limit is based on engineering judgement.

Conceptually, a lower limit on reactor coolant subcooling is used for three different purposes in the EPGs. The manner, specific region, and inputs for determining coolant subcooling to be used depend to a large extent on the specific purpose intended. Coolant subcooling is used in the following ways in the EPGs:

(1) It is one of several parameters (all of which must be satisfied) used to verify adequate core cooling.

(2) It is one of several parameters (any of which may exist) used to determine when and where voiding is occurring in the reactor cooling system.

(3) It is the primary parameter used to validate pressurizer level indication as representative of total RCS inventory. That is, if the RCS is subcooled throughout (except for the upper RV head and using all available indications), then pressurizer level provides a usable indication of acceptable RCS inventory.

In addition to the purpose for which the subcooling is to be used, another factor in determining which subcooling input to use (i.e., temperature input) is the mode of RCS core heat removal being employed.

There are five modes of core heat removal addressed in the emergency procedure guidelines. They are:

(1) Forced circulation using RCPs
(2) Natural Circulation (single phase)
(3) Once through cooling ([feed and bleed using PORVs], or SIS flow through the core and out a break)
(4) Reflux cooling (two phase)
(5) Shutdown Cooling System operation

For Core Cooling and Pressurizer level validation, with forced flow, loop T_{hot} is used in the determination of subcooling. For Core Cooling and Pressurizer level validation, on natural circulation, a representative CET temperature is used in the determination of subcooling. For Void detection, the lowest subcooling value calculated is used. In all cases, all other subcooling values are consulted for corroboration, and/or confirmation of expected trends.

All CEOG plants have a Subcooled Margin Monitor (SMM) or Safety Parameter Display System (SPDS) designed in part to provide on-line indication of subcooled margin. In addition, P-T curves are contained in the EPGs for used by the operator to back up SMM or SPDS.

The importance of maintaining the RCS fluid in a subcooled single phase liquid state to facilitate adequate core cooling gives this application a high degree of nuclear safety significance.

Upper limit

The upper engineering limit is based on engineering judgement. The purpse of the limit is to set an upper bound on RCS sucooling during a blackout to prevent excessive RCS leakage.

The station blackout event is characterized by a loss of RCS inventory and pressure control. The rate at which these losses occur depends on the extent of any RCS leakage (for example, through pre-existing leaks in the steam generator tubes or through the RCP seals). Such leakage will cause a decrease in RCS inventory and pressure, because no make-up flow can be delivered during the blackout. Any leakage from the pressurizer steam space (via the safety valves or the PORVs) will cause an even more rapid decrease in the RCS pressure. Heat removal is maintained by natural circulation.

Eventually, the RCS pressure decrease will result in reaching saturation conditions and heat removal process will transition to a two-phase process. Since the single-phase natural circulation process is better understood and simpler for the operators to control, the station blackout guideline strategy is to maintain the single-phase natural circulation for as long as possible. This is accomplished by controlling the cooldown rate and associated de-pressurization rate (feeding and steaming the steam generators) to maintain saturation margin in the range of [20 to 50]°F.

The intent of the upper limit is to limit the lose of RCS inventory during a blackout. Cooldown of the RCS should be minimized. In the absence of any RCS make-up capability, the volume shrinkage which accompanies a cooldown will only aggravate the loss of inventory control, and could conceivably eventually lead to uncovering the core. The [50]°F value was selected by the EPG writers based on engineering judgement and simulator exercises, to provide a reasonable and achievable operating band.

Uncertainties Application Assessment:

Lower limit

An explicit plant specific instrument uncertainty calculation (C01) should be performed on pressurizer pressure and the various temperature instrumentation used by the operator to monitor RCS subcooling during post-accident conditions. The derived values of uncertainty should be conservatively applied to the associated engineering limit when developing plant specific post-accident RCS minimum subcooling P-T curve.

An explicit plant specific instrument uncertainty calculation (C01) should be performed and conservatively applied to the lower engineering limit when developing plant specific lower limit on RCS subcooling. For consistency, the derived lower operating limit [20] °F should be used consistently throughout the EOPs.

Upper limit

Engineering judgement (C02) may be used to select the upper limit engineering for the operating band. The chosen upper limit should accommodate the expected post trip pressure response to allow adequate maneuvering room for the operator and still limit system pressure to conserve system inventory. Since the ultimate upper operational limit is arbitrary, instrument uncertainties need not be explicitly accounted for.

Potential Margin Loss Options:

Not applicable

References:

1. CE NPSD-928-P, "Subcooled Margin Monitoring System Possible Solutions to Margin Loss," CEOG Task 782, February, 1994

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:______________________________

PAUL KRAMARCHYK / Paul B Kramarchyk / 4/12/96

Independent Reviewer: Name/Signature/Date

PRESSURIZER
PRESSURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2

PRESSURIZER PRESSURE{52}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind. Reviewer	Approver
Draft	08/31/95	ALL	Max	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Kramarchyk	Greene
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul Kramarchyk	[signature]	11/12/96
Name Independent Reviewer	Signature	Date

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

**EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT**

MODULE 5 - DOCUMENT 2 - APPLICATION 1

{521}
System Subject Parameter: PRESSURIZER PRESSURE

Value(s): [SDC Entry Pressure], Nominally

Use: U25
To verify operation within the design limits to prevent damage to safety related SSCs.

Cat: C01

Use: U20 To determine when to activate a safety related SSC for which no automatic initiation is provided in support of a safety function, safe shutdown, cooldown or depressurization.

Cat: C01

Use: U34 To determine if operator actions associated with safety related equipment are necessary to support a safety function.

Cat: C02

Engineering Limit(s):

Upper = shutdown cooling system design pressure.

Summary:

The engineering limit is based on the design pressure of the shutdown cooling system components. During post accident conditions, the shutdown cooling system may be placed in operation when the RCS has been depressurized to the point that the shutdown cooling system will not be exposed to pressures greater than its design pressure.

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. In addition to instrument uncertainties, such factors as the relative location (elevation) of the Pressurizer pressure instruments, with respect to the SDC system, should be accounted for in the operational limit.

Basis for Engineering Limit(s):

The upper engineering limit is based on the shutdown cooling system design pressure. The shutdown cooling system may be placed in operation when the RCS has been depressurized to the point that the shutdown cooling system will not be exposed to pressures greater than its design pressure.

The operational limit (including the instrument uncertainties described below) should be compared to the setpoint of the permissive interlock which prevents opening of the shutdown cooling suction line isolation valves. The operational limit used in the procedures should be adjusted if necessary, to avoid instructions to initiate shutdown cooling operation at pressures above the permissive setpoint.

This application is used in shutdown cooling system entry criteria throughout the EPGs . Aligning the SDC for operation before the RCS has been sufficiently depressurized could initiate an intersystem LOCA with severe consequences.

Due to its relationship to safe shutdown and cooldown of the plant this instrument application is considered to have a high degree of nuclear safety significance.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit. In addition to instrument uncertainties, such factors as the relative location (elevation) of the Pressurizer pressure instruments, with respect to the SDC system, should be accounted for in the operational limit.

Adjusting the engineering limit for instrument uncertainties is necessary to meet the intent of the limit for the following reasons:

1) The engineering limit is based on an explicit design value which is being used to ensure that the SDC system is protected from high pressure conditions.

2) The application of instrument uncertainties in the conservative direction (low side) is necessary to create an unambiguous bounding lower limit, below which the operator can be certain that SCS design pressure will not be exceeded.

3) This application relates to maintaining RCS pressure boundary integrity and control of RCS inventory.

Harsh containment instrument uncertainties need to be applied for the LOCA, ESDE, and FRG instrument applications.

Potential Margin Loss Options:

The operational "window" for reaching shutdown cooling system operation is bounded on the upper side by the SDC system entry pressure. There is no lower limit directly associated with the SDC system. However, RCP NPSH requirements must be considered if SDC entry is accomplished under forced flow conditions. Narrowing of this window could be countered by:

- Securing the RCPs just before the final depressurization to SDC entry pressure. The plant Technical Specifications must be reviewed for limits on operation with the RCPs secured.

- Re-evaluation of RCP operating limits. The pump vendor may be able to provide less restrictive pressure requirements for short-term operation. Typically, operating the RCP with lower suction pressure is permitted for limited time periods if the pump seal temperatures and pressures are monitored.

References:

1) CE Calculation N-PEC-13 / B-PEC-77 / F-PEC-55, "Limitations on Initiation of Shutdown Cooling," 6/30/71

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 2

{522}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Post Accident PT Curves]

Use: U04
To verify or ensure Pressure Control Safety Function Acceptance Criteria are satisfied.

Cat: C01

Use: U19
To provide indirect support for the accomplishment of a safety function.

Cat: C02

Use: U25
To verify operation within the design limits to prevent damage to safety related SSCs.

Cat: C01

Engineering Limit(s):

Pressure/Temperature limits as derived for the plant specific P-T limit curves.

Summary:

The P-T limit curves establish operating limits that provide a margin to brittle failure of the reactor vessel and piping of the reactor coolant pressure boundary (RCPB). Instrument uncertainties must be applied when deriving the plant specific P-T curves for accident conditions.

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limits when determining the plant specific P-T limit curves.

The CEOG is currently sponsoring a project which will address post accident cooldown rates, P-T limits and provide additional guidance to the operator. When the project is completed, the results will be incorporated into this document and a revision issued.

Basis for Engineering Limit(s):

The plant Technical Specifications establish operating limits that provide a margin to brittle fracture of the reactor vessel and piping of the Reactor Coolant Pressure Boundary (RCPB). 10 CFR 50, Appendix G (Ref. 2), requires the establishment of P/T limits for material fracture toughness requirements of the RCPB materials. Reference 2 requires an adequate margin to brittle failure during normal operation, anticipated operational occurrences, and system hydrostatic tests. It mandates the use of the ASME Code, Section III, Appendix G.

The P-T limit curves are composite curves established by superimposing limits derived from stress analyses of those portions of the reactor vessel and RCS that are the most restrictive. At any specific pressure, temperature, and temperature rate of change, one location within the reactor vessel or RCS will dictate the most restrictive limit.

Across the span of the P-T limit curves, different locations are more restrictive, and, thus, the curves are a composite of the most restrictive regions.

The consequence of violating the LCO limits is that the RCS has been operated under conditions that can result in brittle fracture of the RCPB, possibly leading to a non-isolable leak or loss of coolant accident.

P-T limits are derived for the pressure retaining components of the RCPB to provide adequate margins of safety during any condition of normal operation, including anticipated operational occurrences and system hydrostatic tests. The purpose of the P-T curve is to protect the RCPB from stresses that exceed the fracture toughness requirements of 10 CFR 50, Appendix G (Ref. 2); and thereby limit the risk of RCPB failure.

Maintaining the RCS within these P-T limits is addressed throughout the EPGs .

The CEOG is currently sponsoring a project which will address post accident cooldown rates, P-T limits and provide additional guidance to the operator. When the project is completed, the results will be incorporated into this document and a revision issued.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limits when determining the plant specific P/T limit curves.

Harsh containment instrument uncertainties need to be applied for the LOCA, ESDE, and FRG instrument applications.

Potential Margin Loss Options:

None

References:

1. NUREG-1432, CEOG ISTS, revision 1, 04/07/95, LCO 3.4.3 and associated Bases

2. 10 CFR 50, Appendix G

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 3

{523}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Minimum RCP NPSH Limits]

Use: U10
To monitor the operation of non-safety related equipment to prevent equipment damage that otherwise might lead to an adverse impact on one or more safety functions.

Cat: C02

Engineering Limit(s):

Lower = reactor coolant pump suction pressure that meets or exceeds the minimum NPSH and pump seal pressure requirements.

Summary:

Operation of the RCPs must be limited to those conditions that adequate Net Positive Suction Head (NPSH) is available to prevent pump cavitation and damage. The RCP seals also require a minimum pressure for proper operation.

This application is used throughout the EPGs to verify proper operation of the RCPs . This is to protect the RCPs from damage and to protect against RCP seal damage, with a resulting LOCA. Therefore, this application is considered to have a moderate degree of nuclear safety significance. Category (C02) instrument uncertainties should be applied.

Basis for Engineering Limit(s):

Operation of the RCPs must be limited to those conditions that adequate Net Positive Suction Head (NPSH) is available to prevent pump cavitation and damage. The RCP seals also require a minimum pressure for proper operation. The pump suction pressure requirements are usually established by the pump vendor.

This application is used throughout the EPGs to verify proper operation of the RCPs . This is to protect the RCPs from damage and to protect against RCP seal damage, with a resulting LOCA. Therefore, this application is considered to have a moderate degree of nuclear safety significance.

Uncertainties Application Assessment:

The two constraints on RCP operation are normally combined into a single curve plotted on the P-T limit curves. Operation of the RCPs is prohibited below this curve. The effects of instrument uncertainty and elevation head are typically included in the curves, such that the curves are presented in terms of *indicated* pressure vs. *indicated* temperature. Category (C02) instrument uncertainties should be applied for the following reasons:

- Damage and subsequent failure of RCP seals may cause a LOCA, and thus complicating recovery from the event in progress,
- Application of instrument uncertainty is consistent with the approach taken regarding the other curves which accompany the RCP NPSH curve on the P/T limits

Potential Margin Loss Options:

If the RCP operating limits restrict the window for entering shutdown cooling system operation, the pump vendor may be able to provide less restrictive pressure requirements for short-term operation. Typically, operating the RCP with lower suction pressure is permitted for limited time periods if the pump seal temperatures and pressures are closely monitored.

Consideration should also be given to the effects resulting from operation of one or several reactor coolant pumps. It may be beneficial to operate the RCPs in a preferred pump combination, to take maximum advantage of the available pressure.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 4

{524}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Expected Post-Trip Band], nominally 1700 - 2350 psia.

Use: U11
To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = maximum expected post trip value for an uncomplicated reactor trip.

Lower = minimum expected post-trip value for an uncomplicated reactor trip.

Summary:

The intent of this application is to verify that Pressurizer pressure is within the expected range following an uncomplicated reactor trip.

Instrument uncertainties need not be applied for this EOP application because the limits are nominal in nature.

Basis for Engineering Limit(s):

The intent of this application is to verify that Pressurizer pressure is within the expected range following an uncomplicated reactor trip. The upper limit is typically consistent with the high pressure alarm setpoint [2350] psia. The lower limit is typically consistent with the low pressure alarm setpoint [1700] psia.

The instructions to verify that the pressure is within this range are included in the standard post trip actions to check that the pressure control Safety Function is being satisfied and to determine if an event beyond an uncomplicated trip may be in progress. Pressure outside of this range provides diagnostic information to the operators.

This application has a low safety significance.

Uncertainties Application Assessment:

This application is category 03. Instrument uncertainties need not be applied because the limits are nominal in nature.

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 5

{524}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [PORV Setpoint], nominally, 2400 psia.

Use: U11
To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = the setpoint for automatic opening of the PORV.

Summary:

The Pressurizer Code Safety Valves provide over pressure protection for the RCS. The PORVs provide for pressure control. If the PORVs do not open, the code safeties will protect the RCS. If they do not close, Safety Injection will protect the RCS.

The plant specific EOPs should refer to the PORV opening setpoint. No additional instrument uncertainties should be applied.

*This application is only applicable to plants that have PORVs.

Basis for Engineering Limit(s):

The Pressurizer Code Safety Valves provide over pressure protection for the RCS. The PORVs provide for pressure control. As such their setpoint has a moderate degree of safety significance. If the PORVs do not open, the code safeties will protect the RCS. If they do not close, Safety Injection will protect the RCS.

The operators are instructed to verify that the PORVs open at their automatic setpoint, and if the valves fail to open automatically, they should be opened manually. This application is also used in the LOCA guideline, which directs the operators to check for inadvertent PORV opening as the cause of the LOCA. If the PORVs are open and the pressure is below the automatic opening setpoint, the operators are directed to ensure PORV (or block valve) closure to isolate the LOCA.

Additional instrument uncertainties were not applied by the EPG authors in arriving at the operational limit.

Uncertainties Application Assessment:

The plant specific EOPs should refer to the PORV opening setpoint. No additional instrument uncertainties should be applied. This application is used to ensure proper automatic functioning of the PORVs. A lack of absolute instrument accuracy will not inhibit accomplishment of the intended function.

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 6

{526}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [SIT Isolation Pressure], nominally 250 psia.

Use: U39
To determine when to remove a safety system from service for which automatic actuation would complicate the operator's ability to perform a controlled shutdown of the plant.

Cat: C03

Engineering Limit(s):

Upper = maximum Safety Injection Tank (SIT) pressure (as specified in the plant Technical Specifications).

Summary:

The SITs are isolated, vented, or drained to prevent them from discharging into the RCS during a controlled plant depressurization. Inadvertent SIT injection could disrupt the cooldown and depressurization, but it will not prevent the accomplishment of any safety function.

Instrument uncertainty need not be applied for this application.

Basis for Engineering Limit(s):

The SITs are isolated, vented, or drained to prevent them from discharging into the RCS during a controlled plant depressurization . For plants with high pressure SITs, this may be necessary to allow the plant to be brought to shutdown cooling system entry conditions.

Under certain conditions, discharge from the SITs can cause the RCS pressure to "hang up," extending the time required to depressurize to SCS system entry pressure. The concern here is that the time could be extended to the point where condensate inventory is depleted before the SDC can be placed in service (References 1 through 5).

Inadvertent SIT injection could eventually allow the Nitrogen cover gas to enter the RCS. This is not desirable. However, before nitrogen would enter the RCS, a protracted SIT injection must first occur. The time required to inject the contents of the SITs and depressurize is considerable. Within this period of time, it is reasonable to expect that the operator will discover the situation and initiate corrective action to prevent Nitrogen from entering the RCS.

Inadvertent SIT injection could disrupt the cooldown and depressurization, but it will not prevent the accomplishment of any safety function. Since a lack of absolute instrument accuracy will not inhibit accomplishment of the intended function, these applications possess a low degree of nuclear safety significance.

Uncertainties Application Assessment:

Instrument uncertainty need not be applied for this application. The isolation and venting of the SITs is important, but the precise point of initiation is not. Injection of a limited amount of water from a SIT is not a safety issue, but rather a operational issue. In the event that SIT started to discharge, SIT level and pressure would be trending downward as the SITs drained (alarms would actuate), and this would alert the operator to the fact that the SITs were discharging.

When selecting an operational value, it is reasonable to use engineering judgment to apply sufficient operational margin to the engineering limit to ensure that the SITs will not inject during a controlled cooldown/depressurization. Since the actual SIT pressures at any given time cannot be predicted in advance, it would be prudent to base the operational limit on the maximum SIT pressure permitted by the Technical Specifications.

Potential Margin Loss Options:

Not applicable

References:

1. CE Letter to Ebasco L-CE-1287, "PSL-2 Post LOCA Cooldown to Shutdown Cooling Actuation," A. S. Jameson to T. O. Mathisen, dated 3/19/76

2. CE Interoffice Correspondence LOCA-76-231, "Mitigation of Undesirable SIT Injection Following a Small Break LOCA," L. E. Anderson to W. R. Corcoran, dated 4/2/76

3. CE Interoffice Correspondence LOCA-76-254, "Meeting on Small Break SIT Injection Problem," L. E. Anderson to W. R. Corcoran, dated 4/12/76

4. CE Interoffice Correspondence PSD-82-122/604, "Injecting SIT Cover Gas into the RCS," J. J. Connolly to T. E. Krauser, dated 4/1/82

5. CE Letter to FPL, REL-84-F2-041, "Explanation of C-E Recommended Post-LOCA Emergency Operating Procedures to Isolate or Vent SIT's and for Initiating Hot/Cold Side Injection," E. L. Trapp to C. G. O'Farrill, dated 5/3/84

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 7

{527}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Lowest MSSV Setpoint], nominally 1000 psia.

Use: U27
To prevent or mitigate off-site exposure to the public.

Cat: C01

Engineering Limit(s):

Upper = less than the equivalent pressure to the lowest set Main Steam Safety Valve (MSSV), including lift tolerance.

Summary:

The bases for the engineering limit is the lift setpoint of the lowest MSSV, plus lift tolerance. An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

Basis for Engineering Limit(s):

The bases for the engineering limit is the lift setpoint of the lowest MSSV, plus lift tolerance.

The intent of the application is prevent lifting an MSSV, with the potential for it sticking open, resulting in an uncontrolled release to the environment during a SGTR, because the operator would not be able to do anything to stop it. The CEN-152, Revision 03 operational limit [≤ 950 psia] was derived by taking the lowest MSSV setting [1000 psia.], subtracting the lift tolerance, typically ±1% (Ref. 1), [± 10 psi], and additional operational margin [40 psi].

This application appears in the steam generator tube rupture guideline , and in the Heat Removal Success Paths in the Functional Recovery Guideline. The instructions are to maintain the RCS pressure approximately equal to the pressure in the isolated steam generator, and less than [lowest MSSV setpoint] .

This upper limit on the RCS pressure is intended to minimize the potential for the RCS pressurizing the steam generator (through the tube leak), to the point where the secondary safety valves would lift. This is to be avoided, because such a scenario presents an uncontrolled leak path from the RCS to the atmosphere.

Steam Generator pressure is used to back up this application. Should the pressure in the isolated SG approach the lift setpoint for the isolated SG MSSVs, it is more desirable from the perspective of positive operator control, that the ADVs open first. This is accomplished by raising the automatic ADV lift setpoint to the upper end of [expected positive band]. To minimize release of radioactivity to the environment, opening the affected SG ADVs should be minimized. This instrument application relates to preventing and minimizing uncontrolled and unmonitored releases to the environment, therefore minimizing off-site exposure to the public during certain accidents. This instrument application helps ensure that the assumptions in accident analysis associated with off-site exposure during design basis events (DBEs) are not exceeded.

Instrumentation used to mitigate off-site exposure to the public has a high priority in 10 CFR 50 Appendix A criteria. Therefore, this instrument application is considered to have a high degree of nuclear safety significance. The ultimate safety significance is based on plant specific safety analyses.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

The application of instrument uncertainties is important to carrying out the intent of this particular instrument application due to its relationship to off-site exposure to the public as described in the bases section. The plant specific engineering limit is derived as described in the bases section (i.e., MSSV setpoint minus lift tolerance). The plant specific operational limit is arrived at by subtracting plant specific pressure instrument uncertainties from the plant specific engineering limit.

This application is used in SGTR and in the Functional Recovery Procedure. Consequently, harsh containment instrument uncertainties need to be applied for the FRG instrument application.

Potential Margin Loss Options:

Reference 2 contains instructions for maintaining the isolated SG pressure below the MSSV set pressure by steaming through the ADVs.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 8

{528}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [HPSI Pump Shutoff Head], nominally 1300 psia.

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Upper = shutoff head of the HPSI pumps.

Summary:

The engineering limit is based on the nominal shutoff head of the HPSI pumps. This application is used in two different ways in the EPGs. The first is in the acceptance criteria for Once-Through-Cooling and the second is in the RCP restart criteria.

Instrument uncertainties need not be applied.

Basis for Engineering Limit(s):

The engineering limit is based on the shutoff head of the HPSI pumps, nominally [1300] psia.

This application is used in two different ways in the EPGs. The first appears in the Functional Recovery Guideline, Heat Removal safety function, success path HR-4 (Once- Through-Cooling). This success path requires that the RCS pressure be decreased below the shutoff head of the HPSI pumps to ensure SIS flow. When Once-Through-Cooling (OTC) is lined up, i.e. ADVs opened and PORVs opened, pressurizer pressure will decrease to a point where it is being controlled by the HPSI pumps. Observing HPSI pump flow is positive indication that OTC is established.

The second use is in RCP restart instructions to determine whether or not HPSI pumps will deliver flow to the RCS based on system pressure, otherwise there is no reason to start the HPSI pumps. RCP restart may result in pressurizer level decreasing, when any existing voids are condensed by the forced circulation flow. In anticipation of this, the guidelines instruct the operators to run the charging pumps prior to the RCP restart, and if the RCS pressure is below the HPSI pump shutoff head, to operate HPSI pumps as needed to control pressurizer level.

Both applications possess a low degree of nuclear safety significance. In the first case, O-T-C initiation, the operator is instructed to do everything possible to lower RCS pressure, thus ensuring HPSI flow is initiated. It is reasonable to expect that it will decrease to within the capacity of the HPSI pumps. Therefore, the explicit value of pump shutoff head is only a reference point. Pressurizer pressure "decreasing" is the primary desired indication.

Uncertainties Application Assessment:

Instrument uncertainties need not be explicitly applied for these application.

In the first application, pressurizer pressure is used as one of several indications that ensure OTC is established. The primary indications of successful OTC are safety injection flow and RCS temperature stable or decreasing. Pressurizer pressure less than the shutoff head of the HPSI pumps and pressurizer pressure decreasing is a prerequisite to flow.

In the second use, the operators are simply identifying whether or not ~~is~~ it would make ~~since~~ sense to operate the HPSI pumps. Operating or not operating HPSI pumps in this case will only affect the time required to establish the desired pressurizer level.

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 9

{529}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [SBLOCA Plateau Pressure], nominally 1300 psia.

Use: U73
To determine if operator actions associated with non-safety related equipment are necessary to directly support an EPG strategy.

Cat: C01

Engineering Limit(s):

Lower = plant specific maximum "pressure plateau" value analytically determined for selected small break LOCAs.

Summary:

The engineering limit is a plant specific value based on small break LOCA analyses. The limit is, essentially, the maximum "pressure plateau" value observed for selected small break LOCAs.

Category (C01) instrument uncertainties must be applied when deriving the plant specific limit to be used to ensure that the first to two RCPs are tripped in accordance with the Trip Two Leave Two strategy.

Basis for Engineering Limit(s):

Lower Limit

The engineering limit is based on the "pressure plateau" for small break LOCA as determined by analyses (Reference 1). These analyses form the bases for the "Trip Two Leave Two" strategy for tripping the RCPs. The lower limit is based on the fact that following a small break LOCA, the RCS pressure stabilizes at a pressure sufficiently high above the steam generator secondary side pressure to remove the core fission product decay heat. The RCS pressure stabilization is referred to as the "pressure plateau".

Based on the results of the analyses, the nominal setpoint for tripping the first two RCPs is 1210 psia for the 2700 MWt plants, and 1320 psia for ANO-2, and 1361 psia for 3400 MWt plants. Instrument uncertainty are not included in these values. The nominal operational value chosen for the reference plant was [1300] psia, which includes instrument uncertainties. Reference 2 specifically states that instrument uncertainties must applied when developing the plant specific operational limit.

The T2/L2 strategy is aimed at ensuring all RCPs are tripped in the case of a LOCA. The trip scheme provides for at least two RCPs to remain operating for non-LOCA events (SLBs, SGTRs, and AOOs. It is beneficial to trip all RCPs during large break LOCA events to minimize the loss of coolant from the primary system. Conversely, for non-LOCA events involving system depressurization, it is beneficial to keep one or more RCPs running in the interest of maintaining the availability of the main spray flow to the pressurizer for RCS pressure control. In addition, the RCP operation provides better plant control by the operators, by minimizing voiding of the reactor vessel upper head/upper plenum region due to forced coolant flow through this region. RCP operation also provides for better mixing in the reactor vessel downcomer/lower plenum region minimizing PTS concerns.

In the T2/L2 strategy, two RCPs are tripped when RCS pressure falls below a pressure plateau value, and the remaining two RCPs are tripped if pressure continues to decrease and minimizing RCS subcooling is lost.

This use applies to instrument applications associated with non-safety related SSCs that provide direct support of an EPG strategy (in this case, the RCP T2/L2 strategy). The application possesses a high degree of nuclear safety significance because of its relationship to LOCA analyses.

Uncertainties Application Assessment:

An explicit plant specific instrument uncertainty calculation (C01) should be performed for pressurizer pressure instrumentation for this application. The derived uncertainties should be applied to the plant specific engineering limit when determining the appropriate plant specific operational limit.

The application of instrument uncertainties is important to carrying out the intent of this particular instrument application because it may impact the severity of LOCAs. The plant specific engineering limit is derived as described in the bases section. The plant specific operational limit is arrived at by adding plant specific instrument uncertainties to the pressure plateau value (i.e. the plant specific engineering limit).

This application is used in LOCA applications throughout the EPGs. Consequently, harsh containment instrument uncertainties need to be applied for the FRG instrument application.

Potential Margin Loss Options:

Application of uncertainty to the engineering limit is not expected to result in unacceptable margin loss. This particular application has been the subject of extensive review, analysis and simulator exercises. The effects of uncertainty on the setpoint are considered to be well established.

References:

1. CEN 268, Revision 1

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 10

{5210}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Expected PORV Closure Pressure], nominally 2340 psia.

Use: U11
To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = PORV closure pressure (pressure at which the valve open signal is removed).

Summary:

This instrument application is used in the Functional Recovery Guideline, Pressure Control Success Path PC-2 (PORVS/Pzr Vent) , as part of the PORV closure criteria. These criteria include verifying that the PORVs have reduced the RCS pressure to the PORV closure setpoint.

Instrument uncertainties need not be applied to the engineering limit.

*This application is only applicable to plants that have PORVs.

Basis for Engineering Limit(s):

This instrument application is used in the Functional Recovery Guideline, Pressure Control Success PC-2 (PORVS/Pzr Vent) , as part of the PORV closure criteria. These criteria include verifying that the PORVs have reduced the RCS pressure to the PORV closure setpoint. The closure setpoint for the PORVs is plant specific and depends on the detailed design of the valves and their controls. Typically, the closure pressure is several percent below the opening pressure, to minimize valve cycling near the opening pressure. It is also desirable for the closure pressure to be below the RCS high pressure alarm setpoint.

In the context of the Pressure Control success path acceptance criteria, this instrument application is used to verify that the safety function is being satisfied. As such, it is considered to have a high degree of nuclear safety significance.

Uncertainties Application Assessment:

Additional instrument uncertainties need not be applied to the engineering limit. The other PORV closure criteria, particularly the requirement that pressure be constant or decreasing, are more significant than the actual pressure at which the PORV closes. As stated above, the automatic closing setpoint for the valves is plant specific, and is therefore somewhat arbitrary with respect to ensuring the safety functions. For consistency, the operational limit used in the EOPs should refer to the plant specific PORV closure pressure (or the pressure at which the valve open signal is removed).

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 11

{5211}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [LPSI Pump Shutoff Head], nominally 200 psia.

Use: U69
To verify a parameter is in agreement with "Normal Values" provided in SSC design criteria or Safety Analysis.

Cat: C03

Engineering Limit(s):

Upper = shutoff head of the LPSI pumps.

Summary:

The engineering limit is based on the nominal shutoff head of the LPSI pumps. This application is used to direct securing the pumps following a LOCA when RCS pressure remains greater than the shutoff head.

Instrument uncertainties need not be applied.

Basis for Engineering Limit(s):

The engineering limit is based on the shutoff head of the LPSI pumps, nominally [200] psia.

The LPSI pump termination criteria used throughout the EPGs states that the pumps may be stopped if RCS pressure is greater than the shutoff head and controlled . If the pressure is above the shutoff head, the pumps are not delivering any flow to the RCS and are not contributing to maintaining the safety functions. If the pressure is expected to be maintained above the shutoff head (i.e., "controlled"), then the pumps may be stopped.

This instrument application possesses a low degree of nuclear safety significance and is used corroboratively. Termination criteria always consist of more than one independent process parameters. In addition, the SFSCs (which are Category 1) will verify whether the parameters stay within the appropriate ranges.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied to this application. The indicated pressurizer pressure which corresponds to the LPSI pumps operating at shutoff is, to some extent, event specific. Variations in the pump suction pressure, the RCS and pressurizer levels, and the high pressure injection flow rate would all influence the pressurizer pressure at shutoff. The SI pump termination criteria are always followed by restart criteria, which will assure that if the LPSI pump operation were actually contributing to plant stability, the pumps would be restarted. Since the restart criteria are based on trending parameters, instrument uncertainties need not be applied to them, either.

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 12

{5212}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [Normal Control Band], nominally 2225 - 2300 psia.

Use: U11
To verify plant parameters are in the normal or expected post-trip range.

Cat: C03

Engineering Limit(s):

Upper = upper end of the normal control band for the pressurizer pressure control system.

Lower = lower end of the normal control band for the pressurizer pressure control system.

Summary:

Following an uncomplicated reactor trip, the pressurizer pressure control system should function to restore pressure to within the specified range.

Instrument uncertainties need not be applied. The procedures should refer to the pressurizer pressure control system setpoint values.

Basis for Engineering Limit(s):

Following an uncomplicated reactor trip, the pressurizer pressure control system should function to restore pressure to within the specified range. If the pressure is not trending towards this range, the operators should take manual control of the heaters and sprays to bring the pressure into this range.

This instrument application is used to help verify that the control systems are functioning properly to control the pressurizer pressure within the normal post-trip range. It does not substantially impact a safety function. The safety function status check provides the verification that the safety function is being satisfied. This application, therefore, possesses no nuclear safety significance.

Uncertainties Application Assessment:
Instrument uncertainties need not be applied. The procedures should refer to the pressurizer pressure control system setpoint values. The specific setpoint values and actual inputs should be used to determine if the system is working properly. If instrument uncertainties are applied then the assessment cannot be performed based on the *actual* operating parameters.

Potential Margin Loss Options:

Not applicable.

References:

None

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 13

{5213}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [approximately equal] to Isolated SG Pressure, nominally $\pm$ 50 psi.

Use: U69
To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.

Cat: C03

Engineering Limit(s):

Upper = 50 psi greater than SG Pressure

Lower = 50 psi less than SG Pressure

Summary:

The engineering limits provide an operational band that minimizes backflow, while at the same time permitting back flow to control SG level or to aid in cooldown of the affected SG. The 50 psi band is a nominal value.

Instrument uncertainties need not be applied because $\pm$ 50 psi is a "nominal" value. It is a theoretical value considered to be a reasonable estimate of the capability of the operators, using typical plant instrumentation.

Basis for Engineering Limit(s):

The engineering limits provide an operational band that minimizes backflow, while at the same time permitting back flow to control SG level or to aid in cooldown of the affected SG. The 50 psi band is a nominal value.

Maintaining the RCS pressure approximately equal (± 50 psi) to the isolated steam generator pressure will accomplish two goals:

1) minimize the loss of primary fluid to the secondary side and the possibility of overfilling the isolated steam generator;
2) minimize the amount of unborated water flowing into the RCS from the steam generator which could reduce the RCS boron concentration.

During a SGTR event and the subsequent cooldown, the operator should make every attempt to maintain a zero differential pressure between the RCS and the affected SG (during NC or forced circulation) (Reference 2). Reference 1 recognized that maintaining the differential pressure at the tube break at exactly 0 psid would be impossible given the limitations of the available instrumentation. However, references 2 and 3 shed additional light on the subject. They conclude that the best way to determine that zero differential pressure exists is by trending SG level (preferably NR) and Pressurizer level, while maintaining temperatures and inventory stable. They use this method to determine the indicated SG pressure and indicated Pressurizer pressure when zero differential exists by establishing a stable SG level with stable RCS inventory control.

The upper limit allows the operator to maintain the pressurizer pressure greater than steam generator pressure to permit flow of RCS fluid into the steam generator. Maintaining the RCS pressure approximately equal to the isolated SG pressure (+ 50 psi) will minimize the loss of primary fluid to the secondary side. Alternately, the pressure is lowered to less than SG pressure to control level in the steam generator (Ref. 1).

This lower limit allows the operator to maintain pressurizer pressure less than steam generator pressure to permit backflow of steam generator fluid into the RCS to help reduce steam generator level. This helps prevent steam generator overfill and possible damage to the main steam lines and main steam safety valves. Reference 1 presents calculations which demonstrate that, if the RCS could be instantaneously diluted by the entire mass of a non-borated steam generator, other effects on reactivity would prevent a reactor restart. Reference 1 concludes that the flowrate established by a 50 psid differential pressure will not threaten the maintenance of adequate shutdown margin. Therefore, the lower engineering limit for pressurizer pressure will equal the steam generator pressure less 50 psi.

Uncertainties Application Assessment:

Instrument uncertainties need not be applied because ± 50 psi is a "nominal" value. It is a theoretical value considered to be a reasonable estimate of the capability of the operators, using typical plant instrumentation. The ± 50 psi limit is not a precisely calculated value, and maintaining the differential pressure within this range is not necessary to prevent equipment damage or to verify a safety function. Therefore, this instrument application possesses no nuclear safety significance.

Potential Margin Loss Options:

Not applicable.

References:

1. CE-NPSD-407, NSSS Response to Operator Actions During Postulated Events for Resolution of C-E Emergency Procedure Guidelines SER Items, March 1987.

2. CE-NPSD-926, Evaluation of Steam Generator Back Flow During a Tube Rupture Event, February 1994.

3. CE-NPSD-990, Evaluation of the Effects of Intentional Backflow to Cool (depressurize) a Ruptured Steam Generator During a SGTR Event, March 1995.

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 2 - APPLICATION 14

{5214}
System Subject Parameter: PRESSURIZER PRESSURE

Value: [SIAS Setpoint], nominally 1600 psia.

Use: U13
To verify automatic actuation of the ESFAS due to its setpoint being exceeded, or to indicate directly to the operator to manually actuate the safety systems associated with those setpoints since they failed to automatically actuate.

Cat: C03

Engineering Limit(s):

Lower = the Technical Specification (TS) ALLOWABLE TRIP setpoint for SIAS.

Summary:

The bases for the engineering limit is the same as the bases for the TS ALLOWABLE VALUES for SIAS. The operational limit is the same as the engineering limit. The engineering limit establishes the decreasing Pressurizer pressure value at which automatic controls activate to initiate Safety Injection, independent of operator action.

No uncertainty should be applied to the engineering limit, which is the ESFAS actuation setpoint. Since the intent is to verify Safety Injection System Actuation, it serves no useful purpose to add additional uncertainties to those already applied to establish the SIAS setpoint, which is category (C01).

Basis for Engineering Limit(s):

The bases for the engineering limit is the same as the bases for the TS ALLOWABLE VALUES for SIAS. The operational limit is the same as the engineering limit. The engineering limit establishes the decreasing pressurizer pressure value at which automatic controls activate to conserve and restore RCS inventory, independent of operator action.

This instrument application is used through out the EPGs to prompt the operator to ensure that the Safety Injection System has actuated based on Pressurizer pressure decreasing to the SIAS setpoint. The authors of CEN-152 assumed that the same value of indicated Pressurizer pressure is used as the nominal setpoint for the Safety Injection Actuation System (SIAS). Ensuring automatic actuation of SIAS has a high degree of nuclear safety significance, just as the ESFAS setpoint itself is very important to safety. In the unlikely event that the automatic system fails to perform as designed, the operator is expected to perform the exact same function, even though this is beyond design bases. The EOP SFSCs backup the EOP step to verify actuation. The SFSCs provide a independent functional check on the adequacy of the automatic responses to the event.

Uncertainties Application Assessment:

No uncertainty should be applied to the engineering limit, which is the ESFAS actuation setpoint. Since the intent is to verify Safety Injection System Actuation, it serves no useful purpose to add additional uncertainties to those already applied to establish the SIAS setpoint, which is category (C01).

Instrument uncertainties are not applied in this case because we do not want the operator to initiate any safety signal <u>too</u> early. Such action may further complicate an event. Also, we expect the safety systems to automatically initiate when designed and the design setpoint already accounts for instrument uncertainties. Therefore, this should only be a manual backup in case the automatic setpoint does not initiate.

Potential Margin Loss Options:

not applicable.

References:

None

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures ✓ n.a. pk	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK Paul B. Kramarchyk / 11/12/96

Independent Reviewer: Name/Signature/Date

REACTOR VESSEL HEAD TEMPERATURE

ABB COMBUSTION ENGINEERING NUCLEAR OPERATIONS
EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 3

REACTOR VESSEL HEAD TEMPERATURE {53}

RECORD OF REVISIONS

Rev	Date	Pages	Preparer	Ind.Reviewer	Approver
Draft	08/31/95	ALL	Max	Wild	Greene
Draft	10/31/95	ALL	Congdon	N/A	N/A
00	03/29/96	ALL	Congdon	Greene	Whipple
01	11/15/96	ALL	Congdon	Kramarchyk	Greene

PREPARED BY: Joseph R. Congdon
Cognizant Engineer (Print Name)

[signature]
Cognizant Engineer (Signature) Date: 11/8/96

VERIFICATION STATUS: COMPLETE
The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Attachment 2, (QA Checklist) found in the Project Quality Plan.

Paul kramarchyk [signature] 11/12/96
Name Signature Date
Independent Reviewer

APPROVED BY: Mark Greene
Cognizant Engineering Supervisor (Print Name)

[signature] 11/13/96
Cognizant Engineering Supervisor (Signature) Date

EMERGENCY PROCEDURE GUIDELINE (CEN-152)
ENGINEERING LIMIT BASES DOCUMENT

MODULE 5 - DOCUMENT 3 - APPLICATION 1

{531}
System Subject Parameter: RCS RX VESSEL UPPER HEAD TEMPERATURE

Value: [indicates saturated conditions in the reactor vessel upper head]

Use: U22
To provide corroborative information related to the accomplishment of a safety function.

Cat: C03

Engineering Limit(s):

Lower = greater than 0°F subcooling (using RVLMS HJTCs) .

Summary:

The engineering limit is based on avoiding saturated conditions (e.g. subcooling = 0°F) in the reactor coolant system, by ensuring some margin to saturation always exists. The engineering limit does not include instrument uncertainties, process uncertainties, or operational margin.

The engineering limit need not be adjusted for instrument uncertainties when determining the plant specific operational value.

Basis for Engineering Limit(s):

The engineering limit is based on avoiding saturated conditions (e.g. subcooling = 0°F) in the reactor coolant system, by ensuring some margin to saturation always exists. The engineering limit does not include instrument uncertainties, process uncertainties, or operational margin.

Saturation margins greater than 0°F equate to unsaturated (subcooled) coolant. If the saturation margin is greater than 0°F, then saturation conditions do not exist and voiding does not exist in the reactor vessel head.

This instrument application is used throughout the EPGs as an indication of reactor vessel upper head voiding. The heated junction thermocouples (HJTCs) are part of the HJTC reactor vessel level monitoring system supplied by CE at some plants.

The unheated junction thermocouples are located at several elevations within the vessel upper head. In addition to their normal function of RV head region level monitoring, they also provide an indication of the fluid temperature within the head region.

Void formation in the upper RV head region is not a serious problem unless the void inhibits RCS depressurization, or is of sufficient magnitude to interfere with RCS flow (Reference 1 provides analyses which show that this is unlikely). For these reasons, this instrument application is considered to have a moderate nuclear safety significance.

Uncertainties Application Assessment:

The engineering limit need not be adjusted for instrument uncertainties when determining the plant specific operational value.

Since the intent of the engineering limit is to provide an *go, no-go* threshold value that enables the operators to distinguish between voiding and not voiding, it is not possible to apply instrument uncertainties without imposing a potentially significant restriction on the safe operational space.

Also, the engineering limit need not be adjusted for instrument uncertainties because there are other corroborating parameters the may be used to determine whether voids are forming a bubble in the RV head region. The following are examples of other parameters that may be used:

- Letdown flow greater than charging flow
- Pressurizer level increasing more than expected when operating pressurizer spray
- RVLMS indicates voiding

Potential Margin Loss Options:

Not applicable

References:

1. CEN-199, "Effects of Vessel Head Voiding During Transients and Accidents in C-E NSSS's," March, 1982

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 1 of 2)	OK	N/A
1.	Are the deliverables consistent with the Project Plan and the Project Authorization?	✓	
2.	Has the intent of the Engineering Limit been clearly expressed?	✓	
3.	Has the Engineering Limit been clearly identified?	✓	
4.	Has the bases for the Engineering Limit been clearly expressed?	✓	
5.	Has what the Engineering Limit ensures been clearly expressed?	✓	
6.	Have all assumptions been clearly stated?	✓	
7.	Has the relationship of the EPG value or descriptor to nuclear Safety been addressed?	✓	
8.	Does the document explicitly state that instrument uncertainties need or need not be applied for each application?	✓	
9.	Has the rational/justification used in making the applicability determination been clearly expressed?	✓	
10.	Is there evidence that a deliberate effort has been made to consider other options to be used in the event that the instrument uncertainties can not be accommodated when it is desirable for them to be explicitly applied?	✓	

TASK 868 & 884 QUALITY ASSURANCE CHECKLIST

	Review Criteria (page 2 of 2)	OK	N/A
11.	When necessary, have recommendations for additional analyses, verifications or simulator validations, to confirm assumptions or conclusions, been provided?	✓	
12.	Is there evidence that industry operating experience has been considered and incorporated as appropriate?	✓	
13.	Is there evidence that a deliberate effort has been made to consider the impact of the work product on the health and safety of the public?	✓	
14.	Does the title page contain the following: - Document Title - Document Number - Date of Issue - Correct Revision - Pagination (page 1 of X) - All Required Signatures — n.a. PK	✓	
15.	Does the header of each page contain the following: - Sequentially numbered pages (page 1 of X) - Document Number - Correct Revision - Date of Issue	✓	
16.	Is the document legible and reproducible?	✓	
17.	Are all cross-outs and overstrikes initialed and dated by the author?	✓	

Comments/remarks:

PAUL B. KRAMARCHYK Paul B. Kramarchyk / 11/12/96
Independent Reviewer: Name/Signature/Date

CEOG Task 776
ABB Combustion Engineering

Project: Instrument Uncertainties Within the EOPs and Technical Specifications

Project Number: 2001961

Report Title: Use

	(Print Name)	(Sign Name)	Date
Cognizant Engineer:	Joseph R Congdon	[signature]	11/12/96
EPG Task Manager:	NA		
Project Manager:	NA		

Rec	Use_code	Description	Justification	Category
1)	U01	To verify or ensure Reactivity Control Safety Function Acceptance Criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs and SPAC. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
2)	U02	To verify or ensure electrical power is available to specified vital/non-vital buses.	The purpose of this instrument application is to verify that electrical power is available to specified electrical buses. The Use applies to Emergency Operating Procedures and not to Technical Specifications. CEN-152 does not specify how to determine power availability to an electrical bus. It is understood that "nominal voltage" indication, bus power available lights, feeder breaker status lights, and load breaker status lights are all available to the operator to determine if a particular bus is energized. Instrument uncertainties need not be applied to a "nominal voltage" range and can not be applied to status light indications. Therefore, it is appropriate to place this Use in category 3.	C03
3)	U03	To verify or ensure Inventory Control Safety Function Acceptance criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs, SPAC and associated figures. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
4)	U04	To verify or ensure Pressure Control Safety Function Acceptance Criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs, SPAC and associated figures. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
5)	U05	To verify or ensure RCS and Core Heat Removal Safety Function Acceptance	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate	C01

Rec	Use_code	Description	Justification	Category
		Criteria are satisfied.	corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs, SPAC and associated figures. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	
6)	U06	To verify or ensure Containment Isolation Safety Function Acceptance Criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs and SPAC. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
7)	U07	To verify or ensure Containment Temperature and Pressure Safety Function Acceptance Criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs and SPAC. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
8)	U08	To verify or ensure Containment Combustible Gas Control Safety Function Acceptance Criteria are satisfied.	The purpose of this instrument application is to verify that the safety function is satisfied, detect inadequate control of the safety function, and initiate corrective actions to restore the safety function. The Use applies to Emergency Operating Procedure SPTAs, SFSCs and SPAC. It does not apply to Technical specifications. The Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
9)	U09	To monitor operability or operation of safety related Systems, Structures, and Components (SSCs), that could impact the accomplishment of a safety function, if impaired.	This Use applies to instrument applications in the Instruction Section or Contingency Section of the EOPs. The Use is not applicable to the Technical specifications. The associated applications require a best estimate degree of accuracy to obtain the desired result. The values or conditions do not by themselves substantially impact a safety function. The values or conditions are used corroboratively within the body of the EOPs to support accomplishment of a	C02

Rec	Use_code	Description	Justification	Category
			safety function or to restore a safety function that is in jeopardy. The Safety Function Status Checks provide the ultimate safety net to verify or ensure the safety function is satisfied. Safety Function Status Check instrumentation is category 1. Therefore, it is acceptable for this Use to be placed in Category 2.	
10)	U10	To monitor the operation of non-safety related equipment to prevent equipment damage that otherwise might lead to an adverse impact on one or more safety functions.	This Use applies to instrument applications used to prevent non-safety related equipment damage. They are not used for verification of a safety function. Operation of the associated equipment is not required to ensure accomplishment of a safety function or safe control of the plant. This Use possesses a lower degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 2.	C02
11)	U11	To verify plant parameters are in the normal or expected post-trip range.	This Use applies to instrument applications used to confirm key plant parameters are indicating within the expected range (normal control band) following an uncomplicated reactor trip. This Use is applicable only to the EOPs. Instrument uncertainties need not be applied to normal control bands. The associated instruments do not require a high degree of accuracy to verify a parameter is within the normal control band. In addition, there are other checks within the procedures that are outside these normal control limits and are used to ensure the associated engineering limit is not exceeded. Those instrument applications are C01 or C02 as appropriate. The instrument applications are only used to help verify that the control systems are functioning properly to control the associated parameters within that normal Post-trip range. They do not by themselves substantially impact a safety function. The Safety Function Status Checks provide the ultimate safety net to verify the safety function is satisfied. Safety Function Status Check instrumentation is typically category 1. This Use has no significant impact on nuclear safety. Therefore, additional instrument uncertainties need not be encluded.	C03
12)	U12	To calculate or determine the value of a core physics parameter.	Process loop inputs used to calculate or determine the value of a core physics parameter require Category 1 treatment of instrument uncertainties. The resulting instrument uncertainties should be accounted for when the core physics parameter is calculated or determined. Core physics parameters possess a high degree of nuclear safety significance. Therefore, the associated process input instrumentation also requires Category 1 instrument uncertainty treatment.	C01

Rec	Use_code	Description	Justification	Category
13)	U13	To verify automatic actuation of the ESFAS due to its setpoint being exceeded, or to indicate directly to the operator to manually actuate the safety systems associated with those setpoints since they failed to automatically actuate.	The Use applies to instrument applications within the EOPs used to verify ESFAS actuation or manually initiated safety systems when it is determined that the RPS or ESFAS failed to actuate as required. The Use does not apply to Technical Specifications. The associated instrument applications do not possess the same high degree of nuclear safety significance that is attached to the actual RPS or ESFAS setpoint. This is because manual actuation is not the only backup for those setpoints. The Safety Function Status Check safety net of the EOPs provides a function based backup to the RPS and ESFAS and those verifications are category 1. In addition, failure of the RPS and ESFAS systems (as would be the case if manual actuation was required) is considered to be outside design bases space. Therefore it is difficult to calculate and apply instrument uncertainties in a meaningful manner. Also, it would unnecessarily complicate the EOPs to include a second number to be used for actuation verification and backup for each RPS and ESFAS setpoint. Doing so, would place an unjustified burden on the operator. Therefore, no additional uncertainties should be applied to these setpoint values appearing the EOPs. One additional item to consider is that the operator is required to use the indicator associated with the actuation channel to verify actuation. These instruments are qualified instruments of which there are four redundant channels. The only additional uncertainties to consider for verification and manual actuation are those associated with the indicators on the panel. In this context, these uncertainties are considered to be insignificant.	C03
14)	U14	To determine if operator actions associated with non-safety related equipment are necessary to provide indirect support of a safety function.	This Use applies to instrument applications pertaining to non-safety related SSCs that provide indirect support of a safety function. The Use applies only to EOPs. The application possesses a moderate degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 2.	C02
15)	U15	To determine if an ESFAS initiating parameter is less than the reset value, to facilitate resetting the actuation and taking manual control of affected equipment.	This Use applies to instrument applications used to gain control of equipment following an ESFAS actuation. Manual control of equipment may be initiated after the actuating parameter reaches the reset value. Prompt restoration of certain safety systems is important to minimize equipment damage in containment due to prolonged exposure to water and corrosive chemicals. These instrument applications also function to stabilize the plant and initiate long term recovery. This Use is applicable to the EOPs only. It is acceptable for the instrumentation utilized to accomplish this Use to be placed in Category 3.	C03

Rec	Use_code	Description	Justification	Category
16)	U16	To evaluate whether or not automatic control of safety equipment should/may be overridden to regain manual control of affected equipment.	This Use applies to instrument applications used to evaluate weather or not to terminate operation of safety related equipment after it has been activated by the ESFAS. The associated instrument applications possess a moderate degree of nuclear safety significance and are used corroboratively. Termination criteria always consist of more than one independent process parameter, usually several. In addition the SFSCs will verify whether or not the parameters stay within the appropriate ranges and they are category 1. These instrument applications also function to stabilize the plant and initiate long term recovery. This Use is applicable to the EOPs only. Therefore, it is acceptable for this Use to be placed in Category 2.	C02
17)	U17	To detect or prevent a significant abnormal degradation or failure of the RCS pressure boundary.	This Use applies to instrument applications used to monitor and protect the RCS pressure boundary. This Use applies only to Technical Specifications. Protection of the RCS Pressure boundary has a high degree of nuclear safety significance. This conclusion is supported by the high priority assigned to protection of fission product barriers in Regulatory Guide 1.97, 10 CFR 50 Appendix A and the criteria established by the NRC final Policy Statement on Technical specification Improvements. Therefore, it requires Category 1 instrument uncertainty treatment.	C01
18)	U18	Blank Record		
19)	U19	To provide indirect support for the accomplishment of a safety function.	This Use applies to instrument applications used in the EOPs to aid in confirming or restoring a safety function. These are supporting applications found in EOP instructions, contingency actions and figures. They are not found in the SFSCs, SPAC or SPTA instructions. These instrument applications are used corroboratively to monitor the status of a safety function. The Safety Function Status Checks provide the ultimate safety net to verify or ensure the safety function is satisfied. Safety Function Status Check instrumentation is category 1. This Use possesses a lower degree of nuclear safety significance because of this associated supporting role. Therefore, it is acceptable for this Use to be placed in Category 2. Relative to bus voltage indication, this categorization is based on the use of bus voltage indication to verify the safety function when a value is specified in the EOP. If a specific bus voltage value is not specified, this Use becomes category 3 because instrument uncertainties can not be applied to bus power available lights, feeder breaker status lights, and load breaker status lights which are alternative means of verifying that power is available to a bus.	C02

Rec	Use_code	Description	Justification	Category
20)	U20	To determine when to activate a safety related SSC for which no automatic initiation is provided in support of a safety function, safe shutdown, cooldown or depressurization.	This Use applies to instrument applications used in support of a safety function to facilitate safe shutdown and cooldown of the plant and long term accident recovery. These applications are found in EOP instructions and contingency actions, not in SPTAs, SFSCs or SPACs. This Use does not apply to Technical Specifications. If RCS pressure is too high when lining up for SDC, the potential exists for lifting the LTOP relief. If the relief does not reseat, a LOCA situation is created. Therefore, this Use possesses a high degree of nuclear safety significance, relative to its use in the EOPs. It requires Category 1 instrument uncertainty treatment. For plants which use PORVs for LTOP protection, the PZR level instrument applications assigned to this Use can be category 2. For plants which use a spring loaded LTOP, this Use should remain category 1 since the height of the water column places an additional process uncertainty on the instrument application.	C01
21)	U21	To verify operation within the design requirements of SSCs that could directly impact the accomplishment of a safety function, if impaired.	This Use applies to instrument applications used to verify safety related SSC operation is in accordance with design requirements. The applications possess a moderate degree of nuclear safety significance because in these cases lack of absolute instrument accuracy will not inhibit accomplishment of the intended function. This Use is applicable to both the EOPs and TS. In the EOPs, these instrument applications are corroborative in nature. They are not the only parameters available to verify the associated SSC is operating within design limits. Therefore, it is acceptable for this Use to be placed in Category 2.	C02
22)	U22	To provide corroborative information related to the accomplishment of a safety function.	This Use applies to instrument applications where more than one parameter is used corroboratively to verify a condition. This Use has no significant impact on nuclear safety. Therefore, instrument uncertainties need not be applied.	C03
23)	U23	Blank Record		
24)	U24	To monitor the operation of non-safety related SSCs.	This Use applies to instrument applications used to monitor the operation of non-safety related SSCs in the EOPs. The Use does not apply to Technical Specifications. This Use has no significant impact on nuclear safety. Therefore,	C03

Rec	Use_code	Description	Justification	Category
			instrument uncertainties are not required to be accounted for.	
25)	U25	To verify operation within the design limits to prevent damage to safety related SSCs.	This Use applies to instrument applications used to verify RCS operation is within pressure and temperature limits designed to protect RCS components against failure. This Use applies to both the EOPs and TS. Protection of the RCS Pressure boundary has a high degree of nuclear safety significance. This conclusion is supported by the high priority assigned to protection of fission product barriers in Regulatory Guide 1.97 and in 10 CFR 50 App. G Fracture Toughness Requirements. Typically, only instrument applications in EOP SPTAs, SFSCs and SPAC have category 1 instrument uncertainty requirements. This Use is an exception to that rule. Taking the exception is judged necessary due to the high degree of nuclear safety significance associated with maintaining RCS P/T limits. Therefore, these instrument applications require Category 1 instrument uncertainty treatment.	C01
26)	U26	To detect and monitor for significant releases of radioactive material to the environment.	This Use applies to instrument applications used to monitor for and minimize radioactive releases to the environment. This Use applies to alarm trip setpoints specified in Technical Specifications. Monitoring offsite exposure to the public has a very high priority in Regulatory Guide 1.97 and 10 CFR 50 Appendix A criteria. However, offsite dose calculations, using grab sample analysis, is controlled by a separate NRC approved document, the Offsite Dose Calc Manual (ODCM). The application of instrument uncertainties is dealt with separately within this manual. This T.S. Use has a lesser degree of nuclear safety significance because the specified instrument applications are backed up by analysis of grab samples. Consequently, it is acceptable for this Use to be placed in Category 2,	C02
27)	U27	To prevent or mitigate off-site exposure to the public.	This Use applies to instrument applications used to prevent or mitigate off-site exposure to the public. This Use may apply to the EOPs or Technical Specifications. These instrument applications ensure that the assumptions in accident analysis associated with offsite exposure during DBEs are not exceeded. Instrumentation used to monitor offsite exposure has a high priority in Regulatory Guide 1.97 criteria and 10 CFR 50 Appendix A criteria. Typically, only instrument applications in EOP SPTAs, SFSCs and SPAC have category 1 instrument uncertainty requirements. This Use is an exception to that rule. Taking the exception is judged necessary due to the high degree of nuclear safety significance associated with minimizing offsite exposure. Therefore, these instrument applications require	C01

Rec	Use_code	Description	Justification	Category
			Category 1 instrument uncertainty treatment.	
28)	U28	To prevent significant releases of radioactive material to the environment by plant configuration control during accident conditions.	This Use applies to instrument applications used to establish plant conditions in order to prevent or minimize radioactive releases to the environment. This Use is applicable only to the EOPs. The applications are indirectly associated with the mitigation of offsite exposure to the public. They possess a moderate degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 2.	C03
29)	U29	Blank Record		
30)	U30	To monitor the operability or operation of Safety Related SSCs needed to support a Safety Function	This Use applies to instrument applications used to ensure that safety related SSCs needed to support the accomplishment of a Safety Function remain operable, as required by TS. This Use applies to Technical Specifications and not to EOPs. Therefore, the associated instrumentation requires Category 1 instrument uncertainty treatment	C01
31)	U31	Blank Record		
32)	U32	Blank Record		
33)	U33	To monitor the operability or operation of safety related SSCs needed for safe shutdown.	This Use applies to instrument applications used to verify that equipment needed to place or maintain the plant in HOT or COLD SHUTDOWN are operable, with or without offsite power available. This Use applies to Technical Specifications only. These instrument applications possess a high degree of nuclear safety significance. They are part of a broad group of process variables referenced in Reg Guide 1.97 and used in support of 10 CFR 50, App. A General Design Criteria to ensure safe shutdown capability. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
34)	U34	To determine if operator actions associated with safety related equipment are necessary to support a safety function.	This Use applies to instrument applications associated with a broad group of auxiliary support functions found in the EOPs which are necessary to ensure the operability of safety related equipment. The Use does not apply to Technical Specifications. These instrument applications possess a moderate degree of nuclear safety significance. The lack of absolute accuracy of the instrumentation will not prevent the operator from accomplishing the intended function. These instrument	C02

Rec	Use_code	Description	Justification	Category
			applications are used corroboratively. The operator relies on more than one independent process variable to verify SSC status. Therefore, it is acceptable for this Use to be placed in Category 2.	
35)	U35	Blank Record		
36)	U36	To verify the operability of non-safety related equipment such as RCPs, whose failure to operate is not likely to impact a safety function.	This Use applies to instrument applications used to evaluate the operability of non-safety related SSCs such as RCPs. This Use applies only to EOPs. The RCPs are not needed to accomplish a safety function, although in some instances when conditions permit, forced corculation may be perferred. Verification of RCP restart criteria possesses a low degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 3.	C03
37)	U37	To ensure surveillance parameters, other than chemistry parameters, are maintained within limits using special Maintenance and Test Equipment (MTE).	This Use applies to instrument applications associated with Technical Specification surveillances performed IAW section 4.0.5 (Section XI of the ASME Boiler and Pressure Vessel Code), Reg Guide 1.52, ANSI N510-1975, or other similar regulation. This use applies to non-chemistry parameters. It does not apply to EOPs. Typically, these instrument applications involve the use of temporarily installed gages or special Maintenance and Test Equipment (MTE). However, permanently installed process instrumentation may also fall into this category. If the surveillance is performed IAW the previously mentioned documents, the accuracy requirements of the specified instrumentation is governed by the associated document. Typically, accuracy is assured by performing a calibration or re-certification in accordance with a plant specific Nuclear Safety Calibration Program, applicable National Institute of Standards and Technologies procedure or vendor calibration procedure. Loop uncertainties for installed process instrumentation should be accounted for. Loop uncertainties for temporary gages or special MTE may not apply. The determination of accuracy requirements for these instrument applications is not within the scope of this guideline.	C07
38)	U38	Blank Record		
39)	U39	To determine when to remove a safety system from service for which automatic actuation would complicate the operator's ability to perform a	This Use applies to instrument applications used to support safe shutdown and cooldown of the plant and support long term accident recovery. These applications are found in EOP instructions, not in SFSCs or SPACs. Inadvertent SIT injection would disrupt cooldown and depressurization, but it would not likely prevent the	C03

Rec	Use_code	Description	Justification	Category
		controlled shutdown of the plant.	accomplishment of a safety function. These applications possess a moderate degree of nuclear safety significance because in these cases lack of absolute instrument accuracy will not inhibit accomplishment of the intended function. Therefore, it is acceptable for this Use to be placed in Category 2.	
40)	U40	To ensure reactivity control.	This Use applies to instrument applications used to ensure safety related SSCs needed to support accomplishment of the associated Safety Function, are operable as required by Technical Specifications. It does not apply to EOPs. The instrument applications possess a high degree of nuclear safety significance. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
41)	U41	Blank Record		
42)	U42	Blank Record		
43)	U43	To ensure RCS pressure control.	This Use applies to instrument applications used to ensure safety related SSCs needed to support the accomplishment of the associated Safety Function, are operable as required by Technical Specifications. It does not apply to EOPs. The instrument applications possess a high degree of nuclear safety significance. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
44)	U44	To ensure RCS and Core heat removal.	This Use applies to instrument applications used to ensure safety related SSCs needed to support the accomplishment of the associated Safety Function, are operable as required by Technical Specifications. It does not apply to EOPs. The instrument applications possess a high degree of nuclear safety significance. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
45)	U45	Blank Record		
46)	U46	Blank Record		
47)	U47	Blank Record		
48)	U48	Blank Record		

Rec	Use_code	Description	Justification	Category
49)	U49	To ensure a chemistry parameter is maintained within limits based on laboratory or special test equipment.	This Use applies to instrument applications associated exclusively with chemistry parameters. These are non-process parameters determined via sample analysis or with the aid of laboratory testing equipment. The associated instrumentation is usually located in a laboratory environment, but may be portable. Laboratory testing equipment have its own accuracy requirements as specified in the applicable standards. The accuracy of that equipment was taken into consideration when assigning the value in the TS and the EOPs. As long as the instruments are calibrated as required and the expected accuracy is maintained, no additional uncertainty requirements need to be applied. Determination of accuracy requirements for Category 5 parameters are not within the scope of this project.	C05
50)	U50	To ensure RCS activity is within the initial conditions assumed in the accident analysis.	This Use applies to instrument applications associated exclusively radio-chemistry parameters. These are non-process parameters determined via sample analysis or with the aid of laboratory testing equipment. The associated instrumentation is usually located in a laboratory environment, but may be portable. Laboratory testing equipment has its own accuracy requirements as specified in the applicable standards. The accuracy of that equipment was taken into consideration when assigning the value in the TS and the EOPs. As long as the instruments are calibrated as required and the expected accuracy is maintained, no additional uncertainty requirements need to be applied. Determination of accuracy requirements for Category 5 parameters is not within the scope of this guideline.	C05
51)	U51	To monitor core physics parameters to protect the fuel or cladding.	This Use is applicable to core physics parameters only. Parameters in this category possess a high degree of nuclear safety significance, but are not considered process variables. However, when calculations for determination of core physics parameters are performed, calculational uncertainties are typically applied. In addition, anytime data from a process loop inputs to these calculations, category 1 level uncertainty calculations must be performed on those loops and the resulting instrument uncertainties must be accounted for in the core physics parameter calculations/determinations.	C04
52)	U52	Blank Record		
53)	U53	To define mode of operation or determine the applicability of an LCO or Surveillance Requirement via process	This Use applies to instrument applications used to define mode of operation or establish TS applicability and not specify a precise requirement. The associated power plateaus, temperature and pressure limits have uncertainties built into the	C03

Rec	Use_code	Description	Justification	Category
		parameters.	number which establishes the initial conditions for conducting associated tests. The lack of absolute accuracy of the associated parameter/values will not prohibit accomplishment of the intended function. The associated instrument applications possess a low degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 3. If nominal numbers obtained from generic documents are adopted in plant specific procedures and presented as plant specific values, the application of instrument uncertainties should be evaluated.	
54)	U54	To consider parameters in the decision making process.	This Use applies to instrument applications were the parameter is referenced for decision making purposes only. No specific value or limit is included for verification or comparison. This use has no significant impact on nuclear safety. Therefore, instrument uncertainties can not be applied. If specific numbers are added in plant specific applications of this Use, the categorization should be re-evaluated.	C03
55)	U55	To assess requirements to adjust DNBR Penalty Factors via core physics parameters.	This Use is applicable to core physics parameters only. Parameters in this category possess a high degree of nuclear safety significance, but they are not considered process variables. However, anytime data from a process loop inputs to these calculations, category 1 level uncertainty calculations must be performed on those loops and the resulting instrument uncertainties accounted for in the core physics parameter calculations/determinations.	C04
56)	U56	To ensure plant operation within initial assumptions of the Transient and Accident Analyses.	This Use applies to instrument applications used to ensure the plant can be controlled and safely shutdown following a DBA. This Use applies to Technical Specifications only. Design features are based on normal operation within the bounds of the initial conditions assumed in the Accident Analyses. These instrument applications possess a high degree of nuclear safety significance. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
57)	U57	Blank Record		
58)	U58	To determine the rate or direction of a change, the magnitude of a step change, make a relative comparison, monitor, or ensure maximization.	This Use applies to instrument applications used for trending purposes, (i.e., increasing, decreasing, not changing). In these applications, no values or ranges are included. The Use also applies to rates of change or magnitudes of step changes, (i.e., cooldown rate, leakage rate, changes in activity [Alarm/trip setpoint 2 X bkgd]), where a value may be included. In these cases, the point of	C03

Rec	Use_code	Description	Justification	Category
			interest is the delta between two data points, or the change in a parameter over a period of time. Instrument uncertainties need not be applied, because they would not affect the characteristic slope of the trend or the rate of change since the identical instrument is used to indicate the magnitude or rate of change.	
59)	U59	To specify operability requirements for instruments whose applicability is specified elsewhere.	This Use is applies to process parameter instruments required to be operable by Technical Specifications. The application of these instruments is not addressed here, but is covered elsewhere when the instruments are actually used. The instruments possess a high degree of nuclear safety significance, but no values or application criteria are specified. Therefore, instrument uncertainties can not be applied.	C06
60)	U60	To monitor core design parameters to ensure reactivity control.	This Use is applicable to core physics parameters only. Parameters in this category possess a high degree of nuclear safety significance, but are not considered process variables. However, when calculations for the determination of core physics parameters are performed, calculational uncertainties may be applied. In addition, anytime data from a process loop inputs to these calculations, category 1 level uncertainty calculations must be performed on those loops and the resulting instrument uncertainties accounted for in the core physics parameter calculations/determinations.	C04
61)	U61	To ensure power distribution, shutdown margin and CEA positions (excluding part -length CEAs) are maintained within acceptable limits based on the Accident Analyses.	This Use applies to instrument applications used to ensure the plant can be controlled and safely shutdown following a DBA. This Use applies to Technical Specifications only. Design features are based on normal operation within the bounds of the initial conditions assumed in the Accident Analyses. These instrument applications possess a high degree of nuclear safety significance. Therefore, this Use requires Category 1 instrument uncertainty treatment.	C01
62)	U62	Blank record		
63)	U63	To monitor environmental conditions in an area which houses safety-related equipment to ensure the equipment remains operable.	This Use applies to instrument applications used to support safety related SSCs to enable performance of a safety function. This Use applies only to TS. The applications provide an indirect auxiliary function. In these cases, failure to maintain an exact value will not significantly impact the accomplishment of the related safety function. The spaces where the affected equipment is located are continiously monitored or checked on a regular bases and there is time to respond	C02

Rec	Use_code	Description	Justification	Category
			with corrective action before the onset of equipment failure. There is no direct correlation between the ambient temperature in the space and equipment failure. Therefore, these applications possess a moderate degree of nuclear safety significance and it is acceptable for this Use to be placed in Category 2.	
64)	U64	To determine fluid level or component position directly, in cases where no process instrumentation is provided.	This Use applies to direct parameter determinations, when no process instrumentation is provided. The associated instrumentation is not subject to indication error, other than human error. The adequacy of installed scales for direct visual observation of level is established at installation. There are no instrument loops to require instrument uncertainty determinations.	C03
65)	U65	Blank Record		
66)	U66	Blank Record		
67)	U67	Blank Record		
68)	U68	To verify accuracy requirements for CEA position indicator channels or operability requirements for their "Full out/ Full in" position indicators.	This Use applies to instrument applications associated with CEA position indication for which instrument uncertainties can not be applied, (ie. "not fully incerted" and "within 5 inches"). Therefore, instrement uncertainties need not be applied to these applications. This Use applies only to Technical Specifications.	C03
69)	U69	To verify a parameter is in agreement with "nominal values" provided in SSC design criteria or safety analyses.	This Use applies to instrument applications used to monitor nominal values from the design criteria, or safety analyses. Nominal values are defined here to be theoretical values considered to be reasonable estimates of the actual values. They are not precise calculated values. They are not used to prevent equipment damage or to verify a safety function. Therefore, the associated applications possess no nuclear safety significance. If nominal numbers obtained from generic EPGs or TS are adopted in plant specific procedures and presented as plant specific values, the applications of instrument uncertainties should be evaluated.	C03
70)	U70	To verify charging or SI flow is in agreement with "nominal design values" included in the EOPs.	This use applies to instrument applications used to monitor values that are taken from the system design bases. These instrument applications are used to aid the operator in evaluating system performance and to prompt the operator to investigate possible causes of degraded system flow if it is below the expected	C03

Rec	Use_code	Description	Justification	Category
			value. Adding an additional uncertainty value to the required system design flowrate value could have the effect of requiring the operator to obtain a system flowrate beyond that of design if the actual instrument uncertainty during procedure performance is less than that expected via the instrument uncertainty calculations. Since this would be wasting the operator's time and may never be able to be achieved, this practice is not recommended. If instrument uncertainty is such that indicated system flowrate is not equal to the design flowrate, this does not necessarily mean that the flowrate is inadequate. The ultimate adequacy of system flowrate is determined by the status of the Heat Removal, Inventory Control, and/or Reactivity Control Safety Function. If they become jeopardized, the operator will be alerted to the situation and take appropriate action per the EOP (e.g., increase SI/charging flow). Therefore, in this context, these instrument application values are nominal in nature and no instrument uncertainty needs to be applied.	
71)	U71	Blank record		
72)	U72	Blank Record		
73)	U73	To determine if operator actions associated with non-safety related equipment are necessary to directly support an EPG strategy.	This Use applies to instrument applications associated with non-safety related SSCs that provide direct support of a EPG strategy. The Use applies only to EOPs (eg., RCP Trip Two/Leave Two strategy). The applications possesses a low to moderate degree of nuclear safety significance. Therefore, it is acceptable for this Use to be placed in Category 2.	C02

VALUE CROSS
REFERENCE

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-060 3_1-CVCS.1R4	**CVCS**	1. letdown flow greater than charging flow 2. greater than 40 GPM	{311} [letdown flow greater than charging flow] {312} [nominal capacity of one charging pump]
MISC-PENG-ER-061 2_1-RMS.1R4	**Radiation Monitoring**	1. Air ejector high activity alarm 2. No containment area radiation monitors alarming 3. No steam plant activity monitors alarming 4. no process radiation alarms	{211} [condenser offgas monitor alarm] {212} [containment area or atmospheric radiation monitor alarm] {213} [steam plant activity monitor alarm] {214} [process radiation monitor alarm]
MISC-PENG-ER-062 1_1-CST.1R4	**CST Volume**	1. Feedwater Capacity vs Time to Shutdown Cooling 2. Typical Feedwater Required for Sensible Heat Removal 3. Adequate per FW Inventory Requirements (Figure reference) 4. Evaluate condensate inventory	{111} [minimum required inventory]
MISC-PENG-ER-063 2_2-H2.1R4	**Containment Hydrogen Concentration**	1. < 0.5% ≥ 0.5% 2. < 4%	{221}[minimum detectable concentration for hydrogen] {222} [lower flammability concentration for hydrogen]
MISC-PENG-ER-064 2_3-CP.1R4	**Containment Atmospheric Pressure**	1. < 1.5 psig 2. < 3.0 psig 3. < 7.0 psig 4. < 10 psig, ≥ 10 psig 5. < 4 psig, ≥ 4 psig	{231} [maximum expected normal containment pressure] or [high containment pressure alarm setpoint] {232} [CIAS reset pressure] {233} [CSAS reset pressure] {234} [CSAS setpoint] {235} [CIAS setpoint] {236} [containment design pressure]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-065 2_4-CT.1R4	**Containment Atmospheric Temperature**	1. < 120°F 2. < 180°F 3. < 240°F	{241} [maximum expected normal containment temperature] {242} [saturated vapor temperature corresponding to the CIAS setpoint]] {243} [saturated vapor temperature corresponding to CSAS setpoint] {244} [maximum expected containment temperature during station blackout]
MISC-PENG-ER-066 2_5-PWR.1R4	**Core Power**	1. < 1E(-X) %	{251} [maximum expected reactor power 15 minutes after shutdown] {252} [reactor shutdown] {253} [adequate shutdown margin]
MISC-PENG-ER-067 2_6-CEA.1R4	**Core CEA Position**	1. Maximum of 1 CEA not fully inserted	{261} [no more than one full length CEA NOT inserted]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-068 3_4-ECCS.1R4	**ECCS-SI Flow**	1. 30 gpm < 30 gpm > 30 gpm 2. > 40 gpm 3. In accordance with SIS flow curve Acceptable SIS flow vs. RCS pressure injecting water into the RCS per Figure	{341} [minimum required HPSI pump flowrate] {342} [nominal capacity of one charging pump] {343} [SI flow delivery curves]
MISC-PENG-ER-069 3_5-RWT.1R4	**ECCS-SI RWT Level**	1. ≤ 10 %	{351} [RAS setpoint]
MISC-PENG-ER-070 1_2-FW.1R4	**MFW and AFW Flow**	1. > 150 gpm 2. ≤ 150 gpm	{121} [minimum feedflow for heat removal] {122} [maximum feedflow that will not cause water-hammer]
MISC-PENG-ER-071 1_3-SGL.1R4	**MS Steam Generator Level**	1. Above the feed ring Below the feed ring 2. < 15% ≥ 15% 3. > 30%	{131} [above or below the feedring] {132} [SG level for initiating O-T-C] {133} [SG level for terminating O-T-C] {134} [expected post-trip band] {135} Not used {136} [normal control band] {137} [top of the indicating range] {138} [top of the tube bundle]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-072 1_4-SGP.1R4	**MS Steam Generator Pressure**	1. < 800 psia 2. ≤ 950 psia 3. 850 - 950 psia 4. ≤ 500 psia	{141} [minimum expected post-trip pressure] {142} [lowest MSSV lift setpoint] or [maximum expected post trip value] {143} [expected post-trip band] {144} [MSIS setpoint]
MISC-PENG-ER-073 4_1-TAVE.1R4	**RCS Average Temperature**	1. < 545 °F 2. < 525 °F 3. > 535 °F 4. 525 °F to 535 °F 5. < 500 °F	{411} not used {412} [minimum expected post-trip temperature] {413} [maximum expected post-trip temperature] {414} [expected post-trip range] {415} [minimum RCS temperature defining a PTS event]
MISC-PENG-ER-074 4_1-CET.1R4	**RCS Coolant Average CET Temperature**	1. Less than superheat or Not superheated 2. No abnormal difference between T hot (± 10 °F 3. Less than 600 °F	{421} [less than superheat] or [not superheated] {422} [no abnormal difference between CET temperature and T hot] {423} [saturation temperature corresponding to PSVs/PORVs lift pressure]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-075 4_3-TC.1R4	**RCS Cold Leg Temperature**	1. ≤ 275 °F 2. Within post-accident PT limits	{431} [LTOP enabling criteria] {432} [post-accident PT limits] {433} [SDM calculation] {434} [typical feedwater required for sensible heat removal] {435} [minimum expected post-trip temperature] {436} [maximum expected post-trip temperature] {437} [expected post-trip range]
MISC-PENG-ER-076 4_4-TH.1R4	**RCS Hot Leg Temperature**	1. Less than superheat 2. No abnormal difference between T hot (± 10 °F 3. < 525 °F 4. < 600 °F 5. ≤ 300 °F	{441} [less than superheat] or [not superheated] {442} [no abnormal difference] between CET temperature and T hot {443} [MSSV lift prevent temperature]] {444} [saturation temperature corresponding to PSVs/PORVs lift pressure] {445} [SDC entry temperature]
MISC-PENG-ER-077 4_5-DT.1R4	**RCS Loop Delta-T**	1. < normal full power delta-T < the full power delta-T if all RCPs are off 2. Less than 10 °F	{451} [normal full power delta-T] {452} [maximum expected delta T shutdown with forced circulation]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-078 5_1-SUB.1R4	**RCS Coolant Subcooling**	1. ≥ 20 °F, 20 °F subcooling curve	{511} [minimum RCS subcooling]
			{512} Not used
		2. 200 °F subcooling curve	{513} [maximum RCS subcooling for PTS]
		3. 20 - 50 °F	{514} [allowable range of subcooling during SBO]
MISC-PENG-ER-079 3_2-PZRL.1R4	**Pressurizer Level**	1. 35 - 245 IN	{321} [expected post-trip band]
		2. 245 IN	{322} [maximum level for inventory control]
		3. ≤ 35 IN > 35 IN	{323} [minimum level for inventory control]
		4. 120 - 220 IN Normal band	{324} [normal PLCS program band]
		5. 100 - 200 IN	{325} [RCP restart level control band]
		6. > 100 IN	{326} [heater cutoff setpoint]
		7. > 200 IN	{327} Not used

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-080 5_2-PZRP.1R4	**Pressurizer Pressure**	1. SDC maximum entry condition normal SDC parameters exist ≤ 300 psia	{521} [SDC entry pressure]
		2. Within the post-accident PT limits	{522} [post-accident PT limits]
		3. minimum RCP NPSH curve	{523} [RCP NPSH limits]
		4. 1700 - 2350 psia	{524} [expected post-trip band]
		5. 2400 psia < 2400 psia ≥ 2400 psia	{525} [PORV setpoint]
		6. 250 psia	{526} [SIT isolation pressure]
		7. < 1000 psia	{527} [lowest MSSV setpoint]
		8. < 1300 psia	{528} [HPSI pump shut-off head]
		9. < 1300 psia	{529} [SBLOCA plateau pressure]
		10. < 2340 psia	{5210} [expected PORV closure pressure]
		11. > 200 psia	{5211} [LPSI pump shut-off head]
		12. 2225 - 2300 psia	{5212} [normal control band]
		13. Approximately equal to isolated SG pressure (± 50 psi)	{5213} [approximately equal to isolated SG pressure]
		14. ≤ 1600 psia	{5214} [SIAS setpoint]
MISC-PENG-ER-081 3_3-RVLM.1R4	**RCS Reactor Vessel Level**	1. RVLMS indicates a minimum level at the top of the hot leg nozzles	{331} [top of the hot leg nozzles]
		2. RVLMS indicates the core is covered	{332} [top of the active fuel region]
		3. No voiding as indicated by the RVLMS	{333} [full]

CEN-152 REVISION 04 PARAMETER VALUE DESCRIPTOR CROSS REFERENCE

FILE #	PARAMETER	REV 3 VALUE	ELBD # - REV 4 VALUE DESCRIPTOR
MISC-PENG-ER-082 5_3-HEAD.1R4	**RCS Reactor Vessel Upper Head Temperature**	1. saturated conditions in upper head	{531} [saturated conditions in upper head]
MISC-PENG-ER-083 2_7-CS.1R4	**ESF-Containment Spray Flow**	1. ≥ 1500 gpm	{271} [design flowrate]

ENGINEERING LIMIT
BASES CROSS
REFERENCE

CEN-152 Rev4 .Task 884 Cross Reference Report

12-Nov-96

Proc	Path	Step No	884 Code	Code
Diag4	1	1		
Diag4	1	2		
Diag4	1	3		
Diag4	1	4		
Diag4	1	5	136, 134, 121	
Diag4	1	6	524	
Diag4	1	7	323	
Diag4	1	8	511	
Diag4	1	9	141	
Diag4	1	10	211, 213	
Diag4	1	11	231	
Diag4	1	12	212	
Diag4	1	13	211, 213	
Diag4	1	14		
Diag4	1	15		
Diag4	1	16		
ESDE	1	0		

Proc	Path	Step No	884 Code	Code
ESDE4	1	1		*
ESDE4	1	2		
ESDE4	1	3		
ESDE4	1	4	5214	*
ESDE4	1	5	343	*
ESDE4	1	6		
ESDE4	1	7	529, 511	*
ESDE4	1	8		*
ESDE4	1	9		*
ESDE4	1	10		
ESDE4	1	11		
ESDE4	1	12		*
ESDE4	1	13	511, 323, 136, 331	*
ESDE4	1	14		*
ESDE4	1	15	5211	*
ESDE4	1	16	5211	*
ESDE4	1	17	136	*
ESDE4	1	18	432, 522	*
ESDE4	1	19		
ESDE4	1	20	235	*

Proc	Path	Step No	884 Code	Code
ESDE4	1	21	234, 271	*
ESDE4	1	22	233	*
ESDE4	1	23		*
ESDE4	1	24	432	*
ESDE4	1	25	522, 331	
ESDE4	1	26	321	*
ESDE4	1	27		*
ESDE4	1	28	432, 136, 325, 522	*
ESDE4	1	29	325, 528	*
ESDE4	1	30	451, 511, 422, 442	*
ESDE4	1	31	221, 222	*
ESDE4	1	32		
ESDE4	1	33		
ESDE4	1	34	252	*
ESDE4	1	35		
ESDE4	1	36		*
ESDE4	1	37	522, 136, 432	*
ESDE4	1	38	526	*
ESDE4	1	39	431	*
ESDE4	1	40		*

Proc	Path	Step No	884 Code	Code
ESDE4	1	41	326, 511, 521, 445	*
ESDE4	1	42		
ESDE4	EN	1		
ESDE4	EN	2		
ESDE4	EX	1		
ESDE4	EX	2		
ESDE4	EX	3		
ESDE4	SF	1	251, 261, 312. 253	
ESDE4	SF	2		
ESDE4	SF	3	323, 511, 331, 332, 343	
ESDE4	SF	4	343, 522, 432	
ESDE4	SF	5	511, 423, 444	
ESDE4	SF	6	136	
ESDE4	SF	7	235, 211, 212, 213, 214	
ESDE4	SF	8	231, 241	
ESDE4	SF	9	231, 241, 221, 222	
F_CCGC4	1	1	221, 222	*
F_CCGC4	1	2		*
F_CCGC4	1	3	221, 222	*
F_CCGC4	2	1		*

Proc	Path	Step No	884 Code	Code
F_CCGC4	2	2		*
F_CCGC4	2	3		*
F_CCGC4	2	4		*
F_CCGC4	CA	1		
F_CI4	CA	1		*
F_CI4	SF	1	235, 5214, 212	*
F_CI4	SF	2		*
F_CI4	SF	3		*
F_CI4	SF	4	235, 211, 212, 213	*
F_CTPC4	1	1		*
F_CTPC4	1	2		*
F_CTPC4	1	3	231, 242	*
F_CTPC4	2	1	235	*
F_CTPC4	2	2		*
F_CTPC4	2	3	234, 243	*
F_CTPC4	3	1	234, 271	*
F_CTPC4	3	2	233	*
F_CTPC4	3	3	271	*
F_CTPC4	CA	1		*
F_HR4	1	1	252	

Proc	Path	Step No	884 Code	Code
F_HR4	1	2	451, 511, 442, 422	*
F_HR4	1	3	252	*
F_HR4	1	4	514, 511, 136, 421	*
F_HR4	1	5	252	*
F_HR4	1	6	252	*
F_HR4	1	7		*
F_HR4	1	8		*
F_HR4	1	9		*
F_HR4	1	10		
F_HR4	1	11	443	*
F_HR4	1	12	443, 143	*
F_HR4	1	13	143	*
F_HR4	1	14		*
F_HR4	1	15	142, 5213, 522	*
F_HR4	1	16		*
F_HR4	1	17		*
F_HR4	1	18	137	*
F_HR4	1	19		*
F_HR4	1	20		*
F_HR4	1	21	137, 138	*

Proc	Path	Step No	884 Code	Code
F_HR4	1	22		*
F_HR4	1	23		
F_HR4	1	24		*
F_HR4	1	25		*
F_HR4	1	26		*
F_HR4	1	27		*
F_HR4	1	28		*
F_HR4	1	29		
F_HR4	1	30		*
F_HR4	1	31		*
F_HR4	1	32		*
F_HR4	1	33	131, 122, 136	*
F_HR4	1	34	413, 436	*
F_HR4	1	35	132	*
F_HR4	1	36	111	*
F_HR4	1	37	136	*
F_HR4	1	38	523, 136, 325, 522, 432	*
F_HR4	1	39	325, 522, [illegible], 432	*
F_HR4	1	40	526	*
F_HR4	1	41	431	*

Proc	Path	Step No	884 Code	Code
F_HR4	1	42	522, 432, 136	*
F_HR4	1	43		*
F_HR4	1	44	136, 451, 452, 443, 511, 333	*
F_HR4	2	1		*
F_HR4	2	2	343	*
F_HR4	2	3		*
F_HR4	2	4		
F_HR4	2	5	451, 511, 422, 442	*
F_HR4	2	6	343, 136, 421	*
F_HR4	2	7	252	*
F_HR4	2	8	514, 511, 136, 421	*
F_HR4	2	9	252	*
F_HR4	2	10	252	*
F_HR4	2	11		*
F_HR4	2	12		*
F_HR4	2	13		*
F_HR4	2	14		
F_HR4	2	15	443	*
F_HR4	2	16	443, 143	*
F_HR4	2	17	143	*

Proc	Path	Step No	884 Code	Code
F_HR4	2	18		*
F_HR4	2	19	527, 5213, 522	*
F_HR4	2	20		*
F_HR4	2	21		*
F_HR4	2	22	137	*
F_HR4	2	23		*
F_HR4	2	24		*
F_HR4	2	25	137, 138	*
F_HR4	2	26		*
F_HR4	2	27		
F_HR4	2	28		*
F_HR4	2	29		*
F_HR4	2	30		*
F_HR4	2	31		*
F_HR4	2	32		*
F_HR4	2	33		
F_HR4	2	34		*
F_HR4	2	35		*
F_HR4	2	36		*
F_HR4	2	37	131, 122, 136	*

Proc	Path	Step No	884 Code	Code
F_HR4	2	38	413, 436	*
F_HR4	2	39	132	*
F_HR4	2	40	111	*
F_HR4	2	41	136	*
F_HR4	2	42	523, 136, 325, 432, 522	*
F_HR4	2	43	325, 522, 528, 523, 432	*
F_HR4	2	44	526	*
F_HR4	2	45	431	*
F_HR4	2	46	522, 432, 136	*
F_HR4	2	47	351	*
F_HR4	2	48	351	*
F_HR4	2	49	341	*
F_HR4	2	50	323, 331, 511	
F_HR4	2	51	136, 421, 343, 441	*
F_HR4	3	1	132, 343	*
F_HR4	3	2		*
F_HR4	3	3	343	*
F_HR4	3	4		*
F_HR4	3	5		*
F_HR4	3	6	131, 122, 136	*

Proc	Path	Step No	884 Code	Code
F_HR4	3	7	511, 323, 135, 331	*
F_HR4	3	8		*
F_HR4	3	9	5211	*
F_HR4	3	10	5211	*
F_HR4	3	11	133, 331, 444	*
F_HR4	3	12	351	*
F_HR4	3	13	351	*
F_HR4	3	14	341	*
F_HR4	3	15	343, 421, 524	*
F_HR4	CA	1		*
F_HR4	CA	2		*
F_HR4	CA	3		*
F_IC4	1	1		*
F_IC4	1	2		*
F_IC4	1	3		*
F_IC4	1	4	321	*
F_IC4	1	5		*
F_IC4	1	6		*
F_IC4	1	7	323, 511, 331	*
F_IC4	2	1		*

Proc	Path	Step No	884 Code	Code
F_IC4	2	2	343	*
F_IC4	2	3		*
F_IC4	2	4		*
F_IC4	2	5		*
F_IC4	2	6	511, 323, 136, 331	*
F_IC4	2	7		*
F_IC4	2	8	5211	*
F_IC4	2	9	5211	*
F_IC4	2	10	351	*
F_IC4	2	11	351	*
F_IC4	2	12	341	*
F_IC4	2	13	332	
F_IC4	CA	1		*
F_IC4	CA	2		*
F_IC4	CA	3		*
F_IC4	CA	4		*
F_PC	CA	1		*
F_PC	CA	2		*
F_PC	PC-1	1		*
F_PC	PC-1	2	522, 432	*

Proc	Path	Step No	884 Code	Code
F_PC	PC-1	3	522, 432	*
F_PC	PC-1	4	522, 331, 432	
F_PC	PC-1	5	321	*
F_PC	PC-1	6	522, 432	
F_PC	PC-2	1	322, 522, 432	*
F_PC	PC-2	2	5210, 522, 432	*
F_PC	PC-2	3		*
F_PC	PC-2	4	235	*
F_PC	PC-2	5	522, 432	*
F_PC	PC-3	1		*
F_PC	PC-3	2	343	*
F_PC	PC-3	3	511, 323, 136, 331	
F_PC	PC-3	4		
F_PC	PC-3	5	5211	
F_PC	PC-3	6	5211	
F_PC	PC-3	7	343	*
F_RXC	CA	1		*
F_RXC	RC-1	1	251	*
F_RXC	RC-1	2	261	*
F_RXC	RC-1	3	261, 251	*

Proc	Path	Step No	884 Code	Code
F_RXC	RC-2	1	251	*
F_RXC	RC-2	2	251, 253	*
F_RXC	RC-2	3	261	*
F_RXC	RC-2	4	251, 312	*
F_RXC	RC-3	1	251	*
F_RXC	RC-3	2		*
F_RXC	RC-3	3	343	*
F_RXC	RC-3	4	312	*
F_RXC	RC-3	5	511, 323, 136, 331	*
F_RXC	RC-3	6		*
F_RXC	RC-3	7	261	*
F_RXC	RC-3	8	312, 251	*
F_SFSC4	AC-1	2		
F_SFSC4	AC-1	2.2		
F_SFSC4	AC-1	2.3		
F_SFSC4	AC-3	2		
F_SFSC4	AC-3	2.4		
F_SFSC4	CCGC-1	8		
F_SFSC4	CCGC-1	8.1	221, 222	
F_SFSC4	CCGC-2	8		

Proc	Path	Step No	884 Code	Code
F_SFSC4	CCGC-2	8.2		
F_SFSC4	CI-1	6		
F_SFSC4	CI-1	6.1	211, 212, 213, 214, 235	
F_SFSC4	CTPC-1	7		
F_SFSC4	CTPC-1	7.1	242, 231	
F_SFSC4	CTPC-2	7		
F_SFSC4	CTPC-2	7.2	243, 234	
F_SFSC4	CTPC-3	7		
F_SFSC4	CTPC-3	7.3	236	
F_SFSC4	HR-1	5		
F_SFSC4	HR-1	5.1	136, 452, 451, 511, 333	
F_SFSC4	HR-2	5		
F_SFSC4	HR-2	5.2	136, 421, 343	
F_SFSC4	HR-3	5		
F_SFSC4	HR-3	5.3	421, 343, 529	
F_SFSC4	IC-1	3.1	323, 511, 331	
F_SFSC4	IC-2	3		
F_SFSC4	IC-2	3.2	343, 332	
F_SFSC4	PC-1	4		
F_SFSC4	PC-1	4.1	522, 432	

Proc	Path	Step No	884 Code	Code
F_SFSC4	PC-2	4		
F_SFSC4	PC-2	4.2	522, 432	
F_SFSC4	PC-3	4		
F_SFSC4	PC-3	4.3	343	
F_SFSC4	RC-1	1		
F_SFSC4	RC-1	1.1	261, 251	
F_SFSC4	RC-2	1		
F_SFSC4	RC-2	1		
F_SFSC4	RC-2	1.2	312, 251	
F_SFSC4	RC-2	1.3	312, 251	
F_SFSC4	RC-2	2		
F_SFSC4	RC-2	2		
F_SFSC4	RC-2	2.1		
F4	1	1		*
F4	1	2		
F4	1	3	529, 511	*
F4	1	4		*
F4	1	5		
F4	1	6		
F4	1	7		*

Proc	Path	Step No	884 Code	Code
F4	1	8		*
F4	1	9		*
F4	1	10		*
F4	EN	1		
F4	EN	2		
F4	EX	1		
F4	EX	2		
LOAF4	1	1		*
LOAF4	1	2		*
LOAF4	1	3		
LOAF4	1	4		
LOAF4	1	5		*
LOAF4	1	6		*
LOAF4	1	7		*
LOAF4	1	8	132	*
LOAF4	1	9	131, 122, 136	*
LOAF4	1	10	413, 436	*
LOAF4	1	11		
LOAF4	1	12	321	*
LOAF4	1	13	522, 432	*

Proc	Path	Step No	884 Code	Code
LOAF4	1	14		*
LOAF4	1	15	451, 511, 442, 422	*
LOAF4	1	16		*
LOAF4	1	17	522, 523, 136, 325, 432	*
LOAF4	1	18	325, 522, 523, 528, 432	*
LOAF4	1	19	511, 323, 136, 331	*
LOAF4	1	20		*#
LOAF4	1	21		#
LOAF4	1	22	252	*
LOAF4	1	23		
LOAF4	1	24	522, 432	*
LOAF4	1	25	526	*
LOAF4	1	26	431	*
LOAF4	1	27		*
LOAF4	1	28	326, 511, 521, 445	*
LOAF4	EN	1		
LOAF4	EN	2		
LOAF4	EX	1		
LOAF4	EX	2		
LOAF4	EX	3		

Proc	Path	Step No	884 Code	Code
LOAF4	SF	1	251, 261, 312, 253	
LOAF4	SF	2		
LOAF4	SF	3	511, 323, 331	
LOAF4	SF	4	522, 432	
LOAF4	SF	5	444, 423	
LOAF4	SF	6	136	
LOAF4	SF	7	231, 211, 212, 213, 214	
LOAF4	SF	8	231, 241	
LOAF4	SF	9	231, 241	
LOCA4	1	1		*
LOCA4	1	2		*
LOCA4	1	3		
LOCA4	1	4	5214	*
LOCA4	1	5	343	*
LOCA4	1	6	529, 511	*
LOCA4	1	7		*
LOCA4	1	8	5210	
LOCA4	1	9	351	*
LOCA4	1	10		*
LOCA4	1	11	232, 212	*

Proc	Path	Step No	884 Code	Code
LOCA4	1	12	234, 271	*
LOCA4	1	13		*
LOCA4	1	14		
LOCA4	1	15	521, 445	*
LOCA4	1	16		*
LOCA4	1	17	511, 323, 136, 331	*
LOCA4	1	18		*
LOCA4	1	19	5211	*
LOCA4	1	20	5211	*
LOCA4	1	21		*
LOCA4	1	22	321	*
LOCA4	1	23	522, 432	*
LOCA4	1	24	136	*
LOCA4	1	25	111	*
LOCA4	1	26	522, 432	*
LOCA4	1	27		*
LOCA4	1	28	451, 511, 442, 422	*
LOCA4	1	29	343, 136, 421	*
LOCA4	1	30	523, 136, 325, 528, 522, 432	*
LOCA4	1	31	325, 522, 432, 136	*

Proc	Path	Step No	884 Code	Code
LOCA4	1	32	351	*
LOCA4	1	33	351	*
LOCA4	1	34	351	*
LOCA4	1	35	233	*
LOCA4	1	36	341	*
LOCA4	1	37	526	*
LOCA4	1	38	431	*
LOCA4	1	39	323, 331, 511	*
LOCA4	1	40	221, 222	*
LOCA4	1	41		*
LOCA4	1	42		*
LOCA4	1	43		*
LOCA4	1	44	326, 511, 521, 445	*
LOCA4	1	45		
LOCA4	1	46		
LOCA4	1	47	511, 323, 136, 331	*
LOCA4	1	48		*
LOCA4	1	49	5211	*
LOCA4	1	50	5211	*
LOCA4	1	51		*

Proc	Path	Step No	884 Code	Code
LOCA4	1	52	522, 432	*
LOCA4	1	53	522, 331, 432	*
LOCA4	1	54	321	*
LOCA4	1	55	522, 432	*
LOCA4	1	56	136	*
LOCA4	1	57	111	*
LOCA4	1	58	252	*
LOCA4	1	59		
LOCA4	1	60	521, 445	*
LOCA4	1	61		*
LOCA4	1	62	522, 432	*
LOCA4	1	63		*
LOCA4	1	64	451, 511, 442, 422	*
LOCA4	1	65	523, 136, 325, 522, 432	*
LOCA4	1	66	325, 522, 432, 528	*
LOCA4	1	67	526	*
LOCA4	1	68	431	*
LOCA4	1	69		*
LOCA4	1	70	326, 511, 521, 445	*
LOCA4	EN	1		

Proc	Path	Step No	884 Code	Code
LOCA4	EN	2		
LOCA4	EX	1		
LOCA4	EX	2		
LOCA4	EX	3		
LOCA4	SF	1	251, 261, 253, 312	
LOCA4	SF	2		
LOCA4	SF	3	323, 511, 331, 332, 343	
LOCA4	SF	4	343, 522, 432	
LOCA4	SF	5	421, 441	
LOCA4	SF	6	136	
LOCA4	SF	7	235, 211, 212, 213	
LOCA4	SF	8	243, 236, 243	
LOCA4	SF	9	221, 222	
LOOP4	1	1		*
LOOP4	1	2		*
LOOP4	1	3		
LOOP4	1	4		*
LOOP4	1	5		*
LOOP4	1	6		*
LOOP4	1	7	413, 436	*

Proc	Path	Step No	884 Code	Code
LOOP4	1	8	136	*
LOOP4	1	9		*
LOOP4	1	10	321, 324	*
LOOP4	1	11		*
LOOP4	1	12	522, 432	*
LOOP4	1	13	451, 511, 442, 422	*
LOOP4	1	14		*
LOOP4	1	15		*
LOOP4	1	16		*
LOOP4	1	17	522, 523, 136, 325, 432	*
LOOP4	1	18	325, 522, 432, 343	*
LOOP4	1	19	511, 323, 136, 331	*
LOOP4	1	20		* #
LOOP4	1	21		#
LOOP4	1	22	252	*
LOOP4	1	23		
LOOP4	1	24		*
LOOP4	1	25	522, 432, 136	*
LOOP4	1	26	526	*
LOOP4	1	27	431	*

Proc	Path	Step No	884 Code	Code
LOOP4	1	28		*
LOOP4	1	29	326, 511, 521, 445	*
LOOP4	EN	1		
LOOP4	EN	2		
LOOP4	EX	1		
LOOP4	EX	2		
LOOP4	EX	3		
LOOP4	SF	1	251, 261, 312, 253	
LOOP4	SF	2		
LOOP4	SF	3	323, 511, 331	
LOOP4	SF	4	522, 432	
LOOP4	SF	5	452, 451, 511	
LOOP4	SF	6	136	
LOOP4	SF	7	231, 211, 212, 213, 214	
LOOP4	SF	8	241, 231	
LOOP4	SF	9	241, 231	
LTA4	1	1		*
LTA4	1	2		*
LTA4	1	3		*
LTA4	1	4		*

Proc	Path	Step No	884 Code	Code
LTA4	1	5	326, 511, 521, 445	*
LTA4	1	6		
MVA4	AC-1	1		*
MVA4	AC-1	2		*
MVA4	AC-1	3		*
MVA4	AC-1	4		* #
MVA4	AC-1	5		*
MVA4	AC-1	6		*
MVA4	AC-1	7		*
MVA4	AC-2	1		*
MVA4	AC-2	2		*
MVA4	AC-2	3		*
MVA4	AC-2	4		* #
MVA4	AC-2	5		#*
MVA4	AC-2	6		*
MVA4	AC-2	7		*
MVA4	AC-3	1		*
MVA4	AC-3	2		*
MVA4	AC-3	3		*
MVA4	AC-3	4		*

Proc	Path	Step No	884 Code	Code
MVA4	AC-3	5		*
MVA4	AC-3	6		*
MVA4	AC-3	7		*
MVA4	AC-CA	1		*
MVA4	DC-1	1		* #
MVA4	DC-1	2		*
MVA4	DC-1	3		*
MVA4	DC-1	4		
MVA4	DC-CA	1		*
RXTRIP4	1	1		*
RXTRIP4	1	2		*
RXTRIP4	1	3		
RXTRIP4	1	4	321, 324	*
RXTRIP4	1	5	5212, 524	*
RXTRIP4	1	6	414, 437	*
RXTRIP4	1	7	143	*
RXTRIP4	1	8		
RXTRIP4	EN	1		
RXTRIP4	EX	1		
RXTRIP4	EX	2		

Proc	Path	Step No	884 Code	Code
RXTRIP4	EX	3		
RXTRIP4	SF	1	251, 261, 312, 253	
RXTRIP4	SF	2		
RXTRIP4	SF	3	321, 324, 511, 333	
RXTRIP4	SF	4	524, 5212	
RXTRIP4	SF	5	452, 511	
RXTRIP4	SF	6	134, 414, 437	
RXTRIP4	SF	7	231, 211, 212, 213, 214	
RXTRIP4	SF	8	241, 231	
RXTRIP4	SF	9	241, 231	
SBO4	1	1		*
SBO4	1	2		*
SBO4	1	3		
SBO4	1	4		
SBO4	1	5		*
SBO4	1	6	413, 436	*
SBO4	1	7	136	*
SBO4	1	8		
SBO4	1	9		
SBO4	1	10		

Proc	Path	Step No	884 Code	Code	29
SBO4	1	11		*	
SBO4	1	12		*	
SBO4	1	13	451, 511, 442, 422	*	
SBO4	1	14	111	*	
SBO4	1	15	514, 511, 136, 421	*	
SBO4	1	16	252	*	
SBO4	1	17	252	*	
SBO4	1	18		*	
SBO4	1	19		* #	
SBO4	1	20		*	
SBO4	1	21	252	*	
SBO4	1	22	321, 511, 331, 343	*	
SBO4	1	23	522, 432	*	
SBO4	1	24		*	
SBO4	1	25		*	
SBO4	EN	1			
SBO4	EN	2			
SBO4	EX	1			
SBO4	EX	2			
SBO4	EX	3			

Proc	Path	Step No	884 Code	Code
SBO4	SF	1	251, 261, 312, 253	
SBO4	SF	2		
SBO4	SF	3	323, 331, 332, 511, 421	
SBO4	SF	4	522, 421, 432	
SBO4	SF	5	432	
SBO4	SF	6	136	
SBO4	SF	7	231, 211, 212, 213	
SBO4	SF	8	244, 231	
SBO4	SF	9	244, 231	
SGTR4	1	1		*
SGTR4	1	2		*
SGTR4	1	3		
SGTR4	1	4	5214	*
SGTR4	1	5	343	*
SGTR4	1	6	529, 511	*
SGTR4	1	7		*
SGTR4	1	8	443	
SGTR4	1	9	522, 5213, 527, 432	*
SGTR4	1	10		*
SGTR4	1	11		

Proc	Path	Step No	884 Code	Code
SGTR4	1	12	443, 143	*
SGTR4	1	13	143	*
SGTR4	1	14		
SGTR4	1	15	323, 511, 136, 331	*
SGTR4	1	16		*
SGTR4	1	17	5211	*
SGTR4	1	18	5211	*
SGTR4	1	19	522, 432	*
SGTR4	1	20	136	*
SGTR4	1	21	111	*
SGTR4	1	22	252	*
SGTR4	1	23		
SGTR4	1	24		*
SGTR4	1	25		
SGTR4	1	26	137	*
SGTR4	1	27		*
SGTR4	1	28	522, 432	*
SGTR4	1	29	522, 432	
SGTR4	1	30	321	*
SGTR4	1	31		*

Proc	Path	Step No	884 Code	Code
SGTR4	1	32	523, 136, 325, 522, 432	*
SGTR4	1	33	325, 522, 528, 523, 432	*
SGTR4	1	34	451, 442, 511, 422	*
SGTR4	1	35		*
SGTR4	1	36		*
SGTR4	1	37	522, 432, 136	*
SGTR4	1	38	137	*
SGTR4	1	39	526	*
SGTR4	1	40	431	*
SGTR4	1	41		*
SGTR4	1	42	445, 511, 521, 326	*
SGTR4	EN	1		
SGTR4	EN	2		
SGTR4	EX	1		
SGTR4	EX	2		
SGTR4	EX	3		
SGTR4	SF	1	251, 261, 312, 253	
SGTR4	SF	2		
SGTR4	SF	3	511, 323, 331, 343, 332	
SGTR4	SF	4	343, 522, 432	

Proc	Path	Step No	884 Code	Code
SGTR4	SF	5	444, 423	
SGTR4	SF	6	136	
SGTR4	SF	7	231, 211, 212, 213, 214, 443	
SGTR4	SF	8	231, 241	
SGTR4	SF	9	231, 241	
SPTA4	1	1	261, 253	
SPTA4	1	2		
SPTA4	1	3	321, 324, 511	
SPTA4	1	4	524, 5212, 5210, 5214, 523, 511	
SPTA4	1	5	452, 511	
SPTA4	1	6	134, 413, 412, 143, 144, 436, 414,	
SPTA4	1	7	231, 212, 213, 235, 211	
SPTA4	1	8	241, 231, 235, 234, 271	
SPTA4	1	9	241, 231	
SPTA4	1	10		
SPTA4	1	11		