WESTINGHOUSE TECHNOLOGY ADVANCED MANUAL LESSON PLAN	
Ch. 3.1	Title: ANALYSIS OF T/S - UNIT 1
Written by: Van Sickle	Date: 03/99

Learning Objectives (Objective 4 is a standard objective for all T/S sections)	**Learning Objectives:** 1. State the requirements for and briefly describe the categories included in technical specifications. 2. Demonstrate understanding of the meanings of all defined terms in the technical specifications by applying them correctly in operational scenarios. 3. Explain the significance of the safety limits and limiting safety system settings. 4. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.
Introduction Applicable T/S pages are provided in the viewgraph package. The instructor can use these to illustrate his discussion at his discretion.	**3.2.1 Introduction** 1. This 1st T/S section presents: a. Requirements for T/S b. T/S formats c. T/S definitions d. Safety limits & limiting safety system settings e. LCOs, required actions, SRs, bases - use & application f. Technical Requirements Manual
T/S Requirements Instructor should have 10 CFR handy & may wish to quote directly from 10 CFR 50.	**3.1.2 Technical Specification Requirements** 1. Requirement for license applicants to submit proposed T/S in 10 CFR 50.36. License will then include T/S. T/S are derived from analyses & evaluations in FSAR. 2. 10 CFR 50.36 requires T/S to include following categories:

A-4

a. Safety limits (SLs): limits upon process variables necessary to protect the integrity of certain physical barriers (fuel cladding & RCS pressure boundary) which guard against the uncontrolled release of radioactivity.

b. Limiting safety system settings (LSSSs): settings for automatic protective devices related to variables having significant safety functions. The protective action from an LSSS corrects the abnormal situation before an SL is exceeded.

c. Limiting conditions for operation (LCOs): lowest functional performance levels of equipment required for safe operation. Each LCO includes applicability statement (identifies plant conditions in which LCO applies) & action statements (actions to be invoked when LCO not satisfied). Lowest allowed performance level met when LCO or action requirement of LCO is satisfied.

d. Surveillance requirements (SRs): requirements relating to tests, calibrations, & inspections which ensure that LCOs are met.

e. Design features: features of a facility which, if altered or modified, would have a significant effect on safety. Include construction materials & geometric arrangements.

f. Administrative controls: Provisions relating to organization & management, procedures, recordkeeping, review & audit, & reporting necessary to ensure safe operation.

3. Other sections in T/S (though not required to be included by 10 CFR):

a. Definitions: meanings for expressions used throughout T/S.

	b. Bases (for SLs, LSSSs, LCOs, SRs): summary statements of bases or reasons for specs. Required by 10 CFR 50.36(a) to be included w/ license application, but not required to be formally included in T/S. They are routinely included anyway.
Discussed in more detail in section 3.1.6 of the manual & in lecture devoted to manual section 3.3.	4. 10 CFR 50.36a separately requires T/S for radioactive effluents. In earlier T/S versions, these were included in separate LCO sections. In improved standard T/S, these requirements are addressed by admin. controls section of T/S.
	5. Other pertinent sections of 10 CFR 50:.
Show viewgraph displaying 10 CFR 50 breakdown (not in manual).	a. 10 CFR 50.4: provides requirements for submitting applications for permits & licenses.
	b. 10 CFR 50.10: requires a license issued by NRC before utility can operate a facility. Requires construction permit prior to construction of a facility.
	c. 10 CFR 50.21: class 104 license issued to applicant for operation of facility for use in medical therapy.
	d. 10 CFR 50.22: class 103 license issued to applicant for operation of facility for industrial or commercial purposes (includes power plants).
	e. 10 CFR 50.34: requires PSAR to be included in application for construction permit. Requires FSAR to be included in application for operating license.
T/S Formats	**3.1.3 Technical Specification Formats**
	1. 3 different T/S formats currently in use: custom, standard, improved standard.

Attachment A is example (from old Zion T/S). Show viewgraph.	2. Custom: Originally prepared on individual basis for each facility. Addressed all categories required by 10 CFR 50.36, but greatly diverse. Largely supplanted by standard formats, but a few plants still have custom T/S.
Attachment B is example (from Trojan T/S). Show viewgraph.	3. Standard: To provide systematic approach to T/S content, NRC started Standard T/S Program in '70's. For Westinghouse plants, standard format & content provided by NUREG-0452, "Standard T/S for Westinghouse Pressurized Water Reactors." When issued, standard T/S were used by new plants & adopted by some already licensed plants.
	4. Improved standard:
	a. Over time, trend toward including in T/S not just stuff from FSAR analyses, but also other NRC requirements. Lack of well-defined criteria for T/S inclusion. Contributed to making T/S bigger and to lots of amendment applications.
1993 & 1995 Federal Register entries which published final policy & rev. to 10 CFR 50.36 are included in this lesson plan.	b. In response, industry & NRC studied possible changes to T/S requirements, culminating in 1993 issuance of revised criteria for T/S content, "Final Policy Statement on T/S Improvements for Nuclear Power Reactors," & in 1995 incorporation of final policy into 10 CFR 50.36.
	c. Final policy requires LCO for each item satisfying following criteria:
Show viewgraph of LCO criteria taken from 10 CFR 50.36(c)(2)(ii).	1. Installed instr. used to detect & indicate degradation of reactor coolant pressure boundary.
	2. Process variable, design feature, or operating restriction that is initial condition of DBA or transient analysis that assumes failure of or challenges fission product barrier.
	3. Structure, system, or component that is part of primary success path & which mitigates a DBA or transient that assumes failure of or challenges fission product barrier.

4. Structure, system, or component which operating experience or PRA has shown to be significant to health & safety.

Attachment C is example (from TTC Unit 2 T/S). Show viewgraph.

d. Based on above criteria, improved standard T/S devloped for each NSSS design after extensive NRC & industry discussions. For Westinghouse plants, improved standard format & content provided by NUREG-1431, "Standard T/S, Westinghouse Plants," issued in 1992 & 1st revised in 1995.

e. Several licensees have converted to improved standard T/S; it is expected that most eventually will. NRC places highest priority on requests for complete conversions. Improved standard T/S have been developed for TTC Unit 2 (simulator) & are used in Westinghouse courses.

Definitions
Defined terms denoted by upper-case type in T/S manual sections also.

Instructor may wish to display pertinent pgs. from definitions section.

3.1.4 Definitions

1. Provided in a subsection of the use & application section of T/S.
2. Identified by upper-case type throughout T/S.

Instrumentation

3.1.4.1 Instrumentation

1. Channel check: qualitative assessment of channel behavior during ops by observation.
2. Channel operational test: injection of simulated or actual signal into channel as close to sensor as practicable to verify operability of alarm, interlock, display, & trip functions.
3. Channel calibration: adjustment of channel output such that it responds within required range & accuracy to known values of input.

4. Operators routinely perform channel checks. Channel operational tests performed periodically & when deviations identified. Channel calibrations done periodically to adjust a channel's sensor & bistables.

RCS Leakage

Note: Controlled leakage no longer a defined or limited type of leakage in improved standard T/S.

RCS leakage LCO is discussed in some depth in manual chapter 3.2.

3.1.4.2 RCS Leakage

1. Identified leakage: leakage:

   a. Such as that from pump seals or valve packing, that is captured & conducted to collection systems, sump, or collecting tank;

   b. Into containment atmosphere from sources both specifically located & known not to interfere w/ operation of leakage detection systems or not to be pressure boundary leakage.

   c. From RCS through an SG to secondary system.

2. Pressure boundary leakage: leakage (except SG tube leakage) through nonisolable fault in RCS component body, pipe wall, or vessel wall.

3. Unidentified leakage: leakage which is not identified leakage.

Operability
Note that in accordance w/ LCO 3.0.6, supported system required actions need not be entered when support system is inop.

3.1.4.3 Operability

1. Stipulates that a system, subsystem, or component is capable of performing its specified functions, & that all necessary controls, power, & aux. equip. required for system, subsystem, or component to perform its functions are also capable of performing their related support functions.

Operational Modes

Show T/S Figure 1.1-1.

3.1.4.4 Operational Modes

1. A mode is 1 of 6 inclusive combinations of core reactivity condition, power level, avg. coolant temp., & RV head closure bolt tensioning, w/ fuel in RV.

Shutdown Margin	**3.1.4.5 Shutdown Margin**
	1. Def.: instantaneous amt. of reactivity by which reactor is subcritical or would be subcritical from its present condition assuming all control rods are fully inserted, except for single rod of highest worth, which is assumed to be fully withdrawn; & assuming, in modes 1 & 2, that fuel & moderator temps. are changed to zero power levels.
Accounting for worth of untrippable rod is stated in bases for SR 3.1.1.1, pg. B 3.1-4.	2. During power ops, required SDM ensured by satisfying rod insertion limits. If rod is known to be untrippable, SDM verification must account for worths of untrippable rod & max. worth rod.
	3. W/ reactor subcritical, SDM is actual shutdown reactivity determined via reactivity balance calc.
Safety Limits & Limiting Safety System Settings	**3.1.5 Safety Limits & Limiting Safety System Settings**
	3.1.5.1 Safety Limits
Safety Limits	1. SLs established to prevent uncontrolled release of radioactivity by protecting integrity of fission product barriers during normal ops & AOOs.
	2. Reactor core SLs: Clad damage prevented by observing operating limits that preclude violation of design criteria:
	a. 95/95 probability/confidence that hot fuel rod does not experience DNB.
	b. Hot fuel pellet does not experience centerline melting.
Show T/S Figure 2.1.1-1.	3. Above criteria are satisfied when plant operated such that combo of power, pressure, & T_{avg} does not exceed applicable limit curve. Bases for curves:

a. Left-hand segments: Avg. enthalpy at core exit = enthalpy of saturated liquid. Ensures core ΔT is proportional to power & can be used as input to RPS.

b. Right-hand segments: Min. DNBR in core is ≥ DNBR limit. Satisfying DNBR limit prevents high clad temps. resulting from decrease in heat transfer.

c. Center segments of some curves: Local core-exit quality is within limit (typically 15%) defined in applicable DNBR correlation.

4. RCS pressure SL: Integrity of RCS protected by limiting pressure to max. of 110% of design (2735 psig).

Note: SL violation requirements included in the SL section of improved standard T/S.

5. SL violation requirements:

   a. Restore compliance w/ SL & place unit in Mode 3 within 1 hr.
   b. Notify NRC Operations Ctr within 1 hr, per 10 CFR 50.72.
   c. Notify Plant Superintendent & VP - Nuclear within 24 hrs.
   d. Prepare LER within 30 days, per 10 CFR 50.73.
   e. Resume unit ops only upon NRC authorization.

Limiting Safety System Settings

3.1.5.2 Limiting Safety System Settings

1. Prevent exceeding SLs during normal ops & AOOs.

Note difference. RTS LCO is discussed in manual chapter 3.2.

2. In standard T/S, included in separate section. In improved standard T/S, no separate LSSS section; LSSSs are included as RTS setpoints in RTS instr. LCO.

LCOs

3.1.6 Limiting Conditions for Operation

1. Provide lowest functional performance levels required of equipment for safe operation.

Show Attachment A (from old Zion T/S).	2. Custom T/S: Left-hand column specifies extent of equip. operability, applicable modes, additional requirements & time limits for action if LCO not met. Right-hand column specifies SRs applicable to each left-hand paragraph.
Show Attachment B (from Trojan T/S). SRs & bases included.	3. Standard T/S: Statement of LCO, applicability, action requirements from top to bottom in straightforward manner. SRs immediately follow. Consistent throughout T/S (section 3/4 convention). 4. List of standard T/S LCO sections on pg. 3.1-8 in manual.
Show Attachment C.	5. Improved standard T/S: LCO & applicability statements similar to standard T/S. Conditions of LCO not satisfied, required actions, completion times for required actions presented in table. SRs immediately follow, also in table. 6. List of improved standard T/S sections on pg. 3.1-8 in manual. Note: special test exceptions no longer a separate section (incorporated into reactivity control systems section), radioactive effluents & radiological environmental monitoring incorporated into programs required by admin. controls section.
Cover all examples in subsections 1.2, 1.3, 1.4. Viewgraphs provided. Details for instructor provided on examples pgs. Exercises at end of manual chapter reinforce LCO, SR application rules. Content of LCOs covered in manual chapters 3.2, 3.3, 3.4	7. Use and Application section of T/S provides guidance for using action & SR tables of LCOs. Note nuances in subsections 1.2, 1.3, 1.4 associated with: a. Logical connectors (numbering, positions of "<u>OR</u>s" & "<u>AND</u>s." b. 24-hr completion time extension for subsequent inoperability. c. Multiple function completion times/ separate completion times. d. Separate condition entry. e. Completion time extensions for surveillance-type required actions. f. Frequency statements which do & don't qualify for surveillance interval extension per SR 3.0.2.

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<tr><td>Written by: Van Sickle</td><td>Date: 03/99</td></tr>
<tr><td>Show bases for T/S 3.5.2 (not in manual but provided in viewgraph package) to illustrate bases subsections.</td><td>8. Bases section of T/S divided into subsections identical to LCO subsections & provided as separate T/S volume. Subsections of each LCO basis:

a. Background: describes system, component, parameter.
b. Applicable Safety Analyses: describes how LCO relates to FSAR safety analyses (supports init. conditions or provides mitigating function).
c. LCO: somewhat brief statement of how LCO supports safety.
d. Applicability: describes modes & conditions in which LCO is applicable & why.
e. Actions: reasons for actions required by LCO actions table when LCO not met.
f. Surveillance Requirements: reasons for SRs; how they support LCO.
g. References: NRC & industry documents referenced in basis.

9. Bases of improved standard T/S more extensive than standard T/S bases & more indicative of relationship to FSAR safety analyses.</td></tr>
<tr><td>Technical Requirements Manual

Note items in TRM: boration flow paths, various instrumentation, RTS & ESFAS response times, snubbers, refueling cranes. Instructor can thumb through w/ students at his discretion.</td><td>3.1.7 Technical Requirements Manual (TRM)

1. LCOs which had been in standard T/S but don't meet revised criteria for inclusion in improved standard T/S are relocated to TRM.

2. Technical requirements (TRs) & technical requirement surveillances (TRSs) implemented like T/S but treated as plant procedures.

3. Violations of TRs or TRSs, shutdowns to comply w/ TR action statements not reportable per 10 CFR 50.72 or 10 CFR 50.73.

4. Violations of TRs, TRSs treated as procedure violations by licensees & cited as such by NRC.</td></tr>
</table>

Exercises Viewgraphs w/ exercises & exercise answers are included in this lesson plan. Instructor can pass out copies of exercise answers after students have chance to solve on their own.	**3.1.8 Exercises** 3 exercises for students to work on in manual. Students will need to use TTC Unit 2 T/S to answer questions. These exercises are intended to reinforce LCO, SR application rules. Focus should not be on LCO or SR content.

WESTINGHOUSE TECHNOLOGY ADVANCED MANUAL LESSON PLAN

Ch. 3.2	Title: ANALYSIS OF T/S - UNIT 2
Written by: Van Sickle	Date: 03/99

Learning Objectives (standard objectives for all T/S sections)	**Learning Objectives:** 1. Explain the significance of limiting conditions for operation in the areas of applicability, reactivity control systems, instrumentation, the reactor coolant system, and the emergency core cooling systems. 2. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.
Introduction This lesson plan includes viewgraphs of applicable LCO & bases pages of the T/S. The instructor can use these to illustrate his discussion at his discretion.	**3.2.1 Introduction** 1. This section presents LCOs in the areas of: a. Applicability b. Reactivity control systems c. Instrumentation d. RCS e. ECCSs
Applicability Instructor should display & discuss all applicability LCOs & SRs. Viewgraphs are provided.	**3.2.2 Applicability** 1. Applicability ("motherhood") LCOs establish general requirements applicable to all LCOs. 2. Several applicability LCOs: a. LCO 3.0.1: An LCO shall be met during the modes or other specified conditions in the LCO's applicability statement.

	b. LCO 3.0.2: Upon discovery of a failure to meet an LCO, the required actions shall be met. If the LCO is met or no longer applicable before expiration of the specified completion time(s), completion of required actions is not required.
Discuss example presented in manual on pgs. 3.2-1 & 3.2-2 (inoperability of ECCS trains) to illustrate how applicability T/S (specifically, LCOs 3.0.3 & 3.0.4) apply to LCO (specifically, LCO 3.5.2) compliance.	c. LCO 3.0.3: When an LCO is not met & the associated required actions are not met, an associated action is not provided, or if directed by the required actions, the unit shall be placed in a mode or other specified condition in which the LCO is not applicable, in accordance w/ specified completion times. When corrective action permits operation in accordance w/ the LCO or its required actions, completion of actions required by LCO 3.0.3 is not required. d. LCO 3.0.4: When an LCO is not met, entry into a mode or other specified condition in the LCO's applicability statement is not permitted except when the associated required actions permit continued operation for an unlimited period of time. This does not prevent mode changes required to comply w/ actions or to shut down the unit. Exceptions to LCO 3.0.4 are stated in individual LCOs.
Safety Function Determination Program (admin. control entry 5.5.15) implements requirements of LCO 3.0.6. Loss of safety function is defined on T/S pg. 5.0-22.	e. LCO 3.0.6: When the LCO for a supported system is not met solely due to the LCO for a support system not being met, the required actions for the supported system are not required to be entered. Only the required actions for the support system LCO are required to be entered. Entry into the required actions of the supported system LCO may be required, however, if a loss of safety function is determined to exist.
Reactivity Control Systems	**3.2.3 Reactivity Control Systems** Included LCOs: 3.1.1 Shutdown margin - $T_{avg} \geq 350°F$ 3.1.2 Shutdown margin - $T_{avg} < 350°F$

Note: Boration control system LCOs are not included in improved standard T/S; they are now located in Technical Requirements Manual (TRM).	3.1.3 Core reactivity 3.1.4 Moderator temperature coefficient 3.1.5 Rod group alignment limits 3.1.6 Shutdown bank insertion limits 3.1.7 Control bank insertion limits 3.1.8 Rod position indication 3.1.9 Physics test exceptions - Mode 1 3.1.10 Physics test exceptions - Mode 2 3.1.11 Shutdown margin test exceptions
Shutdown Margin	**3.2.3.1 Shutdown Margin** (LCOs 3.1.1, 3.1.2)
	1. Satisfying SDM LCOs ensures reactor can be made subcritical from all operating conditions, transients, & DBAs; postulated reactivity transients during accidents are controllable within acceptable limits; inadvertent criticality while shutdown is precluded.
	2. For subcritical reactor, SDM verified by reactivity balance calc. For critical reactor, SDM verified by satisfaction of rod insertion limits.
Core Reactivity	**3.2.3.2 Core Reactivity** (LCO 3.1.3)
	1. Accurate prediction of core reactivity is assumption of safety analyses. Verifying relative agreement between measured & predicted values of reactivity ensures plant ops are maintained within assumptions of safety analyses.
MTC	**3.2.3.3 MTC** (LCO 3.1.4)
Figure 3.1.4-1 is straight out of improved standard T/S.	1. MTC limiting values ensure MTC is within bounds assumed in accident analyses & inherently stable power ops result during normal ops & accidents.
	2. Max. positive MTC limits consequences of overheating accidents; max. negative MTC limits consequences of overcooling accidents.

Rod Alignment & Position Indication	**3.2.3.4 Rod Alignment & Position Indication** (LCOs 3.1.5, 3.1.6, 3.1.7, 3.1.8) 1. Rod alignment LCOs support safety analysis assumptions; max. rod misalignment is initial assumption & affects power distr., SDM. 2. Rod operability ensures assumed reactivity is available & inserted on reactor trip. 3. Rod insertion limits ensure: a. Sufficient SDM. b. Acceptable power distrs. c. Limited effects from rod ejection accident. 4. Control bank sequence & overlap limits provide uniform rates of reactivity changes & limit power peaking during rod motion. 5. Rod position indication must be available to ensure ability to satisfy rod alignment LCOs. 6. 2 operable position indication systems ensure inoperable, misaligned, or mispositioned rods can be detected.
Test Exceptions Note: Test exceptions are not in separate LCO section in improved standard T/S.	**3.2.3.5 Test Exceptions** (LCOs 3.1.9, 3.1.10, 3.1.11) 1. Test exception LCOs allow suspension of other LCOs during performance of special tests & operations. 2. Physics test exceptions include LCOs for rod alignment, rod insertion limits, AFD, QPTR, MTC, min. temp. for criticality. 3. Mode 2 SDM requirements may be suspended during measurements of rod worths & SDM.

Instrumentation Note: Many requirements of instr. LCOs of previous T/S versions are located elsewhere: incore detectors, seismic monitors, meteorological monitors to TRM, radiation & effluent monitors to admin. controls.	**3.2.4 Instrumentation** Included LCOs: 3.3.1 Reactor trip system instrumentation 3.3.2 Engineered safety feature actuation system instrumentation 3.3.3 Post-accident monitoring instrumentation 3.3.4 Remote shutdown system 3.3.5 Loss of power diesel generator start instrumentation 3.3.6 Containment ventilation isolation instrumentation 3.3.7 Control room emergency ventilation actuation instrumentation
RTS & ESFAS Instrumentation	**3.2.4.1 RTS & ESFAS Instrumentation** (LCOs 3.3.1, 3.3.2) 1. RTS initiates unit shutdown to protect against violating SLs during AOOs & to assist ESF systems in mitigating accidents. 2. ESFAS initiates necessary ESF systems to protect against violating SLs & to mitigate accidents. 3. Operability of RTS & ESFAS instr. & interlocks ensures: a. Associated trip/ESF action will be initiated when required. b. Specified coincidence logic is maintained. c. Sufficient redundancy is maintained to permit a channel to be out of service for testing or maintenance.
Instructor should spend some time explaining the tables & sifting through the info available there.	4. Lots of information in Tables 3.3.1-1 & 3.3.2-1: applicable modes & conditions, no. of channels required to be operable, references to required actions, SRs, trip setpoints, allowable values for each trip or actuation function. 5. Detailed discussions of reasons for each trip or actuation function are included in the LCO bases.

Monitoring & Control Instrumentation Instructor should sift through the info in Tables 3.3.3-1 & 3.3.4-1 to illustrate the functions & instruments that would typically be included in these LCOs at plants.	**3.2.4.2 Monitoring & Control Instrumentation** (LCOs 3.3.3, 3.3.4) 1. Operability of post-accident monitoring instr. ensures sufficient info to monitor & assess unit status after accident. 2. Selected post-accident parameters enable determination of proper safety system operation, of likelihood of breach of barrier to release, of necessary manual actions. 3. Operability of remote shutdown system ensures ability to place unit in Mode 3 from outside control room. 4. Required instr. & controls for remote shutdown system address reactivity control, RCS pressure control, decay heat removal, RCS inventory control.
Other Protection Actuation Instrumentation Note: 4 channels for each function for each ESF bus; coincidence is 1 of 2 taken twice. Functions which cause isolation are listed in Table 3.3.6-1. Functions which isolate normal control room ventilation and/or start CREVS are listed in Table 3.3.7-1.	**3.2.4.3 Other Protection Actuation Instrumentation** (LCOs 3.3.5, 3.3.6, 3.3.7) 1. Operability of loss of voltage & degraded functions for loss-of-power DG starts ensures DGs will start when offsite power is lost & there is no delay in safety system initiation. 2. Containment ventilation isolation instr. closes containment iso. valves in purge supply & exhaust system & hydrogen vent system to minimize release during accident. Appropriate iso. valve response ensures meeting leakage rate assumptions & limits offsite doses. 3. CREVS actuation instr. isolates normal control room ventilation & starts CREVS w/ appropriate signals to maintain control room habitability during accidents.

Reactor Coolant System Note relocations of LCOs from other LCO sections in earlier T/S versions: DNB limits are moved from power distr. section; min. temp. for criticality is moved from reactivity controls section.	**3.2.5 Reactor Coolant System** Included LCOs: 3.4.1 Departure from nucleate boiling limits 3.4.2 RCS minimum temperature for criticality 3.4.3 RCS pressure and temperature limits 3.4.4 RCS loops - Modes 1 and 2 3.4.5 RCS loops - Mode 3 3.4.6 RCS loops - Mode 4 3.4.7 RCS loops - Mode 5, loops filled 3.4.8 RCS loops - Mode 5, loops not filled 3.4.9 Pressurizer 3.4.10 Presurizer safety valves 3.4.11 Pressurizer power-operated relief valves 3.4.12 Low temperature overpressure protection system 3.4.13 RCS operational leakage 3.4.14 RCS pressure isolation valve leakage 3.4.15 RCS leakage detection instrumentation 3.4.16 RCS specific activity
DNB Limits	**3.2.5.1 DNB Limits** (LCO 3.4.1) 1. Limits on pzr pressure, RCS temp., RCS flow rate ensure core is within limits assumed in safety analyses; operating within limits ensures meeting DNBR criterion for DNB-limited transient.
RCS Min. Temp. for Criticality	**3.2.5.2 RCS Minimum Temperature for Criticality** (LCO 3.4.2) 1. Compliance w/ limit ensures reactor not critical below hot zero power temp., a safety analysis assumption. Limit ensures: a. Plant is operated w/ MTC & operating temp. ranges assumed in accident analyses. b. Protective instr. is functioning within normal operating temp. envelope.

c. Pzr conditions are consistent w/ transient & accident analyses.
d. RV temp. is > nil ductility reference temp. when reactor is critical.

RCS Pressure & Temp. Limits

3.2.5.3 RCS Pressure & Temperature Limits (LCO 3.4.3)

1. Limits are not derived from DBA analyses; they are imposed to avoid pressure, temp., heatup & cooldown rates that could cause flaws to propagate & cause nonductile failure of RCS pressure boundary.

PTLR is in viewgraph package. PTLR figures & values have been lifted from Trojan T/S.

2. LCO references PTLR, where numerical limits are located.

RCS Loops

3.2.5.4 RCS Loops (LCOs 3.4.4, 3.4.5, 3.4.6, 3.4.7, 3.4.8)

1. RCS loop LCOs specify no. of reactor coolant and/or RHR loops required to be operating and operable.
2. Modes 1, 2: All reactor coolant loops required to be operating to maintain DNBR > limit for normal ops & AOOs & to satisfy DBA analysis assumptions.
3. Mode 3, rods capable of withdrawal: 2 reactor coolant loops required to be operating to mitigate inadvertent rod withdrawal.
4. Other shutdown conditions: 1 (reactor coolant or RHR) loop operating to remove decay heat, 1 other loop operable to satisfy single-failure considerations.

Pressurizer

3.2.5.5 Pressurizer (LCO 3.4.9)

1. Specified water level ensures steam bubble exists, an assumption of accident analyses.
2. Min. required heater capacity ensures RCS pressure & subcooled conditions can be maintained.

Overpressure Protection	**3.2.5.6 Overpressure Protection** (LCOs 3.4.10, 3.4.12) 1. Modes 1, 2, 3, 4 > 290°F: All pzr safety valves required to be operable; combined safety valve capacity limits RCS pressure to ≤ 110% of design pressure (2750 psia).
PTLR is in viewgraph package. High head pump limitations were in an ECCS LCO in Trojan T/S.	2. Modes 4 ≤ 290°F, 5, 6: LTOP requirements: limited high head injection capacity, isolated accumulators, sufficient relief capacity via pzr PORVs or RCS vent. PORV lift setpoints in PTLR. LTOP is important at low RCS temps., where RV is susceptible to brittle failure.
PORVs & PORV Block Valves	**3.2.5.7 PORVs & PORV Block Valves** (LCO 3.4.11) 1. PORVs, block valves are required to be operable so that they are available to depressurize RCS; SGTR safety analysis assumes PORVs are used to stop break flow. 2. Block valve operability assures capability to isolate failed-open or leaking PORV.
RCS Leakage & Leakage Detection Instrumentation Leakage definitions are in T/S definitions section & manual chapter 3.1 & are included in the viewgraph package. Note that controlled leakage does not exist in improved standard T/S.	**3.2.5.8 RCS Leakage & Leakage Detection Instrumentation** (LCOs 3.4.13, 3.4.14, 3.4.15) 1. Leakage limits: a. 10 gpm identified leakage: allows limited amount of leakage from known sources that will not interfere w/ detection of unidentified leakage. b. 1 gpm unidentified leakage: reasonable min. rate detectable by leakage monitoring systems. c. 0 gpm pressure boundary leakage: this leakage is indicative of material deterioration of RCS pressure boundary. d. 1 gpm SG tube leakage: ensures offsite dose from steam line break is limited to small fraction of 10 CFR 100 limits.

SG Tube Surveillance Program was SG LCO in earlier T/S versions. Applicable admin. controls pages are included in viewgraph package.	e. 500 gpd SG tube leakage: based on assumption that single crack leaking at this rate would not propagate to an SGTR under stress of LOCA or steam line rupture. 2. SG tube structural integrity is verified through inspections in accordance w/ SG Tube Surveillance Program specified in admin. controls section of T/S.
Note: Applicable PIVs are typically listed in Ch. 16 of FSAR (repository for stuff from earlier T/S versions), & FSAR list is referenced by PIV T/S Basis. Such a reference does not appear in TTC Unit 2 T/S because FSAR section does not exist.	3. PIV leakage limit stems from WASH-1400, which identified intersystem LOCA as significant risk contributor. 4. LCO for leakage detection instr. requires operability of instruments of diverse monitoring principles to ensure detection of extremely small leaks. **3.2.5.9 RCS Specific Activity** (LCO 3.4.16) 1. Limit ensures 2-hr doses at site boundary will not exceed small fraction of 10 CFR 100 limits following SGTR.
RCS Specific Activity	2. Operation for limited time w/ dose equivalent I-131 > limit but within acceptable operation domain of Figure 3.4.16-1 accommodates iodine spiking.
ECCS	**3.2.6 Emergency Core Cooling Systems** Included LCOs: 3.5.1 Accumulators 3.5.2 ECCS - operating 3.5.3 ECCS - shutdown 3.5.4 Refueling water storage tank 3.5.5 Seal injection flow

Accumulators	**3.2.6.1 Accumulators** (LCO 3.5.1) 1. Accumulator operability helps to ensure that 10 CFR 50.46 criteria will be met following a LOCA. 2. 4 operable accumulators ensure contents of 3 will reach core during LOCA, assuming contents of 1 are lost through break. 3. Limits on volume, boron concentration, N_2 pressure ensure safety analysis assumptions are met.
ECCS Trains Note: SI (intermediate head) subsystem not included in ECCS train in Mode 4 LCO. Compare LCO sections of bases for LCOs 3.5.2 & 3.5.3.	**3.2.6.2 ECCS Trains** (LCOs 3.5.2, 3.5.3) 1. ECCS train operability ensures sufficient flow available during LOCAs & helps to satisfy 10 CFR 50.46 criteria following LOCA. 2. Borated flow limits potential for return to power after steam line break. 3. Modes 1, 2, 3: Both trains required operable to satisfy single-failure considerations. 4. Mode 4: Only 1 train required operable; single failures not considered.
RWST	**3.2.6.3 RWST** (LCO 3.5.4) 1. Required RWST temp., volume, boron concentration ensure adequate supply of borated water: a. To cool & depressurize containment in event of DBA. b. To cool & cover core in event of LOCA. c. To maintain reactor subcritical following accident. d. To ensure adequate level in containment sump to support ECCS & containment spray in recirc. mode.

Seal Injection Flow	**3.2.6.4 Seal Injection Flow** (LCO 3.5.5) 1. Limit on seal injection flow limits flow through RCP seal injection line & ensures sufficient CCP (high head) injection flow during an accident.
Exercises Viewgraphs w/ exercises & exercise answers are included in this lesson plan. Instructor can pass out copies of exercise answers after students have chance to solve on their own.	**3.2.7 Exercises** 6 exercises for students to work on in manual. Students will need to use TTC Unit 2 T/S to answer questions.

WESTINGHOUSE TECHNOLOGY ADVANCED MANUAL LESSON PLAN	
Ch. 3.3	Title: ANALYSIS OF T/S - UNIT 3
Written by: Van Sickle	Date: 03/99

Learning Objectives (standard objectives for all T/S sections)	**Learning Objectives:** 1. Explain the significance of limiting conditions for operation in the areas of containment systems, plant systems, electrical power systems, and refueling operations; design features; and administrative controls. 2. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.
Introduction This lesson plan includes viewgraphs of applicable LCO & bases pages of the T/S. The instructor can use these to illustrate his discussion at his discretion.	**3.3.1 Introduction** 1. This section presents LCOs in the areas of: a. Containment systems b. Plant systems c. Electrical power systems d. Refueling operations 2. This section also discusses design features & administrative controls.
Containment Systems	**3.3.2 Containment Systems** Included LCOs: 3.6.1 Containment 3.6.2 Containment Air Locks 3.6.3 Containment Isolation Valves 3.6.4 Containment Pressure 3.6.5 Containment Air Temperature 3.6.6 Containment Spray and Cooling Systems 3.6.7 Spray Additive System

	3.6.8 Hydrogen Recombiners 3.6.9 Hydrogen Mixing System 3.6.10 Hydrogen Vent System
Containment	**3.3.2.1 Containment** (LCOs 3.6.1, 3.6.2, 3.6.3)
	1. Design basis for containment is that it must withstand pressures & temps. of limiting DBA without exceeding design leak rate.
L_a is a T/S defined term.	2. Max. allowable leak rate, L_a, is 0.10% of containment air wt. per day at peak pressure.
SRs 3.6.1.1, 3.6.1.2 IN 99-10 discusses tendon degradation found during recent tendon surveillances. IN 99-10 is included in lesson plan.	3. Containment operability verified by determining leak rate in spec per Containment Leakage Rate Testing Program & by satisfying structural integrity requirements per Containment Tendon Surveillance Program. Both programs are required by admin. controls. 4. Operability of each air lock supports max. allowable leakage design basis of containment.
	5. Operability of containment isolation valves supports containment design basis by helping to ensure containment is isolated within time limits assumed in safety analyses.
Containment Pressure & Temp.	**3.3.2.2 Containment Pressure & Temperature** (LCOs 3.6.4, 3.6.5)
	1. Upper limit on pressure & temp. limit are initial conditions in DBA analysis (large LOCA) which eastablishes peak containment pressure.
	2. Lower limit on pressure is initial condition in analysis (inadvertent spray actuation) which establishes min. containment pressure.

Containment Spray & Cooling Systems	**3.3.2.3 Containment Spray & Cooling Systems** (LCOs 3.6.6, 3.6.7)
See Sec. 6.2 of Trojan FSAR for exhaustive description of peak pressure analysis.	1. Operability of containment spray & cooling trains ensures that, for limiting DBA (large LOCA) & worst-case single failure (loss of one containment spray train), remaining trains sufficiently cool containment to keep peak pressure & temp. within design limits.
Note: Trojan FSAR accident analyses take credit for iodine removal by containment spray.	2. Operability of containment spray trains & spray additive system ensures at least one train of spray & spray additive to scavenge iodine from containment atmosphere & maintain alkaline pH in containment sump.
Hydrogen Mitigation Systems	**3.3.2.4 Hydrogen Mitigation Systems** (LCOs 3.6.8, 3.6.9, 3.6.10)
	1. Hydrogen recombiners provide capability of controlling bulk hydrogen concentration to < flammable limit.
	2. Hydrogen mixing system provides capability to reduce local hydrogen concentrations.
	3. Hydrogen vent system provides capability to vent hydrogen from containment after accident.
See required action B.1 of each LCO.	4. Inoperability of both trains of 1 system can be compensated for by hydrogen control capabilities of 1 or both of other systems.
Plant Systems	**3.3.3 Plant Systems**
	Included LCOs:
	3.7.1 Main Steam Safety Valves 3.7.2 Main Steam Isolation Valves 3.7.3 Main Feedwater Isolation Valves, Main Feedwater Regulating Valves, and MFRV Bypass Valves

3.7.4 Atmospheric Dump Valves
3.7.5 Auxiliary Feedwater System
3.7.6 Condensate Storage Tank
3.7.7 Component Cooling Water System
3.7.8 Service Water System
3.7.9 Ultimate Heat Sink
3.7.10 Control Room Emergency Ventilation System
3.7.11 Spent Fuel Pool Exhaust System
3.7.12 Fuel Storage Pool Boron Concentration
3.7.13 Spent Fuel Assembly Storage
3.7.14 Spent Fuel Pool Water Level
3.7.15 Secondary Specific Activity

Steam & Feedwater System Valves

3.3.3.1 Steam & Feedwater System Valves (LCOs 3.7.1, 3.7.2, 3.7.3, 3.7.4)

Note: This lesson plan includes a copy of IN 94-60, which describes a potential deficiency in the calc. of max. allowable power w/ inop. MSSVs.

1. MSSVs provide overpressure protection for secondary & RCS; they limit secondary system pressure to ≤ 110% of design pressure when they are passing 105% of design steam flow.

2. Limiting AOO for MSSVs: Full-power turbine trip without steam dumps.

3. MSIV operability precludes blowdown of > 1 SG during steam line break, assuming 1 MSIV fails. This limits mass & energy to containment & positive reactivity addition to core.

Note: Nothing like LCO 3.7.3.or 3.7.4 was in Trojan T/S; they are included in TTC Unit 2 T/S for consistency w/ improved standard T/S.

4. Operability of FWIVs, MFRVs, & MFRV bypass valves ensures redundant isolation of FW flow to SGs after steam or feed break.

5. Operability of ADVs ensures ability to cool unit to RHR entry conditions without condenser.

6. Limiting event for ADVs: SGTR; cooldown w/ ADVs necessary to terminate primary-to-secondary flow.

	7. 3 operable ADVs ensures 1 available for cooldown if 1 unavailable due to SGTR & 1 fails.
Auxiliary Feedwater	**3.3.3.2 Auxiliary Feedwater** (LCOs 3.7.5, 3.7.6)
	1. Design basis of AFW system is to supply water to SGs to remove decay heat up to lowest set MSSV pressure + 3%, & to replace lost secondary inventory as unit cools to Mode 4.
	2. Required CST volume exceeds that necessary to remove decay heat for 30 min in Mode 3 & cool down RCS to RHR entry conditions at design cooldown rate.
Cooling Water Systems	**3.3.3.3 Cooling Water Systems** (LCOs 3.7.7, 3.7.8, 3.7.9)
	1. Operability of both trains of both CCW & service water in Modes 1 - 4 ensures 1 train of each available to remove post-accident heat loads, assuming worst-case single failure & LOOP.
	2. No CCW or service water LCO for Modes 5 & 6; operability of CCW & service water in those modes determined by systems they support.
See Trojan FSAR section 9.2.5 for description of Trojan UHS.	3. Design basis of UHS is to provide 30-day supply of cooling water to support safe shutdown from any conditions; this capability provided by Columbia River.
	4. Required cooling tower basin volume ensures 100-hr cooling water supply until makeup from Columbia River can be restored.
Ventilation Systems	**3.3.3.4 Ventilation Systems** (LCOs 3.7.10, 3.7.11)
	1. Operability of CREVS ensures maintenance of control room environment after DBA which allows 30-day continuous occupancy without exceeding 5-rem dose to operators.

	2. Operability of SFPES assures filtration of airborne particulates & iodines in event of design-basis fuel handling accident.
	3. 1 SFPES train required to be running during fuel handling, when potential for fuel damage exists.
Spent Fuel Pool	**3.3.3.5 Spent Fuel Pool** (LCOs 3.7.12, 3.7.13, 3.7.14)
Design Features section 4.3 contains some details related to SFP storage racks.	1. SFP has high & low density storage racks; high density racks have smaller center-to-center spacing; spent fuel to be stored in high density racks must fall in acceptable burnup domain of T/S Figure 3.7.13-1.
	2. Requirements for fuel assembly storage ensure SFP k_{eff} stays ≤ 0.95 even if SFP is flooded w/ unborated water.
	3. Boron concentration requirement assures positive reactivity from fuel handling accident can be compensated for. LCO no longer applies when proper fuel assembly storage has been verified.
	4. Min. 23-ft SFP level above top of fuel provides shielding, minimizes dose, satisfies assumptions concerning iodine decontamination factors after accident.
Secondary Specific Activity	**3.3.3.6 Secondary Specific Activity** (LCO 3.7.15)
	1. Activity limit is initial condition for steam line break analysis, ensures resultant offsite dose from steam break is small fraction of 10 CFR 100 limits.
Electrical Power Systems	**3.3.4 Electrical Power Systems**
	Included LCOs:
	3.8.1 AC Sources - Operating 3.8.2 AC Sources - Shutdown

3.8.3 Diesel Fuel Oil, Lube Oil, and Starting Air
3.8.4 DC Sources - Operating
3.8.5 DC Sources - Shutdown
3.8.6 Battery Cell Parameters
3.8.7 Inverters - Operating
3.8.8 Inverters - Shutdown
3.8.9 Distribution Systems - Operating
3.8.10 Distribution Systems - Shutdown

Electrical Power Systems - Operating

3.3.4.1 Electrical Power Systems - Operating (LCOs 3.8.1, 3.8.4, 3.8.7, 3.8.9)

1. Electrical power systems designed to provide sufficient capacity, capability, redundancy, reliability to ensure availability of power to ESF systems so that fuel, RCS, containment design limits are not exceeded.

2. Operability of both trains in Modes 1 - 4 ensures power to safely shut down reactor after AOO or DBA, even w/ assumed loss of all offsite or all onsite power & worst-case single failure.

3. All buses must be energized; must have 2 physically independent circuits between offsite & onsite Class 1E; must have 2 independent diesel generators.

Electrical Power Systems - Shutdown

3.3.4.2 Electrical Power Systems - Shutdown (LCOs 3.8.2, 3.8.5, 3.8.8, 3.8.10)

1. In Modes 5 & 6 & during movement of irradiated fuel assemblies, required operable portions of electrical power systems are those necessary to support equipment required to be operable in those modes.

2. Electrical power system operability ensures power to mitigate events during shutdown conditions & instrumentation & control capability for monitoring shutdown or refueling conditions.

Diesel Support Systems	**3.3.4.3 Diesel Support Systems** (LCO 3.8.3) 1. Diesel support system operability supports DG operability. 2. Required fuel oil & lubricating oil inventories support 7 days of full-load DG operation. 3. Starting air receiver pressure supports 5 successive DG start attempts.
Battery Cell Parameters	**3.3.4.4 Battery Cell Parameters** (LCO 3.8.6) 1. Maintaining battery cell electrolyte level, float voltage, specific gravity within limits ensures availability of DC sources.
Refueling Operations	**3.3.5 Refueling Operations** Included LCOs: 3.9.1 Boron Concentration 3.9.2 Unborated Water Source Isolation Valves 3.9.3 Nuclear Instrumentation 3.9.4 Containment Penetrations 3.9.5 Residual Heat Removal and Coolant Circulation - High Water Level 3.9.6 Residual Heat Removal and Coolant Circulation - Low Water Level 3.9.7 Refueling Cavity Water Level
Boron Concentration & Unborated Water Isolation Valves Applicable page from TTC Unit 2 COLR is in viewgraph package.	**3.3.5.1 Boron Concentration & Unborated Water Isolation Valves** (LCOs 3.9.1, 3.9.2) 1. Boron concentration limit for RCS, refueling canal, refueling cavity ensures k_{eff} remains ≤ 0.95 during fuel handling. Limit is in COLR.

	2. Requiring all unborated water sources to be isolated from the RCS in Mode 6 prevents an unplanned boron dilution, obviates need for Mode 6 boron dilution accident analysis.
Nuclear Instrumentation	**3.3.5.2 Nuclear Instrumentation** (LCO 3.9.3) 1. Operability of 2 source range monitors ensures monitoring capability; no other direct means of checking reactivity in Mode 6.
Containment Penetrations	**3.3.5.3 Containment Penetrations** (LCO 3.9.4) 1. Satisfying this LCO limits potential escape paths from containment for radioactivity released during fuel handling accident. 2. Penetrations covered: equipment hatch, air locks, ventilation penetrations providing access from containment to outside.
Residual Heat Removal & Coolant Circulation	**3.3.5.4 Residual Heat Removal & Coolant Circulation** (LCOs 3.9.5, 3.9.6) 1. 1 RHR loop required to be operating during Mode 6 to provide decay removal & boron mixing. 2. W/ 23 ft of water above reactor vessel flange, only need 1 operable RHR loop; water volume provides backup decay heat removal capability. 3. W/ < 23 ft of water above flange, need 2nd operable RHR loop as backup to operating loop.
Refueling Cavity Water Level	**3.3.5.5 Refueling Cavity Water Level** (LCO 3.9.7) 1. Min. level substantially retains iodine activity during fuel handling accident: allows decontamination factor of 100 for accident analysis, limits offsite doses.

WESTINGHOUSE TECHNOLOGY ADVANCED MANUAL LESSON PLAN	
Ch. 3.3	Title: ANALYSIS OF T/S - UNIT 3
Written by: Van Sickle	Date: 03/99

Design Features	**3.3.6 Design Features** 1. Def.: those features of the facility, such as materials of construction & geometric arrangements, which, if altered or modified, would have a significant effect on safety, & which are not covered by SLs, limiting safety system settings, LCOs, & SRs.
Note the much smaller design features section in improved standard T/S. Many of the design features included in previous versions of T/S have been relocated to other T/S locations or eliminated.	2. Included design features: a. Site 1. Exclusion area 2. Low population zone b. Reactor core 1. Fuel assemblies 2. Control rod assemblies c. Fuel storage
Exclusion area, low population zone definitions per 10 CFR 100.	1. Criticality 2. Drainage 3. Capacity
Trojan T/S didn't include possibility of having ZIRLO clad fuel rods or hafnium control rods; included in TTC Unit 2 T/S for consistency w/ improved standard T/S & because likely to show up in T/S of other plants.	3. Exclusion area: in event of postulated release, doses at EAB will not exceed 25 rem to whole body or 300 rem to thyroid during 2 hrs immediately following start of release. 4. Low population zone: in event of postulated release, doses at low population zone boundary will not exceed 25 rem to whole body or 300 rem to thyroid during entire period of passage of radioactive cloud resulting from release. 5. 193 fuel assemblies consisting of Zircaloy or ZIRLO clad fuel rods containing UO_2. 53 Ag-In-Cd or hafnium control rod assemblies.

6. Spent & new fuel storage racks are designed to ensure $k_{eff} \leq 0.95$ when flooded w/ unborated water.

This is essentially Zion's spent fuel storage arrangement; Trojan didn't have high density storage racks. Included in TTC Unit 2 T/S because likely to be seen in the field. No effect on simulator operation.

7. Storage rack description describes an SFP containing 2 categories of racks: high & low density racks. Low density racks (Region 1) can accommodate new or partially spent fuel assemblies w/ discharge (from the core) burnups in the unacceptable burnup range. High density racks (Region 2) can accommodate sufficiently depleted fuel assemblies (those w/ discharge burnups in the acceptable domain). Acceptable/ unacceptable burnup domains determined by Figure 3.7.13-1 of LCO 3.7.13.

Administrative Controls

3.3.7 Administrative Controls

1. Def.: provisions relating to organization & management, procedures, records, review & audit, & reporting necessary to assure operation of the facility in a safe manner.

Responsibility, Organization, & Staffing

3.3.7.1 Responsibility, Organization, & Staffing

1. Plant Superintendent is responsible for overall operation; Shift Supervisor is responsible for control room command function.

Table specifying min. shift crew composition now included in Technical Requirements Manual.

2. Organization requirements are to be documented in FSAR.
3. Requirements for shift crew composition, absence, & overtime.
4. Min. staff qualifications.

3.3.7.2 Procedures & Programs

1. Required procedures: procedures recommended in Appendix A of Reg. Guide 1.33, EOPs to implement requirements of NUREG-0737, quality assurance procedures for effluent & environmental monitoring, procedures for Fire Protection Program, procedures for all programs specified in admin. controls.

Instructor can read admin. controls section of T/S & associated manual chapter section to find descriptions of these programs. Instructor can determine level of detail for class discussion.	2. Some important programs: a. Offsite Dose Calculation Manual b. Radioactive Effluent Controls Program c. Component Cyclic or Transient Limit Program d. Pre-stressed Concrete Containment Tendon Surveillance Program e. Inservice Testing Program f. Steam Generator Tube Surveillance Program g. Secondary Water Chemistry Program h. Explosive Gas & Storage Tank Radioactivity Monitoring Program
Safety Function Determination Program related to LCO 3.0.6.	i. Safety Function Determination Program j. Containment Leakage Rate Testing Program k. Configuration Risk Management Program
	3. Several programs listed above contain requirements included in LCOs & SRs of previous versions of T/S.
	4. Configuration Risk Management Program (like risk monitor or risk matrix) is committed to by a licensee that uses PRA results to extend equipment outage times.
Reports	**3.3.7.3 Reports**
	1. Reports associated w/ programs listed above.
	2. Core Operating Limits Report (COLR): provides core operating limits for current reload cycle. Includes numerical limits for rod insertion limits, AFD, F_Q, $F^N_{\Delta H}$, MTC, & refueling boron concentration. Placed in T/S binders after admin. controls section of TTC Unit 2 T/S.
	3. Pressure & Temperature Limits Report (PTLR): provides RCS pressure & temp. limits & heatup & cooldown limits (relocated from press./temp. limits LCO) & provides LTOP settings for PORVs. These limits change as RV material toughness decreases over time. Placed in T/S binders after COLR.

Deviations from Technical Specifications	**3.3.8 Deviations from Technical Specifications** 1. 10 CFR 50.54(x) states: "A licensee may take reasonable action that departs from a license condition or a T/S (contained in a license issued under this part [10 CFR 50]) in an emergency when this action is immediately needed to protect the public health & safety & no action consistent w/ license conditions & T/S that can provide adequate or equivalent protection is immediately apparent." 2. 10 CFR 50.72 requires that a licensee notify the NRC as soon as practical & within 1 hr of a deviation from T/S authorized by 10 CFR 50.54(x).
Exercises Viewgraphs w/ exercises & exercise answers are included in this lesson plan. Instructor can pass out copies of exercise answers after students have chance to solve on their own.	**3.3.9 Exercises** 6 exercises for students to work on in manual. Students will need to use TTC Unit 2 T/S to answer questions.

WESTINGHOUSE TECHNOLOGY ADVANCED MANUAL LESSON PLAN	
Ch. 3.4	Title: ANALYSIS OF T/S - UNIT 4
Written by: Van Sickle	Date: 03/99

Learning Objectives (standard objectives for all T/S sections)	**Learning Objectives:** 1. Explain the significance of limiting conditions for operation in the area of power distribution limits. 2. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.
Introduction Note: COLR info for MTC, F_Q, $F^N_{\Delta H}$ has been lifted from Vogtle Unit 2, Cycle 7 COLR. Although not applicable to Trojan, it should be representative & should not affect simulator operation. COLR info for rod insertion limits, AFD is taken from Trojan T/S so that simulator procedures are not affected.	**3.4.1 Introduction** 1. This section presents power distribution LCOs: a. Heat flux hot channel factor (F_Q) b. Nuclear enthalpy rise hot channel factor ($F^N_{\Delta H}$) c. AXIAL FLUX DIFFERENCE (AFD) d. QUADRANT POWER TILT RATIO (QPTR) 2. F_Q & $F^N_{\Delta H}$ are peaking factors & are not monitored constantly. Gross measures of power distr.: AFD (axial) & QPTR (radial) are constantly monitored & kept within limits to ensure infrequently monitored peaking factors are within limits. 3. Traditionally, T/S amendments to change limits in LCOs w/ variations in fuel loading characteristics. Today, COLRs contain limits. COLR revs submitted to NRC without need for T/S amendments. 4. TTC Unit 2 T/S refer to COLR. TTC Unit 2 COLR is referenced for plant-specific power distr. info.
Core Thermal Limits	**3.4.2 Core Thermal Limits** 1. Power distr. & heat removal regulated to avoid fuel & clad damage.

2. Overheating of fuel avoided by preventing fuel centerline melting (5080°F).

Students should be familiar w/ DNB, DNBR, & correlations from power distr. lecture of systems course. Few details are provided here. Instructor can refresh memories as necessary.

3. Clad damage avoided by restricting core operation to nucleate boiling regime (DNB is avoided). DNB avoided by maintaining DNBR > limit. Limit varies w/ particular correlation; some values: 1.30, 1.17, 1.13. Limit is > 1 because correlations don't always conservatively predict DNB.

4. Prevention of fuel centerline melting & maintenance of DNBR > limit are assured during normal ops by compliance w/ core safety limits (SL 2.1.1).

Core safety limits figure is provided in viewgraph package in this lesson plan. Instructor can show if he wishes.

5. Power distr. limits support compliance w/ core safety limits by maintaining local core conditions within design limits. Core safety limit curves are based on $F^N_{\Delta H}$ limits provided in COLR.

6. Power distr. limits establish bounds on initial conditions assumed in accident analyses.

Peaking Factors

3.4.3 Peaking Factors

Note: Peaking factors are administrative limits; no alarms or trips based on them.

1. No online indications of DNBR or fuel temp. Local power density info determined from flux maps. From this info, power distr. expressed in peak-to-average ratios.

Note: T/S Basis for F_Q states that F_Q limits assumed in LOCA analysis are typically limiting relative to analyses for other accidents. Hence, F_Q limit is mostly an initial-condition-for-LOCA limit.

2. Peaking factor LCOs establish limits on power density so that fuel design criteria are not exceeded & accident analysis assumptions remain valid. Specifically, F_Q, $F^N_{\Delta H}$ limits ensure:

   a. 95/95 probability/confidence that hottest fuel rod does not experience DNB during both normal ops & a loss of flow accident.

   b. During large-break LOCA peak fuel clad temp. does not exceed 2200°F.

Note: T/S Basis for $F^N_{\Delta H}$ states that $F^N_{\Delta H}$ is important parameter for transients that are DNB limited.	c. During ejected rod accident, energy deposition to fuel does not exceed 280 cal/gm. d. Control rods can shut down reactor w/ min. required SHUTDOWN MARGIN. Hence, peaking factor limits provide power distr. envelope for normal ops & establish most extreme allowable distr. at start of accident.
F_Q	**3.4.3.1 F_Q** 1. Def.: ratio of max. local fuel rod linear power density to core average fuel rod linear power density.
T/S & bases provided in viewgraph package. Limit is stated in TTC Unit 2 COLR (also in viewgraph package).	2. Traditional limit: (2.32/P) K(Z) for $P > 0.5$; 4.64 K(Z) for $P \leq 0.5$. TTC Unit 2 COLR values are 2.50 & 5.00. Limit increases w/ decreasing thermal power. 3. K(Z) assures that local conditions are sufficiently limited that 2200°F clad temp. limit is not exceeded during LOCA:
Typical K(Z) curve provided as manual Fig. 3.4-1. TTC Unit 2 K(Z) curve provided in COLR. (Viewgraphs for each)	a. K(Z) = 1 for bottom half of core. b. K(Z) decreases linearly from approx. 6 to 11 ft of core ht. because upper half of core blows down 1st & refloods last during LOCA, thus stays uncovered for long time. c. K(Z) decreases linearly w/ larger slope over top ft of core ht. because existing backpressure during small-break LOCA could cause exceptionally slow reflood of very top of core. 4. How F_Q is determined to be within limit: a. F_{xy} methodology (plants w/ CAOC AFD & less common than F_Q methodology): 1. SR 3.2.1.1: Take measured value of F_Q (F^M_Q), increase by 3% for fuel manufacturing tolerances & 5% for flux map uncertainty (multiply by 1.0815), & compare to limit.

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Written by: Van Sickle	Date: 05/00

This is similar to traditional Westinghouse treatment of F_Q. A simplified version of this development appears in the manual chapter. Applicable pages from the Westinghouse improved standard T/S are provided in the viewgraph package and after the last divider in student T/S. Note that this methodology does not apply to the TTC Unit 2 T/S & COLR.

2. SR 3.2.1.2:

   (a) Axial peaking is conservatively considered in nuclear design process, so have to ensure radial peaking is within limits. Accordingly, express $F_Q(Z)$ as $F_{xy}(Z)$ x (normalized average axial power at elevation Z), where $F_{xy}(Z)$ = radial peaking factor at elev. Z.

   (b) F^M_{xy} (measured F_{xy}) is determined from flux map for various discrete (30 to 75) core elevations.

   (c) $F^C_{xy} = F^M_{xy}$ (1.03) (1.05) is calculated for each F^M_{xy}.

   (d) F^C_{xy} is compared to radial peaking factor limits F^{RTP}_{xy} (F_{xy} limit at rated thermal power) & F^L_{xy} (F_{xy} limit at current power level; $F^L_{xy} = F^{RTP}_{xy}$ [1 + PFXY] [1 - P]). F^{RTP}_{xy} & PFXY are provided in the COLR. Required actions differ depending on which limit(s) are exceeded.

This is the more likely F_Q treatment to be encountered by inspectors. A simplified version of this development appears in the manual chapter. Applicable pages from the TTC Unit 2 T/S & COLR are provided in the viewgraph package.

b. F_Q methodology (plants w/ RAOC AFD & most common methodology):

   1. SR 3.2.1.1: Take measured value of $F_Q(Z)$ ($F^M_Q(Z)$), multiply by 1.0815 to obtain $F^C_Q(Z)$, & compare $F^C_Q(Z)$ to $F_Q(Z)$ limit provided in COLR. $F^C_Q(Z)$ is excellent approx. for $F_Q(Z)$ at the steady-state power at which flux map is taken.

   2. SR 3.2.1.2: Calculate $F^W_Q(Z) = F^C_Q(Z)\ W(Z)$, & compare $F^W_Q(Z)$ to $F_Q(Z)$ limit provided in the COLR. W(Z) is a cycle-dependent function that accounts for power distr. transients encountered during normal operation. W(Z) is provided in the COLR for discrete core elevations.

   3. If $F^C_Q(Z)$ & $F^W_Q(Z)$ both satisfy the $F_Q(Z)$ limit, then the $F_Q(Z)$ LCO is satisfied.

$F^N_{\Delta H}$ Applicable pages dealing w/ $F^N_{\Delta H}$ from the TTC Unit 2 T/S & COLR are provided in the viewgraph package.	**3.4.3.2 $F^N_{\Delta H}$** 1. Def.: ratio of integral of linear power along fuel rod with highest integrated power to avg. integrated fuel rod power. 2. Limit: $F^N_{\Delta H} \leq 1.65[1.0 + 0.3(1.0 - P)]$. 1.65 is max. allowable $F^N_{\Delta H}$ at 100% power. Additional margin for higher peaking at lower power levels from reduced thermal feedback & greater rod insertion. 3. Old-style R_1, R_2, rod bow penalty treatment not discussed here; don't think many (if any) plants still use it. 4. Required actions for $F^N_{\Delta H}$ LCO call for reducing power & power range neutron flux - high trip setpoint when limit is exceeded.
Operational Limits	**3.4.4 Operational Limits** 1. Peaking factors are only surveilled once every 31 EFPD; to ensure they are within limits between surveillances, the following operational parameters are frequently monitored & verified satisfactory: a. Rod position b. AFD c. QPTR
Rod Position	**3.4.4.1 Rod Position** 1. Rod position LCOs not in power distr. section of T/S, but part of bases for rod position LCOs concerned w/ power distr.
TTC Unit 2 COLR is provided in viewgraph package.	2. Compliance w/ rod insertion limits helps ensure acceptable axial power profile. Control bank rod insertion limits, sequence, & overlap in COLR.

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	3. Compliance w/ rod operability & positioning LCO prevents operation w/ dropped or misaligned rod & thus limits radial flux peaking.
AFD	**3.4.4.2 AFD**
CAOC is traditional Westinghouse treatment of AFD. Applicable pages from the Westinghouse improved standard T/S are provided in the viewgraph package and after the last divider in student T/S. Manual Figure 3.4-2 shows typical doghouse, target band. Note that this methodology does not apply to the TTC Unit 2 T/S & COLR.	1. Def.: Difference in normalized flux signals between top & bottom halves of 2-section excore neutron detector. Also known as ΔI. 2. AFD limits ensure power distr. not too highly skewed to top or bottom of core, thereby ensuring F_Q limits not exceeded during normal ops or due to Xe redistribution following power changes. 3. AFD limits also restrict range of power distrs. used as initial conditions in transient & accident analyses. 4. 2 methodologies: a. Constant axial offset control (CAOC): Target flux difference, target band, "doghouse," penalty minutes. Target flux difference is periodically updated to follow change of flux difference at steady state w/ fuel burnup.
RAOC is more recent Westinghouse treatment of AFD & probably more likely to be encountered by inspectors. Applicable pages from the TTC Unit 2 T/S & COLR are provided in the viewgraph package. Manual Figure 3.4-3 shows RAOC doghouse.	b. Relaxed axial offset control (RAOC): 1. This methodology establishes a Xe distr. library w/ tentatively wide AFD limits. Axial power distr. calculations performed to demonstrate normal-ops power shapes are acceptable for accidents, transients. Tentative limits are adjusted to meet safety analysis requirements. 2. Limit is doghouse that goes to 100% power. No penalty minutes. Target band maintained for administrative control of power distr.

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QPTR	**3.4.4.3 QPTR**
Note example calculation in manual.	1. Def.: Ratio of max. upper excore detector calibrated output to avg. of upper excore calibrated outputs, or ratio of max. lower excore detector calibrated output to avg. of lower excore calibrated outputs, whichever is greater.
Applicable pages from the TTC Unit 2 T/S & COLR are provided in the viewgraph package.	2. QPTR limit ensures gross radial power distr. remains consistent w/ design values used in safety analyses. QPTR limit at which corrective action is required provides DNB & linear heat generation protection from power peaks resulting from x-y plane power tilts.
	3. Typical limit: 1.02. Sometimes included in COLR.
Verifications of $F_Q(Z)$ & $F^N_{\Delta H}$ are SRs 3.2.1.1 & 3.2.2.1 in required action A.3 of LCO 3.2.4.	4. When QPTR exceeds limit, either restore QPTR to within limit within 2 hrs or reduce power 3% from RTP for each 1% of QPTR > 1.00. Also, more frequent verifications of $F_Q(Z)$ & $F^N_{\Delta H}$ are required. 2-hr allowance allows for identification & correction of dropped or misaligned rod.
Exercises	**3.4.5 Exercises**
Viewgraphs w/ exercises & exercise answers are included in this lesson plan. Instructor can pass out copies of exercise answers after students have chance to solve on their own.	4 exercises for students to work on in manual. Students will need to use TTC Unit 2 T/S to answer questions.

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 1

The unit is operating at 95% power. On May 15 at 1:00 p.m., accumulator A becomes inoperable because its boron concentration is not within limits. On May 17 at 2:00 p.m., accumulator D becomes inoperable for the same reason. On May 17 at 4:00 p.m., the boron concentration of accumulator A is restored to within limits (i.e., the operability of accumulator A is restored). See LCO 3.5.1.

1. At the time the first accumulator becomes inoperable, what condition is entered?
2. At the time the second accumulator becomes inoperable, what condition(s) apply?
3. When the first inoperable accumulator is restored to operable status, what condition(s) apply?
4. How long can accumulator D remain inoperable before a condition requiring a unit shutdown is entered?

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 1 SOLUTION

1. At the time the first accumulator becomes inoperable, what condition is entered?

Condition A of LCO 3.5.1 (one accumulator inoperable due to boron concentration not within limits) is entered.

2. At the time the second accumulator becomes inoperable, what condition(s) apply?

Condition D of LCO 3.5.1 is entered, because two accumulators are now inoperable. Also, the Completion Time for Condition A continues to be tracked.

3. When the first inoperable accumulator is restored to operable status, what condition(s) apply?

When the first inoperable accumulator is restored to operable status, Condition D is exited; operation continues in accordance with Condition A. The unit has been in Condition A for 51 hours.

4. How long can accumulator D remain inoperable before a condition requiring a unit shutdown is entered?

In accordance with the rules for Completion Times and Completion Times example 1.3-2 in the Technical Specifications, the Completion Time for Condition A may be extended if the accumulator restored to operable status is the first inoperable accumulator. A 24-hour extension to the stated 72 hours is allowed, provided that accumulator D does not remain inoperable for greater than 72 hours. Extending the Completion Time by 24 hours allows Condition A to remain in effect until 1:00 p.m. on May 19, at which time accumulator D will have been inoperable for 47 hours. If the boron concentration of accumulator D is not restored by then, Condition C, a condition requiring a unit shutdown, will be entered.

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 2

The unit is in Mode 2. The following sequence of events occurs (see LCO 3.8.1):

June 1, 8:00 a.m.	Diesel generator B becomes inoperable.
June 3, 8:00 a.m.	The offsite circuit which supplies power to ESF bus A becomes inoperable. The diesel generator remains inoperable.
June 3, 4:00 p.m.	Diesel generator B is restored to operable status. The offsite circuit remains inoperable.
June 5, 8:00 a.m.	Diesel generator A becomes inoperable. The offsite circuit remains inoperable.
June 5, 2:00 p.m.	The inoperable offsite circuit is restored to operable status. Diesel generator A remains inoperable.

1. State the conditions which apply at each interval.
2. How long can diesel generator A remain inoperable before a condition requiring a unit shutdown is entered?

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 2 SOLUTION

1. State the conditions which apply at each interval.

June 1, 8:00 a.m. Condition B is entered. Completion Time for restoration of operable status (Required Action B.4): 72 hours. (Other required actions apply.)

June 3, 8:00 a.m. Conditions A & D are entered. Completion Time for restoration of offsite circuit operability (Required Action A.3): 72 hours. (Other required actions for Condition A apply.) Completion Time for restoration of either diesel generator or offsite circuit (Required Action D.1 or D.2): 12 hours. Condition B still applies; the unit has been in Condition B for 48 hours.

June 3, 4:00 p.m. Conditions B & D are exited (each within the specified Completion Time). Condition A still applies; the unit has been in Condition A for 8 hours.

June 5, 8:00 a.m. Conditions B & D are reentered, with Completion Times of 48 (not 72; see answer to 2 below) hours and 12 hours, respectively. Condition A still applies; the unit has been in Condition A for 48 hours.

June 5, 2:00 p.m. Conditions A & D are exited (each within the specified Completion Time). Condition B still applies; the unit has been in Condition B for 6 hours.

2. How long can diesel generator A remain inoperable before a condition requiring a unit shutdown is entered?

Diesel generator A can remain inoperable for another 42 hours, or until 8:00 a.m. on June 7, because of the phrase "6 days from discovery of failure to meet LCO" in the Completion Time for Required Action B.4. LCO 3.8.1 has not been met throughout the scenario. If diesel generator A is not made operable by then, Condition G, a condition requiring a unit shutdown, will be entered.

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 3

On May 8 at 6:00 p.m., with the unit at 90% power, a power range neutron flux channel becomes inoperable, necessitating the performance of Surveillance Requirement 3.2.4.2 for verification of the QPTR (see LCO 3.2.4). The first two verifications are made at the following times: May 9 at 8:00 a.m., and May 9 at 10:00 p.m. Does either of these violate the specified surveillance Frequency?

TECHNICAL SPECIFICATIONS UNIT 1 - EXERCISE 3 SOLUTION

Does either of these violate the specified surveillance Frequency?

In accordance with the rules for surveillance Frequency, Frequency example 1.4-2 in the Technical Specifications, and SR 3.0.2, a single performance indicated by the use of "once" does not qualify for the 25% extension of the surveillance allowed by SR 3.0.2, but subsequent performances designated by "thereafter" do qualify for the extension. The first performance of the surveillance does not fall within the specified 12 hours (i.e., the Frequency is violated), but the second performance falls within (1.25)(12 hours) = 15 hours (i.e., the Frequency is satisfied).

3.1 ANALYSIS OF TECHNICAL SPECIFICATIONS - UNIT 1

Learning Objectives:

1. State the requirements for and briefly describe the categories included in technical specifications.

2. Demonstrate understanding of the meanings of all defined terms in the technical specifications by applying them correctly in operational scenarios.

3. Explain the significance of the safety limits and the limiting safety system settings.

4. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 1

On May 15, plant maintenance personnel are planning to cycle a PORV block valve. During the course of their preparations, they determine that the last time this surveillance was performed was January 5. All PORVs are OPERABLE.

1. Locate in the technical specifications the requirement forPORV block valve cycling.
2. Identify whether the specified frequency for this surveillance has been exceeded.
3. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 1 SOLUTION

1. Locate in the technical specifications the requirement for PORV block valve cycling.

A complete cycle of each PORV block valve is required once every 92 days in accordance with surveillance requirement (SR) 3.4.11.1.

2. Identify whether the specified frequency for this surveillance has been exceeded.

May 15 is 130 days after January 5, so the surveillance has not been performed in the last 130 days. SR 3.0.2 states, "The specified Frequency for each SR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance...." The specified interval for this surveillance is 92 days, and 1.25 times the interval is 115 days. Even with the additional 23-day "grace period," the frequency has been exceeded.

3. State the actions to be taken in accordance with technical specification requirements.

SR 3.0.3 states, "If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the LCO not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is less. This delay period is permitted to allow performance of the Surveillance.

If the Surveillance is not performed within the delay period, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered.

When the Surveillance is performed within the delay period and the Surveillance is not met, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered."

The PORV block valve must be cycled within the next 24 hours. If the surveillance is not performed within that time, or if the surveillance is not met when performed, then the LCO 3.4.11 conditions for an inoperable PORV must be entered.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 2

During operation at 100% power, it is discovered that the individual rod position indicator for rod M-12 is inoperable. In addition, the group l step counter for control bank D is out of service (rod M-12 is in group 1 of control bank D). State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 2 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

LCO 3.1.8 requires that individual and demand position indicators be OPERABLE.

For the inoperable DRPI for rod M-12, condition A applies. The required actions for this condition specify (1) verifying the position of rod M-12 with the movable incore detectors once every 8 hours (required action A.1), or (2) reducing THERMAL POWER to ≤ 50% RTP within 8 hours (required action A.2).

For the inoperable bank D, group 1 demand position indicator, condition C applies. The required actions for this condition specify (1) verifying that all DRPIs for the affected bank are OPERABLE (required action C.1.1) and that the maximum distance between rods in that bank is ≤ 12 steps once every 8 hours (required action C.1.2), or (2) reducing THERMAL POWER to ≤ 50% RTP within 8 hours (required action C.2).

Because rod M-12 is in control bank D, the OPERABILITY of the DRPIs for all rods in that bank cannot be verified in accordance with required action C.1.1. Therefore, to fulfill the action requirements for both inoperable position indicators, THERMAL POWER must be reduced to ≤ 50% RTP within 8 hours.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 3

With the plant at 85% power, a boration is performed to move control bank D from 200 steps withdrawn to 220 steps withdrawn. When the boration is complete, the operator notices that the group step counter for control bank D is reading 220, the individual rod position indication for rod M-12 (a bank D rod) is 198 steps, and the individual rod position indications for all other bank D rods are 222 steps. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 3 SOLUTION

State the actions to be taken in accordance with technical specifications.

From the statement of the problem, it can be concluded that rod M-12 did not withdraw with the other rods in its bank and that M-12 remains where it was before the boration. LCO 3.1.5 requires that all control rods be OPERABLE and that all individual rod position indications be within 12 steps of their group step counter demand positions. Rod M-12's position (198 steps) is now 22 steps below the bank D, group 1 demand position (220 steps).

Without further evidence, a licensee would be unlikely to declare rod M-12 untrippable, so condition A of LCO 3.1.5 would not be considered applicable.

On the other hand, condition B of LCO 3.1.5 is unquestionably applicable. The required actions for this condition specify (1) restoring rod M-12 to within 12 steps of the bank D, group 1 step counter indication within 1 hour (required action B.1), or (2) taking all of the B.2 required actions, which include reducing THERMAL POWER to ≤ 75% RTP within 2 hours.

One way to comply with the required actions is to insert the other bank D rods to within 12 steps of rod M-12 (assuming that rod M-12 doesn't move when bank D rods are inserted). This action would satisfy required action B.1 while providing the licensee time to troubleshoot the rod control problem without having to reduce power. A check of Figure COLR-1 reveals that the rod insertion limits would be satisfied for a bank D position between 186 and 210 steps at 85% power.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 4

During operation at 95% power, pressurizer pressure channel PT-455 fails high; the input of the failed channel into the pressurizer pressure control system causes the pressurizer spray valves to open. Pressurizer pressure decreases to 2170 psig before the operator manually shuts the spray valves. The operator declares PT-455 inoperable and changes pressure control functions to another channel. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 4 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

Several conditions of LCOs have been entered.

First, the current pressure is less than the DNB pressurizer pressure limit (2205 psig) specified by LCO 3.4.1. Condition A of that LCO applies; pressure must be restored to greater than the limit within 2 hours (required action A.1).

Second, the failed pressurizer pressure channel affects the following reactor trip system functions of LCO 3.3.1: overtemperatureΔT (for which condition E applies), pressurizer pressure - low (for which condition M applies), and pressurizer pressure - high (for which condition E applies). The required actions for conditions E and M both require that the inoperable channel be placed in trip within 6 hours (required actions E.1 and M.1), or that the plant be brought to a condition in which those functions are not required to be OPERABLE (required actions E.2 and M.2).

Third, the failed pressurizer pressure channel affects the following ESFAS functions of LCO 3.3.2: safety injection on pressurizer pressure - low (for which condition D applies) and the P-11 interlock (for which condition K applies). The required actions for condition D require that the inoperable channel be placed in trip within 6 hours (required action D.1), or that the plant be brought to a condition in which that ESFAS function is not required to be OPERABLE (required actions D.2.1 and D.2.2). The required actions for condition K require verification that the interlock is in the required state for 95% power operation (required action K.1), or that the plant be brought to a condition in which the interlock is not required to be OPERABLE (required actions K.2.1 and K.2.2).

In summary:

1. Pressurizer pressure should be restored through either manual or automatic operation of the pressurizer pressure control system.
2. Three reactor trip bistables and one ESFAS bistable associated with pressurizer pressure channel PT-455 should be tripped.
3. The P-11 interlock would be in the required state so long as the other two pressurizer pressure channels which provide inputs to the interlock are indicating the correct pressure.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 5

During operation at 50% power, the operators detect a small RCS leak. A water inventory balance determines the leak rate to be two gpm.

1. Classify the LEAKAGE.
2. A containment entry reveals the leakage to be from a weld on the letdown delay pipe. Determine whether the LEAKAGE classification has changed, and determine whether the plant has entered a condition requiring action in accordance with technical specifications.
3. State the actions to be taken in accordance with technical specifications if the leak rate increases to 20 gpm.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 5 SOLUTION

1. Classify the LEAKAGE.

In accordance with the definition for LEAKAGE in the definitions section of the technical specifications, it would be classified as unidentified LEAKAGE. Without further information, the possibility of pressure boundary LEAKAGE cannot be discounted.

2. A containment entry reveals the leakage to be from a weld on the letdown delay pipe. Determine whether the LEAKAGE classification has changed, and determine whether the plant has entered a condition requiring action in accordance with technical specifications.

The LEAKAGE is now specifically located, and it is not pressure boundary LEAKAGE because the leak is isolable (the leak location is downstream of letdown isolation valves LCV-459 and LCV-460). Thus, the LEAKAGE would now be classified as identified LEAKAGE. A condition requiring action has not been entered, as the LCO 3.4.13 limit for identified LEAKAGE is 10 gpm.

3. State the actions to be taken in accordance with technical specifications if the leak rate increases to 20 gpm.

A 20-gpm leak rate exceeds the limit for identified LEAKAGE. Condition A of LCO 3.4.13 applies. The LEAKAGE must be reduced to within limits within 4 hours (required action A.1), or the plant must be brought to MODE 3 within the next 6 hours (required action B.1) and to MODE 5 within the next 36 hours (required action B.2).

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 6

After the drawing of accumulator samples, the volume of accumulator A is determined to be 6470 gallons. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 2 - EXERCISE 6 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

The current accumulator volume is outside the acceptable range stated in SR 3.5.1.2 (6508 - 6956 gallons). As a result, condition B of LCO 3.5.1 applies. The accumulator must be restored to OPERABLE status (the water volume of the accumulator must be increased to ≥ 6508 gallons) within 1 hour. If the 1-hour completion time is not met, actions must be taken to place the plant in a MODE in which the LCO does not apply, in accordance with the required actions for condition C.

Also, it would be a good idea to verify that the boron concentration is within limits following the water addition. If the addition is ≥ 90 gallons and it is not from the refueling water storage tank, SR 3.5.1.4 requires that the boron concentration be verified within 6 hours of the volume addition.

3.2 ANALYSIS OF TECHNICAL SPECIFICATIONS - UNIT 2

Learning Objectives:

1. Explain the significance of limiting conditions for operation in the areas of applicability, reactivity control systems, instrumentation, the reactor coolant system, and the emergency core cooling systems.

2. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 1

At 1:00 p.m. on May 15, with the unit at 3% power during a power ascension, two train A containment air cooler fans fail. Containment cooling train A is declared inoperable. It is later determined that the fans have failed due to excessive bearing wear. At 2:00 p.m. on May 19, with the unit at 45% power, a small leak from containment spray train B near the pump is discovered, and the train is declared inoperable. At 11 p.m. on May 19 (critical events curiously happen on the hour at this plant), with the unit still at 45% power, one of the air cooler fans is fixed, and containment cooling train A is declared operable.

1. Determine the LCO conditions and required actions which have been entered during this time period.
2. Determine whether the licensee has complied with all technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 1 SOLUTION

1. Determine the LCO conditions and required actions which have been entered during this time period.

When containment cooling train A is declared inoperable, condition C of LCO 3.6.6 is entered. Required action C.1 requires restoration of the train to OPERABLE status within 7 days. When containment spray train B is declared inoperable, conditions A and E of LCO 3.6.6 are also entered. The required actions of condition E, entering LCO 3.0.3, are by far the most restrictive. LCO 3.0.3 requires initiating action within 1 hour to place the unit in MODE 3 within 7 hours.

2. Determine whether the licensee has complied with all technical specification requirements.

The licensee did not comply with the required actions of LCO 3.0.3 on May 19. The problem statement contains no mention of the licensee initiating action to shut down within 1 hour of the discovery that 2 required trains covered by LCO 3.6.6 were inoperable. Also, the unit was obviously not in MODE 3 within 7 hours of the required entry into LCO 3.0.3.

In addition, the unit made a transition from MODE 2 to MODE 1 at some point between May 15 and May 19. During this time LCO 3.6.6 was not satisfied. LCO 3.0.4 prohibits entry into MODE 1 in a case like this (LCO 3.6.6 provides no exception to the provisions of LCO 3.0.4).

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 2

Suspicious of mistakes during recent bench testing of the main steam safety valves (MSSVs), a member of the plant maintenance staff consults the test records and finds that the following lift settings were verified for the tested valves:

MSSV	Lift Setting (psig)
PSV-2232	1245
PSV-2234	1260
PSV-2255	1260
PSV-2275	1270

The unit is operating at 87% power. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 2 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

The MSSVs are required to have lift settings as specified in Table 3.7.1-2. The minimum and maximum allowable lift settings for the recently tested valves are as follows:

MSSV	Min. Lift Setting (psig)	Max. Lift Setting (psig)
PSV-2232	1164	1236
PSV-2234	1184	1256
PSV-2255	1194	1266
PSV-2275	1194	1266

The as-tested lift settings for PSV-2232, PSV-2234, and PSV-2275 exceed the maximum allowable lift settings. Condition B of LCO 3.7.1 applies. For 3 OPERABLE MSSVs per steam generator (PSV-2232 and PSV-2234 are on the same steam generator), a power reduction to ≤ 46% RTP is required within 4 hours, and a reduction of the power range neutron flux - high trip setpoint to ≤ 46% RTP is required within 36 hours.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 3

With the unit operating at 30% power, service water booster pump P-148B trips, and booster pump P-148D automatically starts (both pumps are train B pumps). Minutes later, pump P-148D also trips. It is determined that an improperly performed maintenance requirement has rendered both pumps inoperable. At the time both pumps are declared inoperable, the A train safety injection pump has been inoperable for 24 hours. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 3 SOLUTION

State the actions to be taken in accordance with technical specifications.

The basis for LCO 3.7.8 (service water system) states that an OPERABLE service water train has at least 1 OPERABLE service water booster pump. Since both of its booster pumps are inoperable, service water train B is inoperable, necessitating entry into condition A of LCO 3.7.8. Required action A.1 requires restoration of the train to OPERABLE status within 72 hours. Note.1 of required action A.1 requires that the applicable conditions and required actions of LCO 3.8.1 be entered for the diesel generator (B) made inoperable by inoperable service water train B.

LCO 3.0.6 states that when a supported system LCO is not met solely due to a support system LCO not being met, the conditions and required actions of the supported system LCO are not required to be entered. (Note 1 of action A.1 of LCO 3.7.8 is an exception to this rule.) However, in this case the A train safety injection pump is inoperable. Service water train B supports the B train safety injection pump; it provides cooling water to that pump's lubricating oil cooler and room cooler. The B train safety injection pump is thus almost certainly also inoperable, and an evaluation of the safety injection system safety function must be conducted in accordance with the Safety Function Determination Program (see specification 5.5.15 in the administrative controls). If a loss of safety function is determined to exist (and if neither safety injection train is capable of injecting for very long, this is almost certainly the case), the applicable conditions and required actions of LCO 3.5.2 (ECCS OPERABILITY), and potentially LCO 3.0.3, would be entered.

Aside from technical specification requirements, there is a possibility that the cooling water flow from 1 service water train is not capable of handling all normal operating heat loads, and a unit shutdown might be necessary for that reason.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 4

During operation at 100% power, the normal supply breaker for bus #A1 opens. The cause of the event is determined to be a faulty breaker. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 4 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

Two qualified circuits between the offsite transmission network and the onsite Class 1E AC electrical power distribution system no longer exist (there is no circuit between offsite and the A train of the Class 1E system). Condition A of LCO 3.8.1 applies; the required actions associated with this condition must be taken. The circuit must be restored within 72 hours (required action A.3). Also, the inoperable offsite circuit necessitates declaring supported features inoperable if opposite-train redundant features are inoperable (required action A.2).

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 5

During operation at 100% power, a power line problem results in the opening of a switchyard disconnect to the Rivergate substation. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 5 SOLUTION

State the actions to be taken in accordance with technical specification requirements.

Although one of the connections between the switchyard and the utility's electrical grid has been lost, two qualified circuits between the offsite transmission network and the onsite Class 1E AC electrical power distribution system continue to exist (the switchyard is considered part of the offsite transmission network). LCO 3.8.1 is satisfied; no actions are required by the technical specifications.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 6

During a refueling operation, an instrumentation and control technician requests permission from the shift supervisor to perform a retrofit modification to the power range nuclear instruments. To accomplish this change he will have to remove the instrument power fuses for all four power range instruments at the same time. (Hint: Removing the instrument power fuses from a power range instrument trips all bistables associated with that instrument.) Determine whether the shift supervisor should give permission for this work, and explain.

TECHNICAL SPECIFICATIONS UNIT 3 - EXERCISE 6 SOLUTION

Determine whether the shift supervisor should give permission for this work, and explain.

Removing the instrument power fuses from each power range instrument causes all of its associated bistables to trip, including the P-10 permissive bistable. If the instrument power fuses are removed from all four power range instruments simultaneously, then all four P-10 bistables will be tripped, and the two-out-of-four coincidence for the permissive will be satisfied. One of the functions of P-10 is the de-energization of both source range nuclear instruments. This would render both instruments inoperable (without power, they are obviously incapable of monitoring core reactivity) and require entry into conditions A and B of LCO 3.9.3. The shift supervisor should not give permission for this work; he should permit de-energizing only one power range instrument at a time.

3.3 ANALYSIS OF TECHNICAL SPECIFICATIONS - UNIT 3

Learning Objectives:

1. Explain the significance of limiting conditions for operation in the areas of containment systems, plant systems, electrical power systems, and refueling operations; design features; and administrative controls.

2. When given an initial set of operating conditions, use the format and content of the technical specifications to identify the applicable section from which to determine the appropriate plant and/or operator response.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 1

An incore flux map is obtained with the plant at 95% power in accordance with a regularly scheduled surveillance. Core burnup is 150 MWD/MTU. Measured values of the heat flux hot channel factor, $F^M_Q(Z)$, at three core elevations are as follows:

Elevation (ft)	$F^M_Q(Z)$
4	1.8176
6	1.8549
10	1.7932

1. Calculate $F^C_Q(Z)$ for each core elevation.
2. Calculate $F^W_Q(Z)$ for each core elevation.
3. Determine whether the $F_Q(Z)$ limit has been exceeded.
4. State the actions to be taken in accordance with technical specification requirements.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 1 SOLUTION

1. Calculate $F^C_Q(Z)$ for each core elevation.

Calculate each $F^C_Q(Z)$ by multiplying the measured value by 1.0815 to account for manufacturing tolerances and flux map measurement uncertainty.

Elevation (ft)	$F^M_Q(Z)$	x 1.0815 =	$F^C_Q(Z)$
4	1.8176		1.9657
6	1.8549		2.0061
10	1.7932		1.9393

2. Calculate $F^W_Q(Z)$ for each core elevation.

Calculate each $F^W_Q(Z)$ by multiplying $F^C_Q(Z)$ by the W(Z) value for the applicable core elevation. Obtain W(Z) values from Figure COLR-3 for the stated core burnup.

Elevation (ft)	$F^C_Q(Z)$	x	W(Z)	=	$F^W_Q(Z)$
4	1.9657		1.2365		2.4306
6	2.0061		1.2049		2.4171
10	1.9393		1.3090		2.5386

3. Determine whether the $F_Q(Z)$ limit has been exceeded.

Determine the $F_Q(Z)$ limit for each core elevation with the formula provided in the COLR (CFQ = 2.50, P = 0.95) and the appropriate K(Z) value from Figure COLR-2. Then compare each $F^C_Q(Z)$ and $F^W_Q(Z)$ value to the applicable limit.

Elevation (ft)	CFQ/P	x	K(Z)	=	$F_Q(Z)$ limit
4	2.6316		1.000		2.6316
6	2.6316		1.000		2.6316
10	2.6316		0.950		2.5000

The $F^W_Q(Z)$ value at the 10-ft elevation (2.5386) exceeds the $F_Q(Z)$ limit (2.5000).

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 1 SOLUTION (CONTINUED)

4. State the actions to be taken in accordance with technical specification requirements.

Condition B of LCO 3.2.1 applies. In accordance with action B.1, the AFD limits must be reduced at least 1% for each 1% by which $F^W_Q(Z)$ exceeds the limit within 2 hours.

$F^W_Q(Z)$ exceeds the limit by $\frac{(2.5386 - 2.5000)}{2.5000} \times 100 = 1.544\%$.

Round up to 2% for conservatism. AFD limits at 95% power (see Figure COLR-7):

Lower limit: $-40.0 + \frac{(95 - 50)}{(100 - 50)} [-7.5 - (-40.0)] = -10.75$.

Upper limit: $39.0 + \frac{(95 - 50)}{(100 - 50)} (4.0 - 39.0) = 7.5$.

Add 2% to lower limit and subtract 2% from upper limit. New AFD bounds at 95% power are (-8.75, 5.5). If this action is not taken within 2 hours, then the plant must be brought to MODE 2 (where LCO 3.2.1 does not apply) within the next 6 hours, per action C.1.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 2

With reactor power at 100%, it is noted that the current AFD value is-8.3%.

1. State the actions to be taken in accordance with technical specification requirements.
2. State how the operator would restore the AFD to within the limits.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 2 SOLUTION

1. State the actions to be taken in accordance with technical specification requirements.

Condition A of LCO 3.2.3 applies. Power must be reduced to < 50% within 30 minutes if the AFD is not corrected to within the limits during that time.

2. State how the operator would restore the AFD to within the limits.

Since the AFD is too negative, the control rods are probably too deeply inserted; the operator would restore the AFD by borating the reactor coolant to drive the control rods farther out.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 3

While the plant is operating at 98% power, the following annunciators alarm: ROD BOTTOM, ROD DEVIATION POWER TILT, and POWER RANGE COMPARATOR DEVIATION. The digital rod position indication system indicates that one rod is on the bottom. The calculated QPTR immediately after the rod drop is 1.05.

1. State the actions to be taken in accordance with technical specifications.
2. State the basis for the 2-hour completion time for reducing thermal power.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 3 SOLUTION

1. State the actions to be táken in accordance with technical specifications.

Condition A of LCO 3.2.4 applies. The required actions associated with condition A must be taken. In the short term, power would be reduced to 85% (a 15% reduction from RTP because the QPTR exceeds 1.00 by 5%) in accordance with action A.1, unless the QPTR is made less than 1.02 within 2 hours. In addition, the periodic QPTR checks specified by action .A.2 should alert the operators to a worsening QPTR condition, which would mandate further power reductions. Additional actions have longer completion times. Note that actions A.4, A.5, and A.6 if power has been reduced in accordance with actions A.1 and A.2

2. State the basis for the 2-hour completion time for reducing thermal power.

The basis for required action A.1 states, "The Completion Time of 2 hours allows sufficient time to identify the cause [of the QPTR exceeding its limit] and correct the tilt."

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 4

With reactor power at 90%, state the requirements for verifying the QPTR:

1. Under normal circumstances.
2. When the QPTR alarm is inoperable.
3. When one power range channel is inoperable.

TECHNICAL SPECIFICATIONS UNIT 4 - EXERCISE 4 SOLUTION

With reactor power at 90%, state the requirements for verifying the QPTR:

1. Under normal circumstances.

Surveillance requirement (SR) 3.2.4.1 requires verifying the QPTR by calculation once every 7 days.

2. When the QPTR alarm is inoperable.

SR 3.2.4.1 requires verifying the QPTR by calculation once within 12 hours and once every 12 hours thereafter with the QPTR alarm inoperable.

3. When one power range channel is inoperable.

SR 3.2.4.2 requires verifying the QPTR using the movable incore detectors once within 12 hours and once every 12 hours thereafter with one power range channel inoperable and power ≥ 75%.