U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-305/OL-84-01

Docket No. 50-305 License No. DPR-43

Licensee: Wisconsin Public Service Corporation
Post Office Box 1200
Green Bay, WI 54305

Facility Name: Kewaunee Nuclear Power Plant

Examination Administered At: Kewaunee Nuclear Power Plant

Examination Conducted: December 18, 19, 20, 1984

Examiners: T. Reidinger J. I. McMillen for T.R. 1/14/85
Date

B. Picker J. I. McMillen for B.P. 1/14/85
Date

Approved By: J. I. McMillen
J. I. McMillen, Chief
Operator Licensing Section
1/14/85
Date

Examination Summary

Examination administered on December 18, 19, 20, 1984 (Report No 50-305/OL-84-01)
The applicants consisted of four SRO upgrade candidates.
Results: All candidates passed.

8502050322 850115
PDR ADOCK 05000305
Q PDR

REPORT DETAILS

1. Examiners

T. D. Reidinger*
Bob Picker

*Chief Examiner

2. Examination Review Meeting

The exam review was conducted by the examiners and facility representatives as follows:

*F. Stanaszak
R. Zube
D. Kwiatkowski
G. Ruiter

*Facility Training Manager

The facility comments and resolution of those comments are as follows:

Question	Comment/Resolution
5.4a	The facility pointed out that the question may also elicit the fact that Tavg is derived using narrow range RTD's, which are not accurate during natural circulation; therefore, Tavg is not a good indication of well-established natural circulation. The examiner accepted alternative answer.
5.4b	The facility pointed out that the ΔT value (650 and increasing being greater than full power ΔT. This usually means an oversteaming condition and resultant natural circulation flow may be inhibited. The examiner accepted alternative answer.
5.4c	The facility pointed out that an interruption of natural circulation due to excessive steam flow is indicated by a decreasing primary system cold leg temperature. "Rapidly" (in the question), if interpreted as excessive, could cause a student to answer disagree. The examiner accepted alternative answer.

Question	Comment/Resolution
5.5	The facility stated that decreasing steam pressure causes a enthalpy to increase for the operating pressure. They wished to amend the answer key to include this statement. The examiner agreed with their statement but did not amend the answer key as it is referenced indirectly in the key.
5.9	The facility pointed out a typo in answer key. <u>Full</u> should be FUEL. The examiner amended the typo error.
5.12	The facility stated that the student emphasis may not be on flex shift due to low leakage loading pattern and the student may cite detector current changes BOL <u>to EOL</u> due to redistribution. The examiner accepted additional comments.
6.1	The facility provided references that the internals of the relief valve are now removed to prevent over-pressure of the system, and the candidate might include this in the answer. The examiner accepted this inclusion.
6.6b	The facility indicated that the train A feedwater heater string should state, "bypassed vice isolated" in the question. The examiner amended the question.
6.10	The facility made a comment to reword the answer key. The examiner noted the comment.
6.14	The facility wishes to include the abbreviation of WHT to answer key (Waste Holdup Tanks). The examiner accepted the suggestion.
6.15b	The facility pointed out that the candidate could make an assumption that "loss of electrical power" could be interpreted as "loss of all electrical power which causes a loss of air also, after which the AFW control valves would fail open vice "as in". The examiner would accept either answer.
6.16b	The facility pointed out a typographical error in answer key. The examiner noted error.
7.6	The facility made comment about 100 hour requirement in the Technical Specifications. The examiner noted comment.
7.7	The facility noted that the order of the answer key "a & b" should be reversed. The examiner amended the order.

Question	Comment/Resolution
7.9	The facility stated training does not stress all the points listed in answer key. The examiner noted the comments.
7.10	The facility stated their interpretation of the daily test of the diesel. The examiner did not accept the interpretation that the daily test really doesn't mean daily test but could include two days.
8.2b(3)	The facility pointed out that the candidate should assume the time limit is greater than 24 hours. The examiner agreed.
8.3	The facility stated that False should be included in answer key. The examiner agreed.
8.7	The facility made comment that the candidate may respond to the Technical Specification requirements rather than procedure A-NI-48. The examiner noted comment.
8.8b	The facility provided references that indicated that the control room supervisor has new responsibilities. The examiner amended answer key.
8.10	The facility pointed out that the candidates will not know paragraph number in Code of Federal Regulations. The examiner deleted the paragraph number.
8.12	The facility made general comment about other requirements listed in Technical Specifications. The examiner noted the comments.
8.13a(2)	The facility provided references that the leak rate should be 500 gpd total steam generator tube leakage. The examiner amended the answer key.
8.13a(4)	The facility provided 2 letters of interpretation for unisolated and then isolated valve body leakage. The examiner will accept either interpretation.

3. Exit Meeting

Facility representatives from Material Training Simulator Training, Operations and plant management, the NRC Resident Inspector, and the examiners met on December 20, 1984, to summarize the results of the oral and simulator examinations. The examiners indicated those that clearly passed the oral/simulator examinations. Discussion was centered on the erroneous implied interpretations of technical specifications relating to safeguards systems in general. It is related to the "pull to lock" functions on switches which would make that train inoperable, per Technical Specifications. The facility stated that going to pull to lock on that train, i.e. SI pumps, does not make that train inoperable as long as personnel are standing in close vicinity to the switch. The misinterpretation from the utility came from an one-case basis approval of going "to pull to lock" on AFW pumps during a plant startup. The NRC resident inspector will discuss the matter in a separate meeting with the utility concerning corrective measures to re-educate applicable personnel to the correct operating philosophy of operating safeguards systems.

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Answers - Section 5

5.1 a. Decrease, since power defect increases without a rod worth increase. (less boron in core)

b. Increase, (Tavg increases, adding negative reactivity)

c. Increase because power defect is being decreased without reducing withdrawn rod worth significantly.

d. No change, since decrease in power defect is offset by decrease in withdrawn rod worth.

5.2 $\Delta H = \Delta Q - W = 0$

No heat transfer, no work done. For this constant enthalpy process follow the h = 1172 Bxy/lb line to the 100 psia line. Follow the 100 psia line to the saturation line and read. Tsat = 330°F

5.3 a. Increase, because Pu-240 is a high resonant absorber.

b. Increase, because fuel centerline temperature increases.

c. Decrease, due to fuel centerline temperature decrease.

d. Increases, due to less moderation, resonance escape probability or center line temperature increases.

5.4 a. Disagree - Tave is a calculated indication and one parameter decreasing will cause Tave to decrease giving a false indication. Agree - if other indication is used in conjunction with Tave. Tave is derived using narrow range RTD which are

b. Disagree - Natural circulation is indicated by Th stabilizing then tends to decrease and the Tc and Th ΔT tends to decrease as decay heat decreases. ΔT > Full pwr ΔT means an oversteaming condition and Nat circulation flow may be inhibited

c. Agree - Lowering steam pressure will lower saturation temperature which will increase heat transfer across the tubes.
Disagree - Assumption - Nat circulation can be inhibited due to excessive stm flow indicated by a decreasing primary system cold leg temp.

Ref: WNTC thermal/hydraulic Chap. 14 p. 27

5.5 Although the saturation temperature of the steam exiting the steam generator decreases slightly as power increase, the temperature of the feedwater increases with power because of the improved effectiveness of the low and high pressure feedwater heaters. Since the feedwater temperature increases, the enthalpy change across the steam generator decreases with power recalling that

$$Q_{S/G} = \dot{m}\,\Delta h$$

a decrease in Δh requires an increase in $\dot{m}$ in order to increase $Q_{S/G}$. As power increases, therefore, the secondary mass flow rate increases. Although, the change in mass flow rate of the secondary system is not completely linear with respect to power, linear approximations are often used for determining flow rates at various power levels.

Ref: p. 13, Chap 12 Thermal-hydraulic Principles and Application to PWR - Westinghouse

5.6 Reflux boiling is the phenomenon of two phase flow in the RCS where steam entering the S/G U-tubes is condensed and then backflows into the reactor via the hot leg where it picks up additional heat and the process repeats itself.

5.7 Target ΔI shifts in the negative direction as the core ages under the influence of two conflicting effects.

a. Once and twice burned fuel is more enriched in the top half. This tends to shift ΔI in the positive direction.

b. MTC is more negative and favors power production in the bottom half of the core which is cooler than the top half.

Since MTC is more negative at EOL then at BOL effect #1 dominates at BOL, and effect #2 dominates at EOL.

5.8
a. Feedpumping - 3
b. Phase changes in S/G - 5
c. HP turbine expansion - 6
d. HP feedwater heating and SG subcooled heating - 4
e. Condensate pumping - 1
f. LP feedwater heating - 2
g. Moisture separation and reheating - 7
h. Condensation in condenser - 9
i. LP turbine expansion - 8

5.9 In all cases, Tave decreases as steam flow increases in excess of reactor power. For a negative MTC, as Tave decreases, positive reactivity is inserted and reactor power increases to match steam demand (turbine maintains constant MWE as Amp decreases). The more negative the MTC, the less the mismatch between Tave and Tref when the transient stabilizes. For a positive MTC, reactor power will turn since the cooldown inserts negative reactivity with the turbine in Imp in, power and Tave would keep decreasing until the plant trips; fuEl temp coeff will add positive reactivity.

5.10 a. Power decreases at first due to boron addition, the primary to secondary power mismatch causes Tave to decrease. The decrease in Tave inserts positive reactivity and restores power to its original value.

b. Tave is determined by the amount of pump heat and the steam dump pressure setting - it does not change. Power decreases at a -1/3 dpm rate to source level.

5.11 a. Rx power - increases due to rod withdrawal until P-10 at which time Rx trips. (Optional)

b. Steam pressure - stays constant since any pressure error will cause dumps to open to maintain steam at setpoint.

c. Tave - increases with power.

5.12 False; excore detectors will see more at EOL due to increased leakage because of reduced B_{10} and radial flux shifting.

5.13 At a higher flow rates, the thermal boundary layer is smaller and voids are more readily swept off the wall and into the fluid stream. Temperature rise across the core is decreased. (Any two)

Ref; U - Thermal-hydraulics

5.14 1.02

Ref: T/S 3.7

Answers - Section 6

6.1 True. The operator can manually override if CCW pressure > 150psig.

Ref: E2045-C and SNO - July 19, 1984

6.2 The volumetric expansion of coolant on charging side is relieved to the RCS through a check valve (CVC-14) which bypasses the isolation.

Ref: Chap 35-17

6.3 Seal oil backup pump. EHC pumps

Ref: 111-1.7; Ref: AGE-84

6.4 True - A signal from both level channels is required for this switch over.

Ref: Chap. 35-23 para. 3.5.3.3

6.5 a. RCP thermal barrier

b. Excess letdown HX

c. Nonregenerative HX

d. Sample coolers (RCS, RHR, pressurizer, hot leg)

e. RHR HX

f. RHR pump seal HX

g. Spent fuel pit HX

h. Seal water HX

i. Safety injection pumps

Ref: XK100-18, XK100-19, XK100-20

6.6 a. The power mismatch circuit output produces a transient insertion signal as a result of the input failure. The transient dies off quickly and the rods attempt to withdraw and restore Tave. They cannot do so because the over power rod stop has been actuated by the failed detector.

Ref: IV-1.15, IV-3.4, IV-1.36

b. Loss of feedwater heater string will reduce feedwater temperature. This reduces Tave causing the rods to move out and restore Tave to the dead band.

Ref: IV-3.4

6.7 $OT\Delta T$ stpt = ΔT_0 $[(K_1 - K_2\ (Tave-1) + K_3(P-P^1) - f(\Delta I)]$

1. Tave above rated
2. pressure below rated
3. $f(\Delta I)$ greater than (+9% or -12%) (deadband)

Ref: IV-11.6

6.8 a. Four containment fan coils start

b. Containment dome ventilation fans start

c. Shield building ventilation starts

d. Containment purge and ventilation supply and exhaust isolation valves close

e. Auxiliary building special ventilation system starts

f. All turbine and auxiliary building fan coil units start

g. Auxiliary building supply/exhaust fans trip

h. Auxiliary air conditioning units trip

i. Auxiliary air conditioning units and post-accident recirculation fans will start, nonaccident fresh air damper ACC-5 will close

j. Diesel generator ventilation supply fans start

Ref: Chap. 15, 18, 19, 24, 25, 33, 56

6.9 a. CCW return

b. Seal water return to VCT

c. Sample and blowdown line

Ref: Chap. 7, 33, 35

6.10 The RHR heat exchanger flow must be increased to continue the cooldown at a constant rate since the RCS temperature is dropping. The reactor coolant flow through RHR is increased and flow through the bypass line is reduced. Component cooling doesn't change flow rate.

Ref: Chap. 34-7

6.11 No! Since the turbine exhaust steam temperature is at or below that of the condensate temperature there is no efficiency gained.

6.12 a. Yes, steam flow nozzles are upstream of S/G safety valves tap off

b. Nuclear Power ↑ Tave will deviate from Tref, loop Delta-T deviation

Ref: M203-DD

6.13 Source range NI detect fast neutrons that were slowed down by the polyethene shielding of the detector.

Ref: TM-NI

6.14 1. WDS

Ref: X-K100-19, XK100-131

6.15 a. Fails open

Ref: X-K100-36

b. Fail as-is (if assumption is made as loss of all electrical p[ower] which causes a loss of air also, the AFW valves will fail open)

Ref: A-FW-05B

c. S/G PORV fail shut

d. Fail shut

Ref: IV 9.3

6.16 a. Droop is desirable for parallel operation because it allows for load sharing between power sources. With a flat speed droop, any frequency changes result in very large swings in load.

b. Field flashing is an initial supply of external DC to the diesel field to cause initial excitation. It is supplied by an external set of station DC batteries.

Ref: Chap. 42-13

Answers - Section 7

7.1 a. Point 1 - the indicated AFD may deviate from ±5% target band - max. 1 hour - in 24 hours. AFD does not exceed envelope bounded by ±10% at 90% power and increasing by -1% and +1% from Target AFD for each 2.7% decrease in rated power below 90 and above 50%. If cumulative time exceeds 1 hour in 24 hours, Rx power shall be reduced immediately to less than or equal to 50% power and reduce flux setpoints to ≤ 55% power.

Ref: T/S 3.10 - 4 para 11.a, 10

b. Point 2 - Power level >90% if AFD deviates from its target band, the flux difference shall be returned to target band immediately or reactor power shall be reduced to a level no greater than 90% of rated power.

c. Point 3 - Maximum AFD limit no operation allowed outside this curve. ~~AFD shall be returned to within the envelope immediately.~~
~~Ref: W p. 13-52~~ Reduce pwr to ≤ 50% + reset flux trip setpoints to 55% immediately
~~Reduce by 2.7% power level and increase envelope by ±1%.~~
~~Ref: T/S~~

7.2 High Radiation Area - Whole body dose 100 mrem/hr.

$I_1 d_1^2 = I_2 d_2^2$

$(6 \text{ rem})(1)^2 = (100 \text{ mrem}) d_2^2$

$\frac{6 \text{ rem } (1)^2}{100 \text{ mrem}} = d_2^2$

$60 = d_2^2$

$7.7 \text{ ft} = d_2^2$

Ref: KNP Radiation Protection Manual

7.3 1. SS supply data on tank to be discharged, volume, circulating water pumps.

2. Insure R-18 discharge monitor has been checked and tested for proper operation and discharge monitor section of discharge permit filled out prior to start of discharge.

3. Insure discharge permit provisions carried out.

4. Insure only one radiological discharge is made to circulating water system at any one time unless noted.

Ref: ACD 6.7 para 5.1, 5.3, 5.4, 5.7

7.4 1. Perform E-0-04

2. Verify SI discharge flow from one train (actual flow or SI pump discharge pressure and valve position indication.

3. Observe SI and CI active status panels follow up auto action which didn't occur.

4. If RC pressure decreases to 1500 psig or less and SI flow is verified, trip both RC pumps.

5. Stop turbine driven auxiliary feedwater pump.

Ref: E-0-09

7.5 Usually 100 cpm above background so it would be 210 cpm.

7.6 1. Boron concentration - 2100 ppm

2. Subcritical >100 hours

3. Minimum water level above vessel flange 23 feet

4. Direct communications between the control room and operating floor

5. Spent fuel pool sweep system in operation

6. licensed SRO onsite and in charge if refueling

7. RHR pump operable

8. two neutron monitors - visual indications in control room, one audible in containment.

Ref: T.S.

7.7 (1) Rapid uncontrolled decrease in RCS temperature.
(2) Tavg - Tref deviation alarm.
(3) RCS loop A/B Tave low-low alarm
(4) CAF

(1) Abnormal control bank position
(2) Increasing RCS temperature
(3) Increased readings on NI, IR/or PR meters
(4) CAF

Ref: E-CVC-35

7.8 a. De-energize rod drive MG sets

Ref: E-0-04

b. Pressurizer heater groups 1A, 1C, 1D, 1E would not be reenergized which would lead to pressurizer pressure decreasing, SI etc.

Ref: IV 11.13 SI

7.9 The reason is that at such a low power level <u>turbine impulse</u> pressure is <u>too low</u> to provide reliable auto level control so bypass valves are used. Main feed reg. valves are not designed to throttle in this position.

7.10 a. Yes

1. Cause for lite - local engine switch is in manual or stop; local gen control switch is in manual or off.

2. T/S violation - Train B diesel has not been tested daily and Train B diesel is considered inoperative.

b. Rx <u>shall</u> be placed in hot standby immediately.

7.11 a. 320°

Ref: T/S 3.1-3-3

b. <45 psig

Ref: IV 11.27

c. ~~15% Δq/5 sec.~~ 5% / 2sec

Ref: T/S 2.3-1

d. ~~10%~~ Δq/~~5~~ sec. 5% 2sec

Ref: T/S 2.3-1

e. 330°

Ref: T/S Fig. 3.1-1

7.12 a. The head vent system should not be used in the following situations:

(1) If as a result of a controlled natural circulation cooldown a void in the reactor vessel upper head is expected.

(2) If the safety injection pumps are operating.

Ref: Venting procedure

b. (1) RCS subcooling - TC - <50°F

(2) Pressure level <20%

(3) RCS pressure decreases by 200 psi

(4) Venting time > tnan maximum calculated

Answers - Section 8

8.1 a. Containment System Integrity

Containment System integrity is defined to exist when:

(1) The nonautomatic Containment System isolation valves and blind flanges are closed as required.
(2) The Reactor Containment Vessel and Shield Building equipment hatches are properly closed.
(3) At least ONE door in both the personnel and the emergency airlocks is properly closed.
(4) The required automatic Containment System isolation valves are operable or are deactivated in the closed position or at least one valve in each line having an inoperable valve is closed.
(5) All requirements of Specification 4.4 with regard to Containment System leakage and test frequency are satisfied.
(6) The Shield Building Ventilation System and the Auxiliary Building Special Ventilation System satisfy the requirements of Specification 3.6.b.

Note: Standing Note Order - July 23, 1982 for modification

b. (1) The reactor is in the cold shutdown condition with the reactor vessel head installed or
(2) The reactor is in the refueling shutdown condition.

Ref: T/S 3.6-1

8.2 a. Immediate Response

(1) T/S 3.1-14 - Max. RC oxygen, chloride, fluoride conc. exceed limits.
(2) T/S 3.8-3 - LCO - Refueling requirements.
(3) T/S 3.10-4-10 Rx > 90% - AFD outside target band (if greater than 24 hrs)
3.10-4-11 Rx > 50 ≤ 90% power : > 60 min penalty
(4) T/S 3.10-5-4 QP tilt > 1.09, Rx shall immediately be brought to a No Load ≤ 5% power
(5) T/S 3.5-1 Table 3.5-2 (CAF)
(6) T/S 2.1 SAFETY LIMITS, Rx CORE

b. One Hour Response

(1) T/S 3.1-2a - Pressurizer PORV inoperable restore on one hour to operable condition or block valve shall be closed, or block valve if inoperable restore in one hour to operating condition or block valve closed with power removed.
(2) T/S 3.3-3 - Accumulator out of service
(3) T/S 3.10-4-11 - Rx > 50 ≤ 90% - AFD penalty hour
(4) T/S 3.15-1-a - Fire detection instruments less than min. establish a fire watch
(5) T/S 3.15-2-c - Spray and or Sprinkler systems
(6) T/S 3.15-2-d - Low pressure CO_2 systems

(7) T/S 3.15-3-e - Fire hose stations
(8) T/S 3.15-3-f - Penetration Fire Barriers

8.3 No, FAlse Jumpers and lifted leads in use for trouble shooting or component testing do not require the administrative controls of this directive.

Ref: ACD 1.6 para 4.1 note

8.4 True

Ref: ACD 4.2 para. 5.6.5

8.5 (1) Area radiation levels $\geq$ 1000 mr/hr

(2) For outage related work, if a system prestartup checklist for each component involved is completed prior to its requirement for operability.

Ref: ACD 4.3 para. 5.18c App. A

8.6 Valid for maximum of six weeks.

Ref: ACD 4.2 para. 5.6.7

8.7 QPTR only includes the power range upper or lower Hi flux deviation alarm not computer power tilt monitor. SRO-check QPTR monitor
-flux physics map of core
(axial/radial pwr peaks)
- NI currents

Ref: A-N1-48; T/S 3.10-7

8.8 a. Shift Supervisor until relieved by designated member of plant management staff.

b. ~~Shift Technical Advisor~~ CONTROL ROOM Supervisor until relieved.

c. ~~SRO~~ CONTROL ROOM supervisor

Ref: Emergency Plan

8.9 (1) Determination of Emergency Classification
(2) Recommendation of protective actions to offsite authorities.
(3) Authorization of emergency exposures in excess of 10 CFR Part 20 limits.

8.10 50.~~54~~ delete para so it should be 10 CFR 50

Ref: 10 CFR p. 435

8.11 a. Special RWP required for any entry posted as Radiation Hazard area or for work on any component having a radiation reading on contact greater than 1 R/hr.

Ref: ACD 6.3

b. Radiation Technologist on shift during nights weekends or holidays may sign a special RWP only after contacting one of the supervisors in the Radiation Protec.ion group by telephone, gaining his approval and noting this fact on the RWP.

8.12 (1) Failure of RPs to complete required protection function.

(2) Reactivity anomalie 1% delta K/K in S/G

(3) Occurrence of any unplanned criticality

(4) Abnormal degradation discovered in fuel cladding, RCS pressure boundary or primary containment.

(5) Personnel error which prevents functional requirement of systems to cope with accidents as analyzed.

8.13 a.
(1) 1 gpm
(2) ~~1 gpm~~ 500 gpd
(3) 10 gpm
(4) 0 gpm

b.
(1) Containment air particulate monitor
(2) Containment humidity
(3) Containment radiogas
(4) Containment sump level
(5) Area radiation monitors
(6) Process radiation monitors
(7) Sump pump RUN Time
8) ΔP between inlet/outlet service water lines in containment

Ref: T/S 3.1-11

8.14 90 minutes of hot shutdown plus suitable margin to prevent loss of net positive suction head prior to switching suction to service water system.

Ref: T/S 3.4-2

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U.S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: Kewaunee
REACTOR TYPE: Westinghouse
DATE ADMINISTERED: December 18, 1984
EXAMINER: T. D. Reidinger
APPLICANT: ____________________

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%.

Category Value	% Of Total	Applicant's Score	% Of Category Value	Category
25	25	_____	_____	5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics
25	25	_____	_____	6. Plant Systems Design, Control, and Instrumentation
25	25	_____	_____	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
25	25	_____	_____	8. Administrative Procedures, Conditions, and Limitations
100	100	_____	_____	TOTALS

Final Grade ______%

All work done on this exam is my own, I have neither given nor received aid.

____
Applicant's Signature

EQUATION SHEET

$f = ma$

$v = s/t$

Cycle efficiency = (Network out)/(Energy in)

$w = mg$

$s = V_0 t + 1/2\ at^2$

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_0)/t$

$A = \lambda N$

$A = A_0 e^{-\lambda t}$

$PE = mgh$

$V_f = V_0 + at$

$w = \theta/t$

$\lambda = \ln 2/t_{1/2} = 0.693/t_{1/2}$

$t_{1/2}eff = \frac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$W = v\ \Delta P$

$\Delta E = 931\ \Delta m$

$I = I_0 e^{-\Sigma x}$

$\dot{Q} = \dot{m}C_p\Delta t$

$\dot{Q} = UA\Delta t$

$Pwr = W_f \Delta h$

$I = I_0 e^{-ux}$

$I = I_0\ 10^{-x/TVL}$

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

$P = P_0 10^{sur(t)}$

$P = P_0 e^{t/T}$

$SUR = 26.06/T$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$SUR = 26\rho/\ell^* + (\bar{\beta} - \rho)T$

$CR_1(1 - K_{eff1}) = CR_2(1 - k_{eff2})$

$T = (\ell^*/\rho) + [(\bar{\beta} - \rho)/\lambda\rho]$

$T = \ell/(\rho - \beta)$

$T = (\beta - \rho)/(\lambda\rho)$

$\rho = (K_{eff}-1)/K_{eff} = \Delta K_{eff}/K_{eff}$

$M = 1/(1 - K_{eff}) = CR_1/CR_0$

$M = (1 - K_{eff0})/(1 - K_{eff1})$

$SDM = (1 - K_{eff})/K_{eff}$

$\ell^* = 10^{-5}$ seconds

$\bar{\lambda} = 0.1\ \text{seconds}^{-1}$

$\rho = [(\ell^*/(T\ K_{eff})] + [\bar{\beta}_{eff}/(1 + \bar{\lambda}T)]$

$I_1 d_1 = I_2 d_2$

$I_1 d_1{}^2 = I_2 d_2{}^2$

$P = (\Sigma\phi V)/(3 \times 10^{10})$

$\Sigma = \sigma N$

$R/hr = (0.5\ CE)/d^2(\text{meters})$

$R/hr = 6\ CE/d^2\ (\text{feet})$

Water Parameters

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.

Miscellaneous Conversions

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics

5.1 For each of the following conditions indicate whether shutdown margin increases, decreases or remains the same (explain each case).

a. Power increase from 80% to 100% without rod motion (Tavg compensation by dilution). (0.75)

b. Steam dump controller pressure setpoint increases, with plant at Hot Shutdown. (0.75)

c. At end of life, Tavg is allowed to sag 5°F below Tref, with rods fully withdrawn. (0.75)

d. 10% power decrease with rods in auto, no boration or dilution. (0.75)

5.2 Saturated steam at a pressure 1400 psia leaks past a valve into a tank pressurized to 100 psia. What temperature is the steam which enters the tank? (Use the Mollier chart and explain how you used the chart to determine this value.) (1.25)

5.3 For each of the following conditions, indicate whether the reactivity defect associated with fuel temperature coefficient would increase, decrease or remain the same. (Explain each case.)

a. Buildup of plutonium isotopes (0.5)

b. Fuel densification (0.5)

c. Clad shrink over fuel cycle (0.5)

d. Increase in full power Tavg (0.5)

5.4 Assume that your plant has experienced a degraded electrical power condition and that you are monitoring the plant's cooldown on natural circulation. Explain <u>why</u> you agree or disagree with the following statements.

a. A slow downward trend in indicated Tave is a good indication of well established natural circulation flow. (0.75)

b. A difference between wide range Th and wide range Tc of 65°F and slowly increasing indicates developing natural circulation flow. (0.75)

c. Natural circulation flow rate can be increased by rapidly increasing steam flow rate. (0.75)

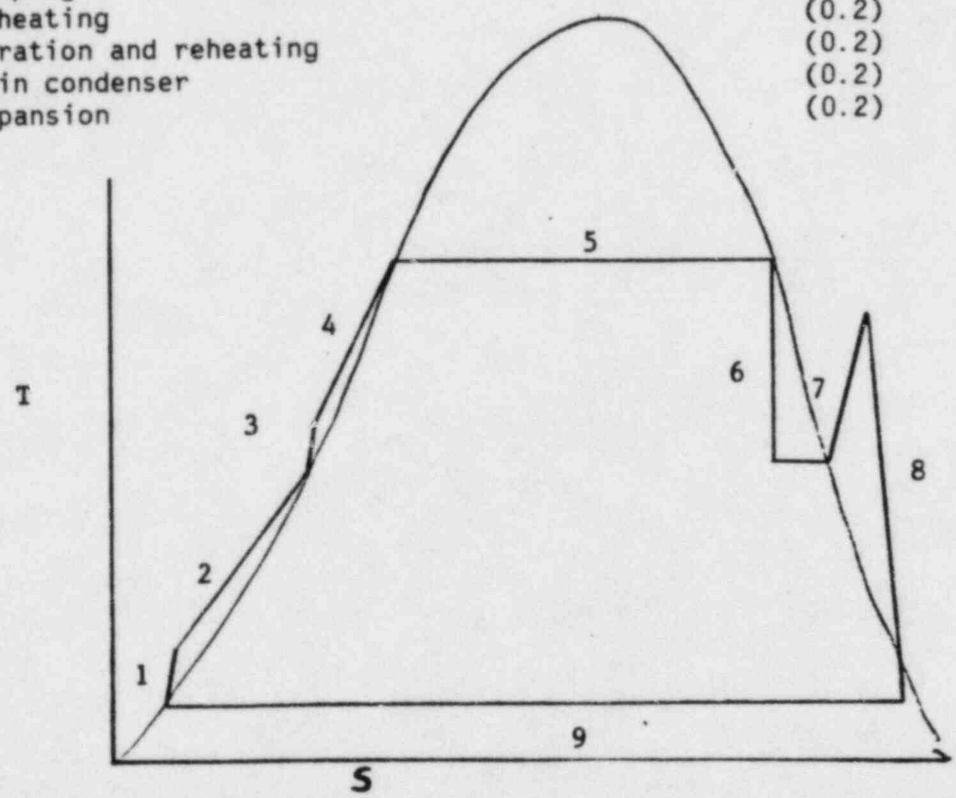
5.5 Describe how the Δh (enthalpy) changes across the steam generators as reactor power increases from 70% to 100% power. (1.5)

5.6 Void formation can occur in the RCS during certain accident conditions while on natural circulation resulting in a phenomenon called "reflux boiling". Explain how reflux boiling cools the reactor core. (Be specific.) (1.25)

5.7 How does 100% target ΔI change from BOL to EOL in a typical recycle core? Explain why the change occurs. (1.25)

5.8 The figure is a T-S diagram for the Kewaunee steam cycle. Identify processes 1 through 9.

a. Feedpumping (0.2)
b. Phase change in S/G (0.2)
c. HP turbine expansion (0.2)
d. HP feedwater heating and SG subcooled heating (0.2)
e. Condensate pumping (0.2)
f. LP feedwater heating (0.2)
g. Moisture separation and reheating (0.2)
h. Condensation in condenser (0.2)
i. LP turbine expansion (0.2)



5.9 The reactor is operating at 50% power in manual and the turbine is in "Imp In". For a small (10%) load increase, how would you expect Tave and reactor power to respond under the following conditions: (Explain)

a. small negative MTC (1.0)

b. large negative MTC (compared to part a) (1.0)

c. small positive MTC (1.0)

5.10 The effects of Emergency boration for one minute on power and Tave can be different depending on the reactor power.

a. What happens to power and Tave if Emergency Boration is performed at 100% power? Explain. (Assume rods in manual.) (1.25)

b. What happens to power and Tave if Emergency Boration is required while in Mode 2 (10^{-8} amps, 547°F)? Explain. (1.25)

5.11 The reactor is at 1% power with the steam dumps in the pressure mode. A rod withdrawal accident causes Bank D to move out at 40 SPM. What happens to Tave, steam pressure, Rx power? Explain. (1.25)

5.12 For a given thermal power level, the excore neutron detectors will detect the same number of neutrons at EOL as they do at BOL. True/False. Defend your answer. (1.5)

5.13 Assuming constant coolant temperature, heat flux, and pressure, DNBR will increase with increasing coolant flow. List two (2) reasons for this. (1.5)

5.14 What is the highest value of the Quadrant Power Tilt Radio for which no corrective action is required? (0.95)

6. Plant Systems Design, Control, and Instrumentation

6.1 Can the RO manually override the automatic closure of the component cooling surge tank vent valve which shuts on a high radiation signal from the radiation detectors within the component cooling water system? Explain how and when? (1.0)

6.2 How is the charging side of the regenerative heat exchanger protected against over pressurization should the charging side of the heat exchanger become isolated while hot letdown flow is at maximum rate? (1.25)

6.3 What pump/s are necessary to supply <u>all</u> the oil pressure sufficient to enable the turbine to be latched? (1.25)

6.4 2/2 coincidence is required from both level channels LIT-112 and LIT-141 on the VCT to transfer charging pump suctions to the RWST. True/False (0.5)

6.5 List eight (8) components cooled by CCW which, if leaking, would cause the surge tank level to rise and the surge tank vent to shut. (2.0)

6.6 Kewaunee Plant has been operating at 95% power with all systems in automatic. For each of the following conditions, give the direction of rod motion and explain the rod motion for the following.

a. The lower detector of Power Range Channel N43 fails high. (1.25)

b. Train A feedwater heater string becomes ~~isolated~~ BYPASSED. (1.25)

6.7 OTΔT trip is designed to protect against departure from nucleate boiling (DNB). List <u>all</u> the factors which would reduce its setpoint. (1.5)

6.8 List eight (8) ventilation systems that are affected upon safety injection actuation. (i.e., turn on/off, trip , etc.) (2.0)

6.9 Containment isolation is actuated by the safety injection signal. List what is isolated on the following components.

a. Excess Letdown Heat exchanger (0.75)

b. Reactor coolant pumps (0.75)

c. Steam generators (0.75)

6.10 Kewaunee is being cooled down for refueling and the decay heat load is constant. Will the RHR flow rate and component cooling flow rate require any adjustment to maintain a constant cooldown rate? Explain. (1.25)

6.11 Does locating feedwater heaters in the condenser neck enhance the plant's thermal efficiency? Explain. (0.5)

6.12 During operation at 80% power, a "B" steam generator safety valve fails wide open with control rods at 220 steps.

a. Will the steam generator level control system detect the added steam flow? (1.0)

b. How can nuclear instrumentation and RCS temperature indication alert the operator that a problem has occurred? (1.25)

6.13 Does source range nuclear instrumentation detect slow or fast neutrons that leak out of the core? Choose the correct one and explain. (1.0)

6.14 Where does the Component Cooling Water Surge tank relief valve discharge to? (1.0)

6.15 List the failed positions of the following valves (open, shut, as-is) Choose one.

a. Back pressure regulating valve LD-10 (0.5)

b. Aux feedwater flow control valves (loss of electrical power) (0.5)

c. S/G PORV (0.5)

d. Steam dump atmospheric relief valves (0.5)

6.16 a. Why is speed droop a desirable characteristic for parallel operation? (1.25)

b. What is field flashing and how is it supplied for the diesel? (1.5)

7. Procedures - Normal, Abnormal, Emergency, and Radiological Control

7.1 Assume each case independently and list the required response per Kewaunee Technical Specifications (see Fig. 7.1)

a. Point 1 - Reactor has been operating for sixty-two (62) minutes in steady state at point 1. (0.75)

b. Point 2 - Reactor has been operating for two (2) minutes in steady state at point 2. (0.75)

c. Point 3 - Reactor has been operating for two (2) minutes in steady state at point 3. (0.75)

7.2 The HP technician reports that he has detected a small piece of metal on the floor in the auxiliary building which is reading 6 Rem gamma/hr at one foot. How far from this source should you erect a "Danger - High Radiation" barricade? (1.5)

7.3 What are the physical and administrative requirements that have to be met by the Shift Supervisor prior to a discharge of any radiological liquid waste? (List four (4)) (2.0)

7.4 List the immediate actions for the operator for the steam generator Tube rupture. (list all steps) (1.5)

7.5 When frisking yourself, when are you considered contaminated? Provide the frisker reading if background reading is 110 cpm. (1.0)

7.6 During refueling, core reactivity shall be controlled during core alternations by maintaining, monitoring or providing limits. Name seven of them. (2.0)

7.7 a. List three examples of unexplained or uncontrolled reactivity increases which as an SRO you would order an emergency boration. (1.25)

b. List three examples of an uncontrolled cooldown which as an SRO you would order an emergency boration. (1.25)

7.8 In the turbine/reactor trip procedure for an ATWAS, it states that the supply breakers should be opened up to buses 1-33 and 1-43.

a. What is/are the reasons(s) to open the breakers? (1.0)

b. What would be the plant's response if in part a. the breakers were <u>not</u> later closed and buses 1-43, 1-33 were not reenergized as per procedure (assume no operator action)? (1.25)

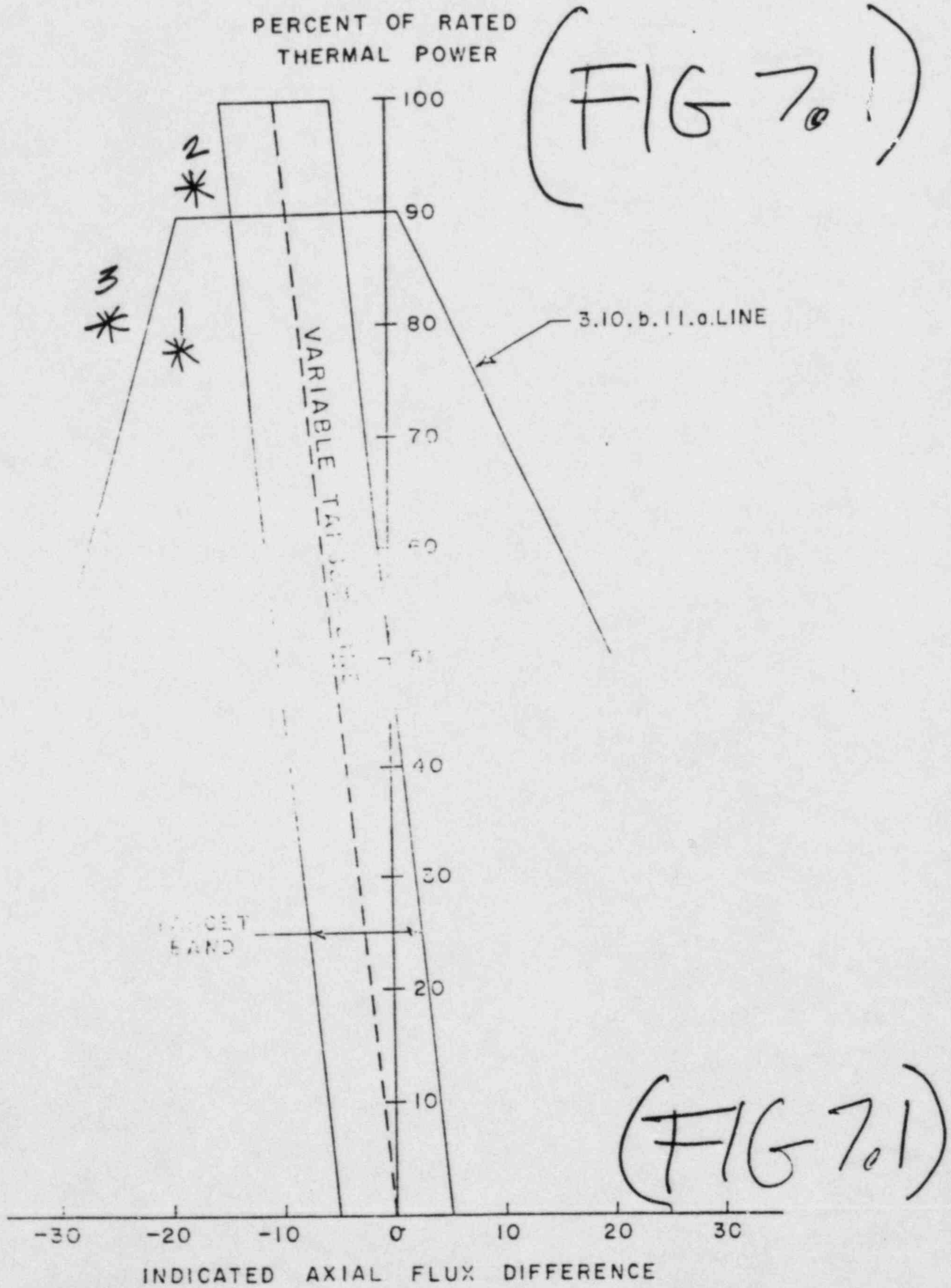


FIGURE TS 3.10-5 TARGET BAND ON
INDICATED FLUX DIFFERENCE AS A

7.9 Per the feedwater system normal operation procedure, a precaution states that "during feedwater flow condition less than 15%, the bypass flow control valves should be used rather than the main feed regulating valve". What is the primary reason for this precaution in not using the main feed regulating valves? Be specific. (1.25)

7.10 Kewaunee is at 100% power, steady state. The SRO noted in the log that IC technicians were performing surveillance testing on Train A diesel at 1:00 p.m. on December 16, and the control room diesel generator (B) local control annunciator is illuminated. The SRO next day same time noted the same exact conditions. (No other log entries were made.)

a. Are there any Technical Specification violations? Explain your answer. (1.5)

b. What should be your action/s as a SRO? (1.5)

7.11 State the following setpoints/limits.

a. Pressurizer and spray fluid temperature difference (0.75)

b. Auto stop oil pressure trip (0.75)

c. Power range fast flux rate trip (positive) (0.75)

d. Power range fast flux rate trip (negative) (0.75)

e. RCS lowest minimum temperature for criticality (0.75)

7.12 a. List two conditions in which the reactor head vent system should not be used. (1.0)

b. If venting was utilized to release noncondensable gases, list the four (4) termination criteria for stopping the venting process. (1.0)

8. Administrative Procedures, Conditions, and Limitations

8.1 a. List five of the six criteria required to establish Containment System integrity. (2.0)

b. Containment System Integrity can be relaxed under two (2) conditions. What are those conditions? (1.25)

8.2 a. List five Technical Specifications which, if exceeded, would require a responsive action (hot standby, restorative action, etc.) immediately. (2.0)

b. List five Technical Specifications which, if exceeded, would require a responsive action within one (1) hour. (2.0)

8.3 The use of jumpers and lifted leads for trouble shooting or component testing requires a temporary change as per ACD 1.6. True/False (0.5)

8.4 The Shift Supervisor can terminate a Temporary Operating Procedure at any time, even if it has the approval signatures of two (2) members of Plant Supervisory Staff. True/False (1.0)

8.5 List the requirements of which the physical independent verification of restoration of equipment to service is not required. (1.5)

8.6 What is the maximum length of time a Temporary Operating Procedure is valid? (1.0)

8.7 Kewaunee power level is at 100% and the reactor operator informs you at 9:05 a.m. that the plant process Computer Quadrant Power Tilt Monitor indicates a power tilt > 1.09. (No indication of rod misalignment.)

What wculd you check prior to taking any action? (1.25)

8.8 a. In the event of any classified emergency at Kewaunee, who is the initial Emergency Director of the plant emergency response operations and for how long? (0.5)

b. If for some reason that person in part a. is incapacitated, who then takes charge and assumes position of Emergency Director and for how long? (0.5)

c. Who then takes charge of control room operations? (0.5)

8.9 List the three (3) responsibilities of the Emergency Director which may <u>not</u> be delegated. (1.5)

8.10 Title 10 of the Code of Federal Regulation (10 CFR) has numerous parts. In which part does one find the requirements for the presence of a SRO at the facility? (1.0)

8.11 a. What two (2) conditions would required a Special RWP? (1.15)

b. Under what conditions can a Radiation Technologist approve a Special RWP? (1.15)

8.12 Give four (4) examples of reportable occurrences that must be reported to the NRC within 24 hours. (1.2)

8.13 a. For each location below, indicate the reactor coolant leakage criteria per the Technical Specification that would apply.

(1) Unknown location (0.5)
(2) Total steam generator tube leakage (0.5)
(3) Through pressurizer code safety valves to the PRT (0.5)
(4) Valve LD-10 body is leaking (0.5)

b. The detection of leakage from the RCS is based on four methods according to the technical specifications. State the four (4) methods of detection. (2.0)

8.14 What is the basis for the specified minimum water level in the condensate storage tanks? (Be specific.) (1.0)