SAFETY LIMIT

1.1 FUEL CLADDING INTEGRITY

Applicability:

The Safety Limits established to preserve the fuel cladding integrity apply to those variables which monitor the fuel thermal behavior.

Objectives:

The objective of the Safety Limits is to establish limits which assure the integrity of the fuel cladding.

Specification:

A. Reactor pressure ≥800 psia and Core Flow ≥10% of Rated

The existence of a minimum critical power ratio MCPR less than 1.07 for two recirculation loop operation, or 1.08 for single loop operation, shall constitute violation of the fuel cladding integrity safety limit.

To ensure that this safety limit is not exceeded, neutron flux shall not be above the scram setting established in specification 2.1.A for longer than 1.15 seconds as indicated by the process computer. When the process computer is out of service this safety limit shall be assumed to be exceeded if the neutron flux exceeds its scram setting and a control rod scram does not occur.

LIMITING SAFETY SYSTEM SETTING

2.1 FUEL CLADDING INTEGRITY

Applicability:

The Limiting Safety System Settings apply to trip settings of the instruments and devices which are provided to prevent the fuel cladding integrity Safety Limits from being exceeded.

Objectives:

The objective of the Limiting Safety System Settings is to define the level of the process variables at which automatic protective action is initiated to prevent the fuel cladding integrity Safety Limits from being exceeded.

Specification:

The limiting safety system settings shall be as specified below:

A. Neutron Flux Scram

1. APRM Flux Scram Trip Setting (Run Mode)

When the Mode Switch is in the RUN position, the APRM flux scram trip setting shall be:

$$S \leq 0.66W + 54\% - 0.66\ \Delta W$$

where:

S = Setting in percent of rated thermal power (3293 MWt)

W = Loop recirculation flow rate in percent of rated (rated loop recirculation flow rate equals 34.2×10^6 lb/hr).

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING
1.1 FUEL CLADDING INTEGRITY	2.1 FUEL CLADDING INTEGRITY

ΔW = Difference between two loop and single loop effective recirculation drive flow rate at the same core flow. During single loop operation, the reduction in trip setting (-0.66 ΔW)) is accomplished by correcting the flow input of the flow biased scram to preserve the original (two loop) relationship between APRM scram setpoint and recirculation drive flow or by adjusting the APRM flux trip setting.
ΔW = 0 for two loop operation.

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING
	2.1.A (Cont'd)

In the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP), the setting shall be modified as follows.

$$S \leq (0.66\ W + 54\% - 0.66\ \Delta W) \left(\frac{FRP}{MFLPD}\right)$$

where,

FRP = fraction of rated thermal power (3293 MWt)

MFLPD = maximum fraction of limiting power density where the limiting power density is 13.4 KW/ft for all 8x8 fuel.

The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

2. APRM--When the reactor mode switch is in the STARTUP position, the APRM scram shall be set at less than or equal to 15 percent of rated power.

3. IRM--The IRM scram shall be set at less than or equal to 120/125 of full scale.

4. When the reactor mode switch is in the STARTUP or RUN position, the reactor shall not be operated in the natural circulation flow mode.

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING

2.1.A (Cont'd)

In the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP), the setting shall be modified as follows.

$$S \leq (0.66\ W + 54\% - 0.66\ \Delta W)\left(\frac{FRP}{MFLPD}\right)$$

where,

FRP = fraction of rated thermal power (3293 MWt)

MFLPD = maximum fraction of limiting power density where the limiting power density is 18.5 KW/ft for all 7X7 fuel and 13.4 KW/ft for all 8X8 fuel.

The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

2. APRM--When the reactor mode switch is in the STARTUP position, the APRM scram shall be set at less than or equal to 15 percent of rated power.

3. IRM--The IRM scram shall be set at less than or equal to 120/125 of full scale.

4. When the reactor mode switch is in the STARTUP or RUN position, the reactor shall not be operated in the natural circulation flow mode.

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING

B. Core Thermal Power Limit (Reactor Pressure ≤ 800 psia)

When the reactor pressure is ≤ 800 psia or core flow is less than 10% of rated, the core thermal power shall not exceed 25% of rated thermal power.

B. APRM Rod Block Trip Setting

$SRB \leq 0.66\ W + 42\% - 0.66\ \Delta W$

where:

SRB= Rod block setting in percent of rated thermal power (3293 MWt)

W = Loop recirculation flow rate in percent of design W is 100 for core flow of 102.5 million lb/hr or greater.

ΔW = difference between two loop and single loop effective recirculation drive flow at the same core flow. During single loop operation, the reduction in trip setting (-0.66 ΔW) is accomplished by correcting the flow input of the flow biased rod block to preserve the original (two loop) relationship between APRM Rod block setpoint and recirculation drive flow or by adjusting the APRM Rod Block trip setting. ΔW = 0 for two loop operation.

In the event of operation with maximum fraction limiting power density (MFLPD) greater than the fraction of rated power (FRP); the setting shall be modified as follows.

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING
B. Core Thermal Power Limit (Reactor Pressure ≤ 800 psia)	B. APRM Rod Block Trip Setting $SRB \leq (0.66\ W + 42\% - 0.66\ \Delta W)\ \frac{(FRP)}{MFLPD}$ where: FRP = fraction of rated thermal power (3293 MWt). MFLPD = maximum fraction of limiting power density where the limiting power density is 13.4 KW/ft for all 8x8 fuel The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.
C. Whenever the reactor is in the shutdown condition with irradiated fuel in the reactor vessel, the water level shall not be less than 17.1 in. above the top of the normal active fuel zone.	C. Scram and isolation--reactor low water level: ≥538 in. above vessel zero (0" on level instruments)

SAFETY LIMIT	LIMITING SAFETY SYSTEM SETTING
B. Core Thermal Power Limit (Reactor Pressure ≤ 800 psia)	B. APRM Rod Block Trip Setting

$$SRB \le (0.66\ W + 42\% - 0.66\ \Delta W)\ \frac{(FRP)}{MFLPD}$$

where:

FRP = fraction of rated thermal power (3293 MWt).

MFLPD = maximum fraction of limiting power density where the limiting power density is 18.5 KW/ft for all 7x7 fuel and 13.4 KW/ft for all 8x8 fuel

The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

C. Whenever the reactor is in the shutdown condition with irradiated fuel in the reactor vessel, the water level shall not be less than 17.1 in. above the top of the normal active fuel zone.

C. Scram and isolation reactor low water level -- ≥538 in. above vessel zero (0" on level instruments)

TABLE 3.1.1

REACTOR PROTECTION SYSTEM (SCRAM) INSTRUMENTATION REQUIREMENT

Minimum No. of Operable Instrument Channels per Trip System (1)	Trip Function	Trip Level Setting	Modes in Which Function Must be Operable			Number of Instrument Channels Provided by Design	Action (1)
			Refuel (7)	Startup	Run		
1	Mode Switch In Shutdown		X	X	X	1 Mode Switch (4 Sections)	A
1	Manual Scram		X	X	X	2 Instrument Channels	A
3	IRM High Flux	≤120/125 of Full Scale	X	X	(5)	8 Instrument Channels	A
3	IRM Inoperative		X	X	(5)	8 Instrument Channels	A
2	APRM High Flux	(.66W+54-0.66ΔW) FRP/MFLPD (12) (13)			X	6 Instrument Channels	A or B
2	APRM Inoperative	(11)	X	X	X	6 Instrument Channels	A or B
2	APRM Downscale	≥2.5 Indicated on Scale			(10)	6 Instrument Channels	A or B
2	APRM High Flux in Startup	≤15% Power	X	X		6 Instrument Channels	A
2	High Reactor Pressure	≤1055 psig	X (9)	X	X	4 Instrument Channels	A
2	High Drywell Pressure	≤2 psig	X (8)	X (8)	X	4 Instrument Channels	A
2	Reactor Low Water Level	≥0 in. Indicated Level	X	X	X	4 Instrument Channels	A

NOTES FOR TABLE 3.1.1 (Cont'd)

10. The APRM downscale trip is automatically bypassed when the IRM instrumentation is operable and not high.

11. An APRM will be considered operable if there are at least 2 LPRM inputs per level and at least 14 LPRM inputs of the normal complement.

12. This equation will be used in the event of operation with a maximum fraction of limiting power density (MFLPD(greater than the fraction of rated power (FRP), where:

    FRP = fraction of rated thermal power (3293 MWt).

    MFLPD = maximum fraction of limiting power density where the limiting power density is 13.4 KW/ft for all 8x8 fuel.

    The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

    W = Loop Recirculation flow in percent of design. W is 100 for core flow of 102.5 million lb/hr or greater.

    ΔW = the difference between two loop and single loop effective recirculation drive flow rate at the same core flow. During single loop operation, the reduction in trip setting ($-0.66\Delta W$) is accomplished by correcting the flow input of the flow biased High Flux trip setting to preserve the original (two loop) relationship between APRM High Flux setpoint and recirculation drive flow or by adjusting the APRM Flux trip setting. W = 0 for two loop operation.

    Trip level setting is in percent of rated power (3293 MWt).

13. See Section 2.1.A.1.

NOTES FOR TABLE 3.1.1 (Cont'd)

10. The APRM downscale trip is automatically bypassed when the IRM instrumentation is operable and not high.

11. An APRM will be considered operable if there are at least 2 LPRM inputs per level and at least 14 LPRM inputs of the normal complement.

12. This equation will be used in the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP), where:

    FRP = fraction of rated thermal power (3293 MWt).

    MFLPD = maximum fraction of limiting power density where the limiting power density is 18.5 KW/ft for all 7x7 fuel and 13.4 KW/ft for all 8x8 fuel.

    The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

    W = Loop Recirculation flow in percent of design. W is 100 for core flow of 102.5 million lb/hr or greater.

    ΔW = the difference between two loop and single loop effective recirculation drive flow rate at the same core flow. During single loop operation, the reduction in trip setting ($-0.66\Delta W$) is accomplished by correcting the flow input of the flow biased High Flux trip setting to preserve the original (two loop) relationship between APRM High Flux setpoint and recirculation drive flow or by adjusting the APRM Flux trip setting. W = 0 for two loop operation.

    Trip level setting is in percent of rated power (3293 MWt).

13. See Section 2.1.A.1.

TABLE 3.2.C
INSTRUMENTATION THAT INITIATES CONTROL ROD BLOCKS

Minimum No. of Operable Instrument Channels Per Trip System	Instrument	Trip Level Setting	Number of Instrument Channels Provided by Design	Action
2	APRM Upscale (Flow Biased)	$\leq (0.66W+42-0.66\Delta W) \times \frac{FRP}{MFLPD}$ (2)	6 Inst. Channels	(1)
2	APRM Upscale (Startup Mode)	$\leq$12%	6 Inst. Channels	(1)
2	APRM Downscale	$\geq$2.5 indicated on scale	6 Inst. Channels	(1)
1 (7)	Rod Block Monitor (Flow Biased)	$\leq (0.66W+41-0.66\Delta W \times \frac{FRP}{MFLPD}$ (2)	2 Inst. Channels	(1)
1 (7)	Rod Block Monitor Downscale	$\geq$2.5 indicated on scale	2 Inst. Channels	(1)
3	IRM Downscale (3)	$\geq$2.5 indicated on scale	8 Inst. Channels	(1)
3	IRM Detector not in Startup Position	(8)	8 Inst. Channels	(1)
3	IRM Upscale	$\leq$108 indicated on scale	8 Inst. Channels	(1)
2 (5)	SRM Detector not in Startup Position	(4)	4 Inst. Channels	(1)
2 (5) (6)	SRM Upscale	$\leq 10^5$ counts/sec.	4 Inst. Channels	(1)

UNITS 2,3

NOTES FOR TABLE 3.2.C

1. For the startup and run positions of the Reactor Mode Selector Switch, there shall be two operable or tripped trip systems for each function. The SRM and IRM blocks need not be operable in "Run" mode, and the APRM and RBM rod blocks need not be operable in "Startup" mode. If the first column cannot be met for one of the two trip systems, this condition may exist for up to seven days provided that during that time the operable system is functionally tested immediately and daily thereafter; if this condition lasts longer than seven days, the system shall be tripped. If the first column cannot be met for both trip systems, the systems shall be tripped.

2. This equation will be used in the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP) where:

   FRP = fraction of rated thermal power (3293 MWt)
   MFLPD = maximum fraction of limiting power density where the limiting power density is 13.4 KW/ft for all 8x8 fuel.

   The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

   W = Loop Recirculation flow in percent of design. W is 100 for core flow of 102.5 million lb/hr or greater.
   Trip level setting is in percent of rated power (3293 MWt).

   ΔW is the difference between two loop and single loop effective recirculation drive flow rate at the same core flow. During single loop operation, the reduction in trip setting ($-0.66\Delta W$) is accomplished by correcting the flow input of the flow biased Rod Block Monitor (RBM) to preserve the original (two loop) relationship between the RBM setpoint and recirculation drive flow, or by adjusting the RBM setting. W = 0 for two loop operation.

3. IRM downscale is bypassed when it is on its lowest range.

4. This function is bypassed when the count rate is ≥ 100 cps.

5. One of the four SRM inputs may be bypassed.

6. This SRM function is bypassed when the IRM range switches are on range 8 or above.

7. The trip is bypassed when the reactor power is ≤ 30%.

8. This function is bypassed when the mode switch is placed in Run.

NOTES FOR TABLE 3.2.C

1. For the startup and run positions of the Reactor Mode Selector Switch, there shall be two operable or tripped trip systems for each function. The SRM and IRM blocks need not be operable in "Run" mode, and the APRM and RBM rod blocks need not be operable in "Startup" mode. If the first column cannot be met for one of the two trip systems, this condition may exist for up to seven days provided that during that time the operable system is functionally tested immediately and daily thereafter; if this condition lasts longer than seven days, the system shall be tripped. If the first column cannot be met for both trip systems, the systems shall be tripped.

2. This equation will be used in the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP) where:

   FRP = fraction of rated thermal power (3293 MWt)

   MFLPD = maximum fraction of limiting power density where the limiting power density is 18.5 KW/ft for all 7x7 fuel and 13.4 KW/ft for all 8x8 fuel.

   The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which case the actual operating value will be used.

   W = Loop Recirculation flow in percent of design. W is 100 for core flow of 102.5 million lb/hr or greater.
   Trip level setting is in percent of rated power (3293 MWt).

   ΔW is the difference between two loop and single loop effective recirculation drive flow rate at the same core flow. During single loop operation, the reduction in trip setting ($-0.66\Delta W$) is accomplished by correcting the flow input of the flow biased Rod Block Monitor (RBM) to preserve the original (two loop) relationship between the RBM setpoint and recirculation drive flow, or by adjusting the RBM setting. W = 0 for two loop operation.

3. IRM downscale is bypassed when it is on its lowest range.

4. This function is bypassed when the count rate is ≥ 100 cps.

5. One of the four SRM inputs may be bypassed.

6. This SRM function is bypassed when the IRM range switches are on range 8 or above.

7. The trip is bypassed when the reactor power is ≤ 30%.

8. This function is bypassed when the mode switch is placed in Run.

LIMITING CONDITIONS FOR OPERATION

3.5.I Average Planar LHGR

During power operation, the APLHGR for each type of fuel as a function of average planar exposure shall not exceed the limiting value shown in Figure 3.5.1.C, D, F, G, H, and I as applicable during two recirculation loop operation. During single loop operation, the APLHGR for each fuel type shall not exceed the above values multipled by the following reduction factors: 0.82 for 8X8 fuel; 0.79 for LTA; 0.80 for 8X8R, and P8X8R fuel. If at any time during operation it is determined by normal surveillance that the limiting value of APLHGR is being exceeded, action shall be initiated within one (1) hour to restore APLHGR to within prescribed limits. If the APLHGR is not returned to within prescribed limits within five (5) hours reactor power shall be decreased at a rate which would bring the reactor to the cold shutdown condition within 36 hours unless APLHGR is returned to within limits during this period. Surveillance and corresponding action shall continue until reactor operation is within the prescribed limits.

3.5.J Local LHGR

During power operation, the linear heat generation rate (LHGR) of any rod in any fuel assembly at any axial location shall not exceed the design LHGR.

LHGR $\leq$ LHGRd
LHGRd = Design LHGR
13.4 Kw/ft for all 8X8 fuel.

SURVEILLANCE REQUIREMENTS

4.5.I Average Planar LHGR

The APLHGR for each type of fuel as a function of average planar exposure shall be checked daily during reactor operation at $\geq$25% rated thermal power.

4.5.J Local LHGR

The LHGR as a function of core height shall be checked daily during reactor operation at $\geq$25% rated thermal power.

LIMITING CONDITIONS FOR OPERATION

3.5.I Average Planar LHGR

During power operation, the APLHGR for each type of fuel as a function of average planar exposure shall not exceed the limiting value shown in Figure 3.5.1.A,B, C, D, F,G & H as applicable during two recirculation loop operation. During single loop operation, the APLHGR for each fuel type shall not exceed the above values multipled by the following reduction factors: 0.71 for 7X7 fuel; 0.83 for 8X8 fuel; 0.81 for PTA, 8X8R and P8X8R fuel. If at any time during operation it is determined by normal surveillance that the limiting value of APLHGR is being exceeded, action shall be initiated within one (1) hour to restore APLHGR to within prescribed limits. If the APLHGR is not returned to within prescribed limits within five (5) hours reactor power shall be decreased at a rate which would bring the reactor to the cold shutdown condition within 36 hours unless APLHGR is returned to within limits during this period. Surveillance and corresponding action shall continue until reactor operation is within the prescribed limits.

3.5.J Local LHGR

During power operation, the linear heat generation rate (LHGR) of any rod in any fuel assembly at any axial location shall not exceed the maximum allowable LHGR as calculated by the following equation:

$LHGR \leq LHGRd\ (1-(\Delta P/P)max(L/LT)$

LHGRd = Design LHGR
 = 18.5 kW/ft for 7X7 fuel
 13.4 kW/ft for all 8x8 fuel

(P/P)max = Maximum power spiking penalty
 = 0.026 for 7x7 fuel
 = 0.000 for 8x8 fuel

LT = Total core length
 = 12.167 ft for 7x7 & 8x8 fuel
 = 12.5 ft for 8x8R, 8x8 PTA and P 8x8R fuel

L = Axial position above bottom of core

SURVEILLANCE REQUIREMENTS

4.5.I Average Planar LHGR

The APLHGR for each type of fuel as a function of average planar exposure shall be checked daily during reactor operation at ≥25% rated thermal power

4.5.J Local LHGR

The LHGR as a function of core height shall be checked daily during reactor operation at ≥25% rated thermal power.

Table 3.5-2

OPERATING LIMIT MCPR VALUES AS DETERMINED FROM INDICATED TRANSIENTS FOR VARIOUS CORE EXPOSURES

Fuel Type	MCPR Operating Limit* For Incremental Cycle 5 Core Average Exposure	
	BOC to 1000 MWD/t Before EOC	1000 MWD/t before EOC To EOC
8x8	1.28	1.28
8x8R & LTA	1.28	1.28
P8x8R	1.30	1.30

* These values shall be increased by 0.01 for Single Loop Operation

Table 3.5-2

OPERATING LIMIT MCPR VALUES AS DETERMINED FROM INDICATED TRANSIENTS FOR VARIOUS CORE EXPOSURES

Fuel Type	MCPR Operating Limit* For Incremental Cycle 4 Core Average Exposure	
	BOC to 2000 MWD/t Before EOC	2000 MWD/t before EOC To EOC
7x7	1.23 (LH)	1.23 (LR)
8x8	1.24 (LH)	1.30 (LR)
PTA & P 8x8R	1.27 (RWE)	1.32 (LR)
8x8R	1.27 (RWE)	1.30 (LR)

RWE - Rod Withdrawal Error
LR - Load Rejection with failure of bypass valves to open
LH Loss of 100 °F Feedwater Heating

* These values shall be increased by 0.01 for single loop operation.

LIMITING CONDITION FOR OPERATION

3.6.E Jet Pumps

1. Whenever the reactor is in the startup or run modes, all jet pumps shall be operable. If it is determined that a jet pump is inoperable, an orderly shutdown shall be initiated and the reactor shall be in a Cold Shutdown within 24 hours.

2) Flow indications from each of the 20 jet pumps during two loop operation or 10 jet pumps during single loop operation shall be verified prior to initiation of reactor startup from a cold shutdown condition.

3) The indicated core flow is the sum of the flow indication from each of the 20 jet pumps. If flow indication failure occurs for two or more jet pumps immediate corrective action shall be taken. If flow indication for all but 1 jet pump cannot be obtained within 12 hours an orderly shutdown shall be initiated, and the reactor shall be in cold shutdown condition within 24 hours.

SURVEILLANCE REQUIREMENTS

4.6.E Jet Pumps

1. Whenever there is recirculation flow with the reactor in the startup or run modes, jet pump operability shall be checked daily by verifying that the following conditions do not occur simultaneously:

a) The two recirculation loops have a flow imbalance of 15% or more when the pumps are operated at the same speed.

b) The indicated value of core flow rate varies from the value derived from loop flow measurements by more than 10%.

c) The diffuser to lower plenum differential pressure reading on an individual jet pump varies from the mean of all jet pump differential pressures by more than 10%.

2. Additionally when operating with one recirculation pump with the equalizer valves closed, the diffuser to lower plenum differential pressure shall be checked daily and the differential pressure of any jet pump in the idle loop shall not vary by more than 10% from established pattern.

3. The baseline data required to evaluate the conditions in specification 4.6.E.1 and 4.6.E.2 will be obtained each operating cycle.

LIMITING CONDITION FOR OPERATION	SURVEILLANCE REQUIREMENTS
3.6.F Recirculation Pumps	3.6.F Recirculation Pumps
1. Following one-pump operation, the discharge valve of the low speed pump may not be opened unless the speed of the faster pump is less than 50% of its rated speed.	
2. The requirements applicable to single loop operation as identified in sections 1.1.A, 2.1.A, 2.1.B, 3.5.I & 3.5.K shall be in effect within 24 hours following the removal of one recirculation loop from service, or the unit placed in the Hot Shutdown condition.	
3.6.G Structural Integrity	4.6.G Structural Integrity
The structural integrity of the primary system boundary shall be maintained at the level required by the original acceptance standards throughout the life of the station. The reactor shall be maintained in a Cold shutdown condition until each indication of a defect has been investigated and evaluated.	The nondestructive inspections listed in Table 4.6.1 shall be performed as specified. The results obtained from compliance with the specification will be evaluated after 5 years and the conclusions of this evaluation will be reviewed with the AEC.

3.6.F & 4.6.F BASES

Jet Pump Flow Mismatch

Requiring the discharge valve of the lower speed loop to remain closed until the speed of faster pump is below 50% of its rated speed provides assurance when going from one to two pump operation that excessive vibration of the jet pump risers will not occur.

Operation with one recirculation loop in service is permitted. In such instances, the designated adjustments for APRM rod block and scram setpoints, RBM setpoint, MCPR fuel cladding integrity safety limit, MCPR operating limits, and MAPLHGR limits are required.