UNIT 1 Only

AREVA Fuel Transition

Expires March 2012

B 2.0 SAFETY LIMITS (SLs)

B 2.1.1 Reactor Core SLs

BASES

BACKGROUND

Reference 1, Appendix 1C, Criterion 6 requires, and Safety Limits (SLs) ensure, that specified acceptable fuel design limits are not exceeded during steady state operation, normal operational transients, and anticipated operational occurrences (AOOs). This is accomplished by having a departure from nucleate boiling (DNB) design basis, which corresponds to a 95% probability at a 95% confidence level (95/95 DNB criterion) that DNB will not occur, and by requiring that fuel centerline temperature stays below the melting temperature.

The restrictions of this SL prevent overheating of the fuel and cladding and possible cladding perforation that would result in the release of fission products to the reactor coolant. Overheating of the fuel is prevented by maintaining the steady state peak linear heat rate below the level at which fuel centerline melting occurs. Overheating of the fuel cladding is prevented by restricting fuel operation to within the nucleate boiling regime, where the heat transfer coefficient is large and the cladding surface temperature is slightly above the coolant saturation temperature.

Fuel centerline melting occurs when the local linear heat rate or power peaking in a region of the fuel is high enough to cause the fuel centerline temperature to reach the melting point of the fuel. Expansion of the pellet upon centerline melting may cause the pellet to stress the cladding to the point of failure, allowing an uncontrolled release of activity to the reactor coolant.

Operation above the boundary of the nucleate boiling regime could result in excessive cladding temperature because of the onset of DNB and the resultant sharp reduction in heat transfer coefficient. Inside the steam film, high cladding temperatures are reached and a cladding-water (zirconium-water) reaction may take place. This chemical reaction results in oxidation of the fuel cladding to a structurally weaker form. This weaker form may lose its integrity, resulting in an uncontrolled release of activity to the reactor coolant.

The Reactor Protective System (RPS), in combination with the Limiting Conditions for Operation (LCOs), is designed to prevent any anticipated combination of transient conditions for Reactor Coolant System (RCS) temperature, pressure, and THERMAL POWER level that would result in a violation of the reactor core SLs.

APPLICABLE SAFETY ANALYSES

The fuel cladding must not sustain damage as a result of normal operation and AOOs. The reactor core SLs are established to preclude violation of the following fuel design criteria:

a. There must be at least 95% probability at a 95% confidence level (the 95/95 DNB criterion) that the hot fuel rod in the core does not experience a DNB; and

b. The hot fuel pellet in the core must not experience fuel centerline melting.

The RPS setpoints, LCO 3.3.1, in combination with all the LCOs, are designed to prevent any anticipated combination of transient conditions for RCS temperature, pressure, and THERMAL POWER level that would result in a departure from nucleate boiling ratio (DNBR) of less than the DNBR limit and preclude the existence of flow instabilities.

Automatic enforcement of these reactor core SLs is provided by the following functions:

a. Pressurizer Pressure-High trip;

b. Power Level-High trip;

c. Rate of Change of Power-High trip;

d. Reactor Coolant Flow-Low trip;

e. Steam Generator Pressure-Low trip;

f. Steam Generator Level-Low trip;

g. Axial Power Distribution-High trip;

h. Thermal Margin/Low Pressure trip;

i. Steam Generator Pressure Difference trip; and

j. Steam Generator Safety Valves.

The SL represents a design requirement for establishing the RPS trip setpoints identified previously. Limiting Condition for Operation (LCO) 3.2.1, or the assumed initial conditions of the safety analyses (as indicated in Reference 1, Section 14.1), provide more restrictive limits to ensure that the SLs are not exceeded.

SAFETY LIMITS

The curves provided in Figure 2.1.1-1 show the loci of points of THERMAL POWER, pressurizer pressure, and highest operating loop cold leg temperature for which the minimum DNBR is not less than the safety analysis limit. Safety Limit 2.1.1.2 ensures that fuel centerline temperature remains below melting.

APPLICABILITY

Safety Limit 2.1.1 only applies in MODEs 1 and 2 because these are the only MODEs in which the reactor is critical. Automatic protection functions are required to be OPERABLE during MODEs 1 and 2 to ensure operation within the reactor core SLs. The steam generator safety valves or automatic protection actions serve to prevent RCS heatup to the reactor core SL conditions or to initiate a reactor trip function, which forces the unit into MODE 3. Setpoints for the reactor trip functions are specified in LCO 3.3.1.

In MODEs 3, 4, 5, and 6, Applicability is not required, since the reactor is not generating significant THERMAL POWER.

SAFETY LIMIT VIOLATIONS

The following SL violation responses are applicable to the reactor core SLs.

2.2.1

If SL 2.1.1 is violated, the requirement to go to MODE 3 places the unit in a MODE in which this SL is not applicable.

BASES

The allowed Completion Time of 1 hour recognizes the importance of bringing the unit to a MODE of operation where this SL is not applicable and reduces the probability of fuel damage.

REFERENCES 1. UFSAR

UNIT 2 Only

AREVA Fuel Transition

Expires March 2012

B 2.0 SAFETY LIMITS (SLs)

B 2.1.1 Reactor Core SLs

BASES

BACKGROUND

Reference 1, Appendix 1C, Criterion 6 requires, and Safety Limits (SLs) ensure, that specified acceptable fuel design limits are not exceeded during steady state operation, normal operational transients, and anticipated operational occurrences (AOOs). This is accomplished by having a departure from nucleate boiling (DNB) design basis, which corresponds to a 95% probability at a 95% confidence level (95/95 DNB criterion) that DNB will not occur, and by requiring that fuel centerline temperature stays below the melting temperature.

The restrictions of this SL prevent overheating of the fuel and cladding and possible cladding perforation that would result in the release of fission products to the reactor coolant. Overheating of the fuel is prevented by maintaining the steady state peak linear heat rate below the level at which fuel centerline melting occurs. Overheating of the fuel cladding is prevented by restricting fuel operation to within the nucleate boiling regime, where the heat transfer coefficient is large and the cladding surface temperature is slightly above the coolant saturation temperature.

Fuel centerline melting occurs when the local linear heat rate or power peaking in a region of the fuel is high enough to cause the fuel centerline temperature to reach the melting point of the fuel. Expansion of the pellet upon centerline melting may cause the pellet to stress the cladding to the point of failure, allowing an uncontrolled release of activity to the reactor coolant.

Operation above the boundary of the nucleate boiling regime could result in excessive cladding temperature because of the onset of DNB and the resultant sharp reduction in heat transfer coefficient. Inside the steam film, high cladding temperatures are reached and a cladding-water (zirconium-water) reaction may take place. This chemical reaction results in oxidation of the fuel cladding to a structurally weaker form. This weaker form may lose its integrity, resulting in an uncontrolled release of activity to the reactor coolant.

The Reactor Protective System (RPS), in combination with the Limiting Conditions for Operation (LCOs), is designed to prevent any anticipated combination of transient conditions for Reactor Coolant System (RCS) temperature, pressure, and THERMAL POWER level that would result in a violation of the reactor core SLs.

APPLICABLE SAFETY ANALYSES

The fuel cladding must not sustain damage as a result of normal operation and AOOs. The reactor core SLs are established to preclude violation of the following fuel design criteria:

a. There must be at least 95% probability at a 95% confidence level (the 95/95 DNB criterion) that the hot fuel rod in the core does not experience a DNB; and

b. The hot fuel pellet in the core must not experience fuel centerline melting.

The RPS setpoints, LCO 3.3.1, in combination with all the LCOs, are designed to prevent any anticipated combination of transient conditions for RCS temperature, pressure, and THERMAL POWER level that would result in a departure from nucleate boiling ratio (DNBR) of less than the DNBR limit and preclude the existence of flow instabilities.

Automatic enforcement of these reactor core SLs is provided by the following functions:

a. Pressurizer Pressure-High trip;

b. Power Level-High trip;

c. Rate of Change of Power-High trip;

d. Reactor Coolant Flow-Low trip;

e. Steam Generator Pressure-Low trip;

f. Steam Generator Level-Low trip;

g. Axial Power Distribution-High trip;

h. Thermal Margin/Low Pressure trip;

BASES

i. Steam Generator Pressure Difference trip; and

j. Steam Generator Safety Valves.

The SL represents a design requirement for establishing the RPS trip setpoints identified previously. Limiting Condition for Operation (LCO) 3.2.1, or the assumed initial conditions of the safety analyses (as indicated in Reference 1, Section 14.1), provide more restrictive limits to ensure that the SLs are not exceeded.

SAFETY LIMITS

The curves provided in Figure 2.1.1-1 show the loci of points of THERMAL POWER, pressurizer pressure, and highest operating loop cold leg temperature for which the minimum DNBR is not less than the safety analysis limit. Safety Limit 2.1.1.2 ensures that fuel centerline temperature remains below melting.

Safety Limit 2.1.1.2 ensures that fuel centerline temperature remains below the fuel melt temperature of 5081°F for AREVA fuel and 5080°F for Westinghouse fuel during normal operating conditions or design AOOs with adjustments for burnup and burnable poison. For AREVA fuel, an adjustment of 58°F per 10,000 MWd/MTU has been established and adjustments for burnable poisons are established based on Topical Report XN-NF-79-56(P)(A) (Reference 2). For Westinghouse fuel, an adjustment of 58°F per 10,000 MWd/MTU has been established and adjustments for burnable poisons are established based on Topical Report CENPD-382-P-A (Reference 3).

APPLICABILITY

Safety Limit 2.1.1 only applies in MODEs 1 and 2 because these are the only MODEs in which the reactor is critical. Automatic protection functions are required to be OPERABLE during MODEs 1 and 2 to ensure operation within the reactor core SLs. The steam generator safety valves or automatic protection actions serve to prevent RCS heatup to the reactor core SL conditions or to initiate a reactor trip function, which forces the unit into MODE 3. Setpoints for the reactor trip functions are specified in LCO 3.3.1.

BASES

In MODEs 3, 4, 5, and 6, Applicability is not required, since the reactor is not generating significant THERMAL POWER.

SAFETY LIMIT VIOLATIONS	The following SL violation responses are applicable to the reactor core SLs. <u>2.2.1</u> If SL 2.1.1 is violated, the requirement to go to MODE 3 places the unit in a MODE in which this SL is not applicable. The allowed Completion Time of 1 hour recognizes the importance of bringing the unit to a MODE of operation where this SL is not applicable and reduces the probability of fuel damage.
REFERENCES	1. UFSAR 2. XN-NF-79-56(P)(A), Gadolinina Fuel Properties for LWR Fuel Safety Evaluation 3. CENPD-382-P-A, Methodology for Core Designs Containing Erbium Burnable Absorbers

B 2.0 SAFETY LIMITS (SLs)

B 2.1.2 Reactor Coolant System (RCS) Pressure SL

BASES

BACKGROUND	The SL on RCS pressure protects the integrity of the RCS against overpressurization. In the event of fuel cladding failure, fission products are released into the reactor coolant. The RCS then serves as the primary barrier in preventing the release of fission products into the atmosphere. By establishing an upper limit on RCS pressure, continued RCS integrity is ensured. According to Reference 1, Appendix 1C, Criteria 9 and 33, the reactor coolant pressure boundary (RCPB) design conditions are not to be exceeded during normal operation and AOOs. Also, according to Reference 1, Appendix 1C, Criterion 32, reactivity accidents do not result in rupturing the RCPB. The design pressure of the RCS is 2500 psia. During normal operation and AOOs, the RCS pressure is kept from exceeding the design pressure by more than 10%, in accordance with Reference 2, Section III, Article NB-7000. To ensure system integrity, all RCS components are hydrostatically tested at 125% of design pressure, according to the American Society of Mechanical Engineers (ASME) Code requirements, prior to initial operation, when there is no fuel in the core. Following inception of unit operation, RCS components shall be pressure tested, in accordance with the requirements of Reference 2, Section XI, Article IWX-5000. Overpressurization of the RCS could result in a breach of the RCPB. If this occurs in conjunction with a fuel cladding failure, fission products could enter the containment atmosphere, raising concerns relative to limits on radioactive releases specified in Reference 1, Chapter 14.
APPLICABLE SAFETY ANALYSES	The RCS pressurizer safety valves, the main steam safety valves, and the Reactor Pressure-High trip have settings established to ensure that the RCS pressure SL will not be exceeded. The RCS pressurizer safety valves are sized to prevent system pressure from exceeding the design pressure by more than 10%, in accordance with Reference 2, Section III,

Article NB-7000. The transient that establishes the required relief capacity, and hence the valve size requirements and lift settings, is a complete loss of external load without a direct reactor trip. During the transient, no control actions are assumed except that the safety valves on the secondary plant are assumed to open when the steam pressure reaches the secondary plant safety valve settings, and nominal feedwater supply is maintained.

The Reactor Protective System trip setpoints (LCO 3.3.1), together with the settings of the main steam safety valves (LCO 3.7.1) and the pressurizer safety valves, provide pressure protection for normal operation and AOOs. In particular, the Pressurizer Pressure-High trip setpoint is specifically set to provide protection against overpressurization (Reference 1, Section 14.1). Safety analyses for both the Pressure-High trip and the RCS pressurizer safety valves are performed, using conservative assumptions relative to pressure control devices.

More specifically, no credit is taken for operation of the following:

a. Pressurizer power-operated relief valves;

b. Steam Bypass Control System;

c. Pressurizer Level Control System; or

d. Pressurizer Pressure Control System.

SAFETY LIMITS

The maximum transient pressure allowable in the RCS pressure vessel in Reference 2, Section III, Article NB-7000 is 110% of design pressure. The maximum transient pressure allowable in the RCS piping, valves, and fittings under Reference 3, is 110% of design pressure. The most limiting of these two allowances is the 110% of design pressure; therefore, the SL on maximum allowable RCS pressure is established at 2750 psia.

APPLICABILITY

Safety Limit 2.1.2 applies in MODEs 1, 2, 3, 4, and 5 because this SL could be approached or exceeded in these MODEs due to overpressurization events. The SL is not applicable in MODE 6 because the reactor vessel head is unbolted, making it unlikely that the RCS can be pressurized.

SAFETY LIMIT VIOLATIONS

The following SL violation responses are applicable to the RCS pressure SL.

2.2.2.1

If the RCS pressure SL is violated when the reactor is in MODE 1 or 2, the requirement is to restore compliance and be in MODE 3 within 1 hour.

With RCS pressure greater than the value specified in SL 2.1.2 in MODE 1 or 2, the pressure must be reduced below this value. A pressure greater than the value specified in SL 2.1.2 exceeds 110% of the RCS design pressure and may challenge system integrity.

The allowed Completion Time of 1 hour provides the operator time to complete the necessary actions to reduce RCS pressure by terminating the cause of the pressure increase, removing mass or energy from the RCS, or a combination of these actions, and to establish MODE 3 conditions.

2.2.2.2

If the RCS pressure SL is exceeded in MODE 3, 4, or 5, RCS pressure must be restored to within the SL value within 5 minutes.

Exceeding the RCS pressure SL in MODE 3, 4, or 5 is potentially more severe than exceeding this SL in MODE 1 or 2, since the reactor vessel temperature may be lower and the vessel material, consequently, less ductile. As such, pressure must be reduced to less than the SL within 5 minutes. This action does not require reducing MODEs, since this would require reducing temperature, which would compound the problem by adding thermal gradient stresses to the existing pressure stress.

BASES

REFERENCES

1. UFSAR
2. ASME, Boiler and Pressure Vessel Code
3. ASME, USAS B31.7, Standard Code for Pressure Piping, 1967