NRC FORM 157 (10-75) U.S. NUCLEAR REGULATORY COMMISSION

LICENSE APPLIED FOR: RO ☐ SRO ☒

CURRENTLY A LICENSED OPERATOR HERE? YES ☐ NO ☒

EXAMINATION REPORT

APPLICANT'S NAME	REACTOR	LOCATION
	TMI Unit 2	Harrisburg, Pa.

WRITTEN EXAMINATION

OPERATOR (SECTION 55.21)	ADMINISTERED BY: d. d. Busby	DATE 8/17/77	WAIVED ☐
	GRADED BY: "	GRADE 81 %	EVALUATION PASSED ☒ FAILED ☐
	CATEGORY GRADES A 91 % B 76 % C 74 % D 80 % E 98 % F 71 % G 75 %		
SENIOR OPERATOR (SECTION 55.22)	ADMINISTERED BY: d. d. Busby	DATE 8/18/77	WAIVED ☐
	GRADED BY: "	GRADE 77 %	EVALUATION PASSED ☒ FAILED ☐
	CATEGORY GRADES H 84 % I 76 % J 85 % K (67) % L 74 %		

OPERATING TEST

(SECTION 55.23)	ADMINISTERED BY: B. A. Wilson	DATE Wed P.M 9/14/77	WAIVED ☐ PASSED ☐ FAILED ☒ HOT ☐ COLD ☒

COMMENTS

RECOMMENDATION	APPROVE FOR: SENIOR LICENSE ☐ OPERATOR LICENSE ☒	SIGNATURE: J. R. Busby 9/29/77
	DO NOT APPROVE FOR: SENIOR LICENSE ☒ OPERATOR LICENSE ☐	EXAMINER / DATE
ISSUE LICENSE	SENIOR LICENSE ☐ OPERATOR LICENSE ☒	SIGNATURE: R. C. Ellis 10/17 Chief, Operator Licensing Branch

NOTE: The operator and oral examination check sheet must be completed for each applicant. If applicant has failed the operating and oral test at the Senior Level, the check sheet should be completed to indicate applicant's evaluation at the operator level.

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7904260288

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OPERATING AND ORAL EXAMINATION SUMMARY REPORT

If an SRO applicant is unsatisfactory at the SRO Level, complete the RO column to evaluate applicant's adequacy at the RO Level.

**For each unsatisfactory ("U"), list the page number(s) of the operating oral examination notes on which the unsatisfactory responses are explained.*

	EVALUATION		
	SRO	RO	*PAGE NUMBER FOR "U"
1. OPERATING DEMONSTRATION	S	S	
1.1 Pre-startup and Instrument Checks			
1.2 Console Operation	N/A	N/A	
a. Manipulations	S	S	
b. Understanding			
2. FACILITY EQUIPMENT	S	S	
a. Major	S	S	
b. Auxiliary	M	M	4
c. Engineered Safeguards Systems			
3. INSTRUMENTATION	S	S	
a. Nuclear	S	S	
b. Process	U	U	8,4
4. REACTOR PROTECTION			
5. PROCEDURES	S	S	
a. Normal	S	S	
b. Abnormal	S	S	
c. Emergency	S	S	
6. REACTIVITY EFFECTS (Except Console Operation)	U	M	4, 8, 9
7. ADMINISTRATIVE REQUIREMENTS	S	S	
8. EMERGENCY PLAN	S	S	
9. RADIATION PROTECTION	S	S	
10. RESPONSIBILITIES			

COMMENTS

79-012

U. S. NUCLEAR REGULATORY COMMISSION

SENIOR REACTOR OPERATOR LICENSE EXAMINATION

Facility: Three Mile Island - Unit 2
Reactor Type: PWR - B&W
Date Administered: 8/7 & /77
Examiner: J. J. Buzy
Applicant: 1500

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Staple question sheet on top of the answer sheets. Points for each question are indicated in parenthesis after the question.

Category Value	% of Total	Applicant's Score	% of Cat. Value	Category
14	20	11.8	84	H. Reactor Theory
14	20	10.7	76	I. Radioactive Materials Handling, Disposal and Hazards
14	20	11.9	85	J. Specific Operating Characteristics
14	20	9.4	67	K. Fuel Handling & Core Parameters
14	20	10.3	74	L. Administrative Procedures, Conditions and Limitations
70	--	54.1	___	Totals

Final Grade: 77 %

79-043

H. REACTOR THEORY (14)

H. 1. Two minutes after a reactor trip from full power, a large number of neutrons are still present in the core. List these neutrons and give their origin. (1.5)

H. 2. Assume your reactor is on a 1 DPM startup rate at 5×10^{-9}, group 6/7 is at 15% withdrawn.

a) What should be the rod position when the operator levels off at 10^{-8}? Show all work, include any assumptions. (2.0)

b) With maximum rod speed, how long should the operator move the rods to level off at 10^{-8}? Explain how you arrived at your answer. (1.5)

c) If power were allowed to increase, how far do you expect the power level to rise? Include any assumptions. (1.0)

d) Will the same reactivity addition produce the same S.U.R. during core lifetime? Explain. (1.5)

H. 3. Refer to figure 28. Control rod groups 5-7 reactivity worth at 532°F.

a) Sketch the approximate reactivity worth of group 5-7 when the temperature is 582°F. (0.5)

b) Explain why the curve will change. (2.0)

H. 4. Refer to question K3. Assume the individual responsible for taking the count rate reads and records the data immediately after the fuel element is inserted into the core. Would the resulting plot be more or less conservative? Explain your answer. (2.0)

H. 5. One of the limiting conditions for operation at your station is the value of the moderator temperature coefficient. Is this value of concern early or at the end of core lifetime? Explain the reason(s) for your answer. (2.0)

I. RADIOACTIVE MATERIALS HANDLING, DISPOSAL AND HAZARDS (14.0)

I. 1. Periodically, during power operation, it is necessary to purge the reactor building. Describe the procedures and limitations that you, as shift supervisor, are responsible for during the purge. Include the following:

a) Administrative requirements, including individuals who approve the release. (1.0)

b) What monitors are required to be in service? (1.0)

c) Why is it necessary for the fire protection system to be operational during the release? (0.7)

d) Maximum reactor building pressure prior to release. (0.3)

I. 2. A smear is taken on a calibrated pressure gauge which was used in the waste disposal area.

Smear Area - 100 CM^2 Background - 16 CPM
5 minute count - 900 Scaler efficiency - 15%

a) Determine if the gauge can be returned to the instrument shop. (1.5)

b) Discuss how you would take a smear(s) for this gauge. (1.0)

I. 3. Assume a reactor coolant leak develops in the reactor building.

a) What are limits on reactor coolant system leakage as a function of location or identity of the leakage? (1.5)

b) Assume the leakage collects in the reactor building sump. Describe in sequence what happens to the water from the sump to its ultimate disposal. (1.5)

c) Prior to entering the reactor building to search for the leak, what installed monitoring system(s) can be used by the inspection team to evaluate the levels of radiation? (1.5)

I. 4. An operator has dropped a set of keys on top of a spent fuel element in the storage pool. He wants to fabricate a tool made of ten foot long, one inch diameter sections of electrical conduit joined by couplings. In addition, he has had a hook welded to a pipe cap to join with the end of the conduit sections which will be used to pick up the key ring. Should you allow him to assemble the tool and use it? Explain <u>why</u> or <u>why not</u>. (2.0)

Section I continued next page

I. 5. The maximum activity contained in one gas decay tank is limited to _____.

a) What is the limit and who is responsible to assure this limit is not exceeded? (1.0)

b) What is the reason for this limit? (1.0)

79 046

J. SPECIFIC OPERATING CHARACTERISTICS (14)

J. 1. Lithium hydroxide and hydrazine are two chemicals that are added to the reactor coolant system.

a) Discuss when it may be necessary to add these chemicals. (1.5)

b) What precautions must be observed when handling these chemicals? (1.0)

J. 2. During the unit heatup, one of the steps requires a hard bubble degasification when the coolant temperature reaches 350°F.

a) Outline how this step is performed. (1.0)

b) What would be the consequences if this step was not performed? Assume power operations with steady state and transient conditions. (1.5)

J. 3. About two years ago, TMI Unit One went critical during a plant heatup, while the RC temperature was 505°F.

a) What procedural steps were modified to prevent a repeat incident? (1.5)

b) What is the L.C.O. for minimum R.C. temperature for criticality and what is the basis for this L.C.O.? (1.5)

J. 4. When operating from 50 to 100% rated power with 4 RC pumps running, the staff is required to maintain cold leg differential temperatures to less than 5°F.

a) How does the operating staff comply with this limitation? Include controls the staff must manipulate. (1.5)

b) Why is this condition required? (1.0)

J. 5. Assume a reactor startup is in progress and within 5% of rod position for criticality. At the same time, an I.C.S. representative is "fine tuning" the control system. Suddenly, all turbine bypass valves go full valves open. Assume (i) one main feed pump in service and (ii) R.C. temperature decreases at 30°F/min.

a) What protective device(s) should respond to trip the reactor if no action is taken? (0.3)

b) What immediate action is required by the operating staff? (0.7)

Section J continued on next page

J. 5. c) Assume no action by the operating staff. What systems will respond if the turbine by-pass valves cannot be shut. Attempt to show if the plant systems will or will not terminate this transient without operator action. (2.5)

79 048

K. FUEL HANDLING & CORE PARAMETERS (14)

K. 1. Listed below are several fuel handling devices and maneuvers. List and explain the purpose of the interlock(s) during each maneuver.

a) Control rod handling mechanism while inserting and withdrawing control rods. (1.0)

b) Rotation of the fuel transfer baskets and the main fuel or spent fuel storage handling bridge. (1.0)

c) Fuel grapple mechanism and hoists when inserting or removing fuel in the core. (1.0)

K. 2. Assume a malfunction on one of the safety rods in group 2 results in a dropped rod. The reactor is at rated power and the reactor demand station is in manual.

a) What immediate action is required by the operator? (1.0)

b) Why is the above action necessary? (1.0)

c) Assume trouble shooting cannot begin for several hours, would the axial power imbalance and/or the quadrant power tilt become the limiting condition for operation? Explain your answer. (1.5)

K. 3. Initial fuel loading at most PWRs develops as a "slab". The source is located in the center and the fuel is loaded outward (see figure K-3). Temporary chambers (A&B) are located in the vessel and subcritical multiplication plots are made for each section of the slab loading.

a) Sketch the expected plot of subcritical multiplication for each chamber. (1.5)

b) Explain any difference in the plots. (2.0)

K. 4. During the initial power escallation and immediately following a control rod interchange, the rate of power increase is limited to 3%/hr. between 75 to 90% power; also, a 5 hour hold is required at 90% power.

a) What are the normal maneuvering rates between 75 to 90% power? Provide transient and controlled conditions. (0.5)

b) Why is it necessary to perform a control rod interchange and why are power increases reduced to 3%/hr? (2.0)

K. 5. Attached is figure 1A, Core Excess Reactivity, for your facility. Explain the shape of the curve during the first 100 EFPD. (1.5)

L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS (14)

L. 1. If any safety limit is exceeded, the shift supervisor is required to notify the station/unit superintendent and have the reactor in hot standby conditions within one hour.

a) What parameters and limits are considered in the safety limits for your station? (1.5)

b) What instrumentation in the reactor protecting system should prevent reaching a safety limit? (1.5)

c) What are the plant conditions for hot standby? (0.5)

L. 2. Title 10 CFR Part 55, Operators Licenses, defines an operator as any individual who manipulates a control of a facility.

a) Define control as it applies to this definition and give two examples. (1.0)

b) Is it necessary to be a licensed operator to manipulate a control? Explain. (0.5)

c) Assume an operator was injured during a motorcycle accident. He is disabled for 5 months. When can he return to normal duties? (1.0)

L. 3. When a shift is relieved, a number of items must be completed.

a) What shift records are maintained? (1.5)

b) What conditions are required in order for an entire shift to be relieved? (1.0)

c) List the shift organization required by the technical specifications during (i) fuel loading and (ii) plant startup. (1.5)

L. 4. Assume you are the shift supervisor in charge of your shift. For each condition below provide (i) immediate and subsequent action and (ii) the reason for your action, including any administrative limits.

a) The unit is shutdown for OTSG tube inspection. You are informed that the sodium hydroxide tank was inadvertantly lined up to the decay heat pumps. About half of the tank volume is left. (1.5)

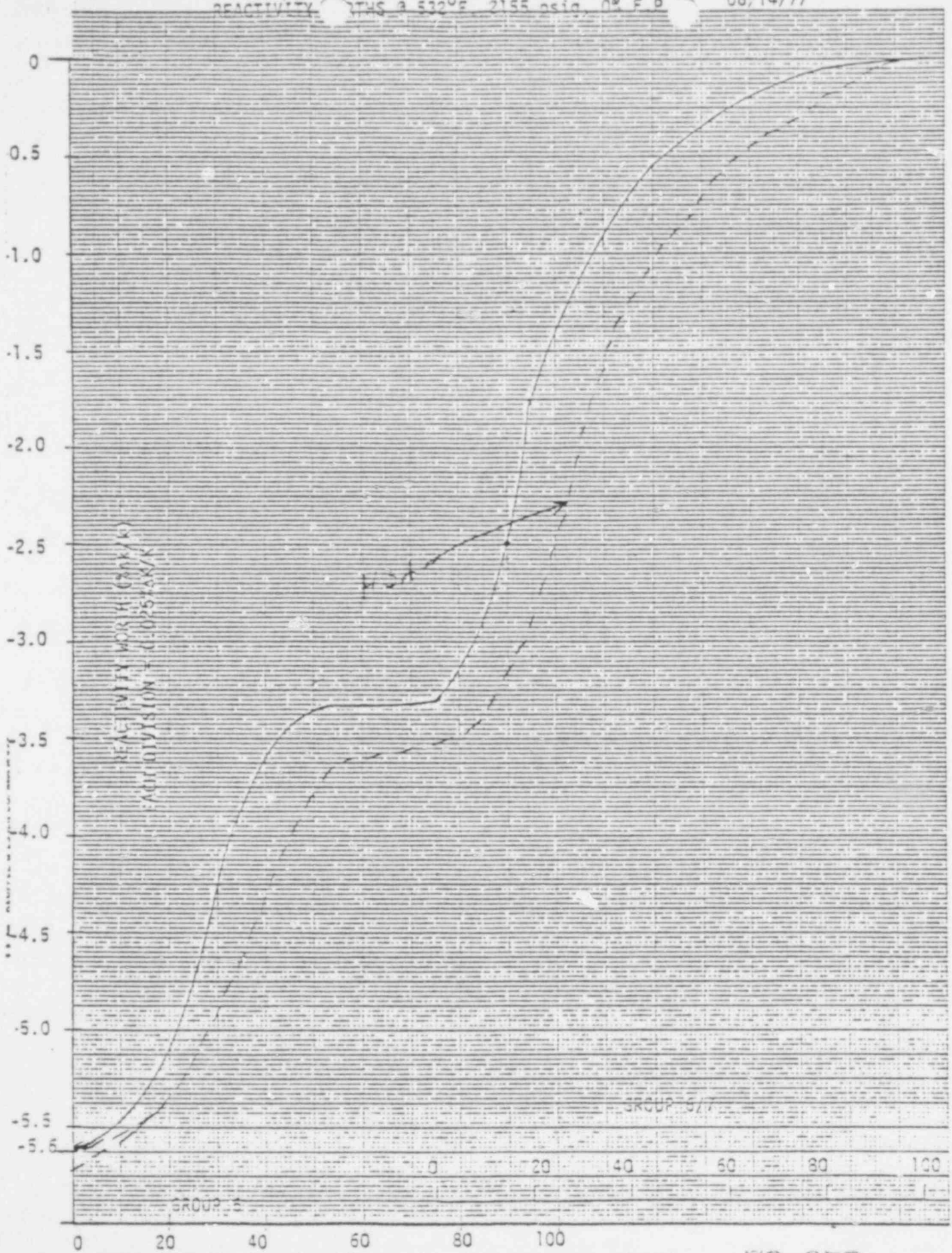
b) The plant is at rated power during the winter. The auxiliary operator informs you that the vent(s) on the BWST tank seem to have frozen due to condensation and ice formation. (1.0)

Section L continued on next page

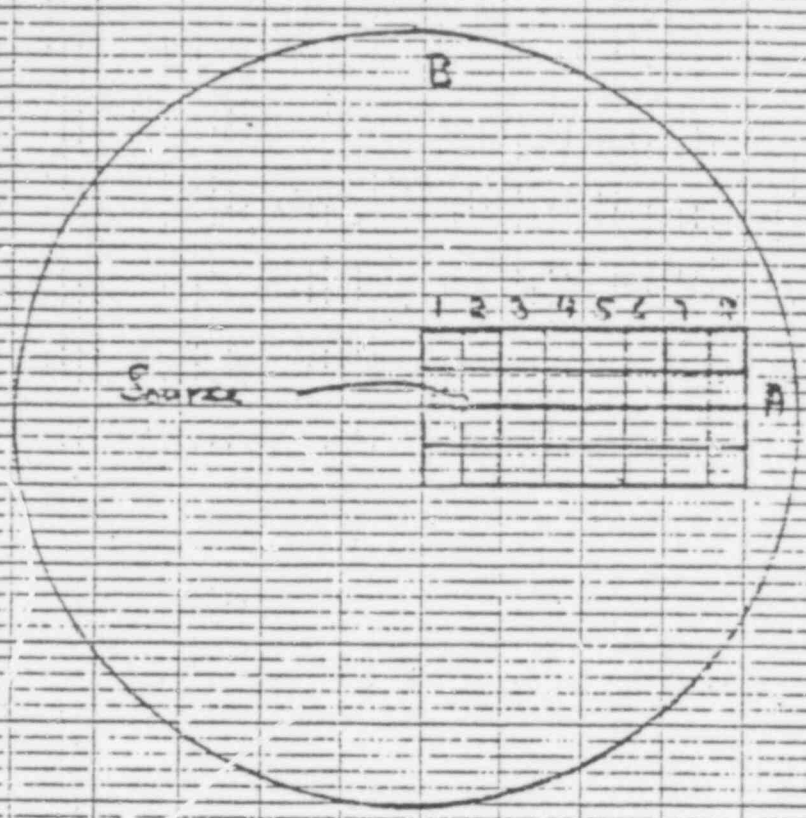
L. 4. c) During a test of the containment isolation valves, one of the valves begins to leak at the packing gland. The test engineer suggests he can "back seat" the valve by holding in the open relay with an insulated screwdriver at the motor control center. (1.5)

79 051

FIGURE 28: CONTROL ROD GROUPS 5,6 & 7 Revision 0
REACTIVITY WORTHS @ 532°F, 2155 psig, 0% F.P. 06/14/77



79 052



K3

79 053

FIGURE 1 : CORE EXCESS REACTIVITY VS EFPD

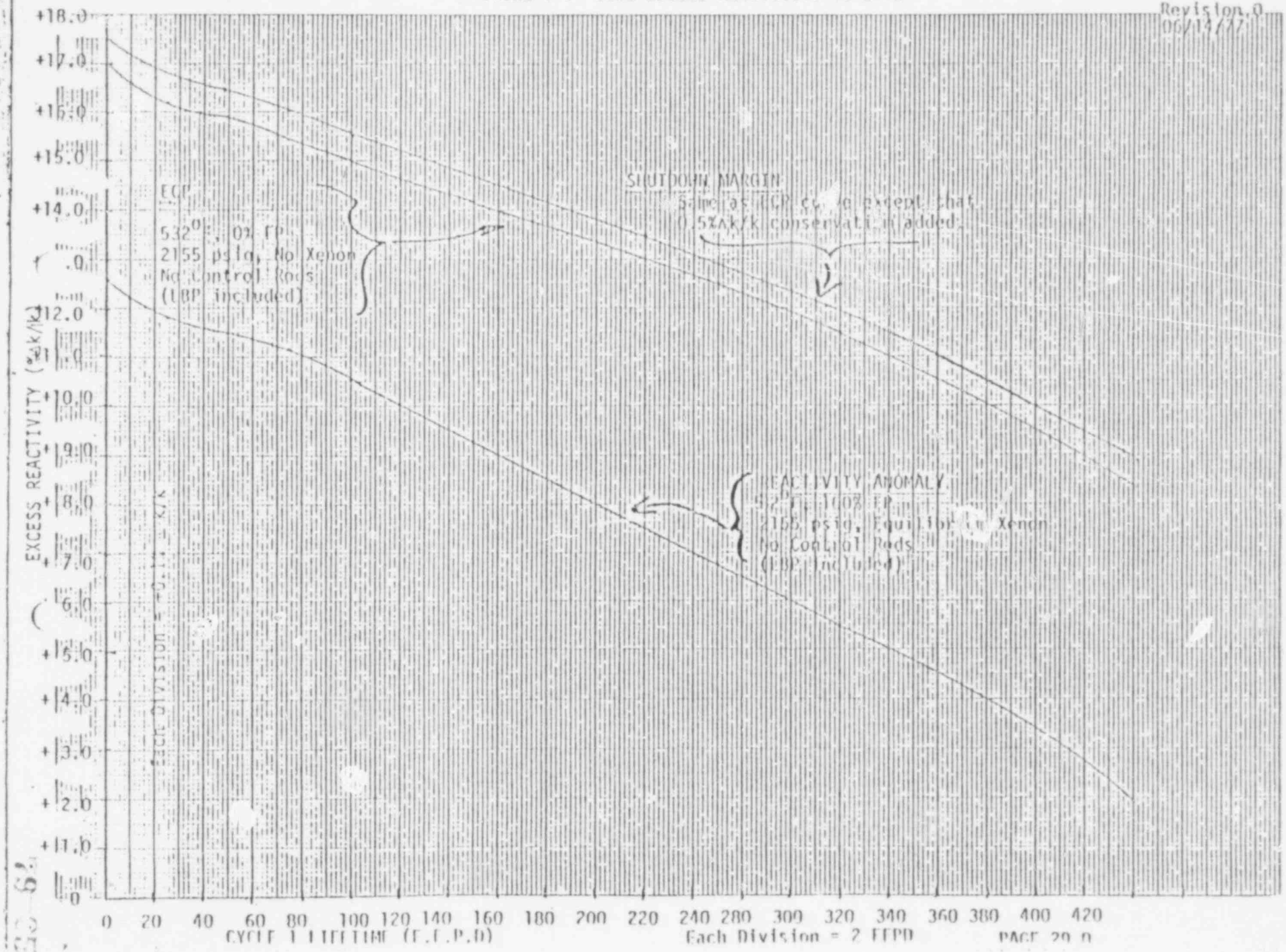


Table 1. MISCELLANEOUS — 10 CFR 20 Appendix B

Material	Half-Life	Energy MEV per disintegration	Table I Col 1 Air μc/ml	Table I Col II Water μc/ml	Table II Col 1 Air μc/ml	Table II Col II Water μc/ml
A-41	1.83 h	1.3	2×10^{-6}	?	4×10^{-8}	
Co-60	5.3 y	2.5	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
I-131	8.1 d	0.36	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
Kr-85	10.8 y	0.04	1×10^{-5}		3×10^{-7}	
Ni-65	2.5 h	0.59	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
Pu-239	2.4×10^{4} y	0.008	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
Sr-90	28 y		1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-6}
Xe-135	9.2 h	0.25	4×10^{-6}		1×10^{-7}	
Any single radionuclide with $T_{\frac{1}{2}} > 2$ hr which does not decay by α or spontaneous fission			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}

Neutron Energy (MEV)	Neutrons per cm^2 equivalent to 1 rem	Average flux to deliver 100 mrem in 40 hours
Thermal	970×10^{6}	670
0.02	400×10^{6}	280
0.5	43×10^{6}	30
10	24×10^{6}	17

LINEAR ABSORPTION COEFFICIENTS (cm^{-1})

Energy (MEV)	Water	Concrete	Iron	Lead
0.5	0.090	0.21	0.63	1.7
1.0	0.067	0.15	0.44	0.77
1.5	0.057	0.13	0.40	0.57
2.0	0.048	0.11	0.33	0.51
2.5	0.042	0.097	0.31	0.49
3.0	0.038	0.088	0.30	0.47

FORMULAS AND CONVERSIONS

$$\text{r/hr} = \frac{6CE}{d^2} \qquad I_x = I_o e^{-\mu x} \qquad I_2 = \frac{I_1}{d^2} \qquad N = N_o e^{-\lambda t}$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \qquad p = \frac{\Sigma \phi V}{3\times10^{10}} \qquad \rho = \frac{1}{Tk} + \sum \frac{\beta_i}{1+\lambda T} \qquad T = \frac{\beta - \rho}{\lambda \rho} \qquad T = \frac{\ell}{\rho - \beta}$$

$$T = \frac{\ell^*}{\rho} + \frac{\beta - \rho}{\lambda \rho}$$

1 gal = 3.78 liters
1 in = 2.54 cm
1 yr = 3.15×10^{7} sec.
1 kg = 2.21 lbs
1 gm/cm^3 = 62.4 lbs/ft^3
1 ft^3 = 7.48 gal

$N_A = 6.03\times10^{23}$
$\pi = 3.14$
$e = 2.72$

H

1. The Neutrons remaining in the core are from 6 principle precursors of fission fragment decay, spontaneous fission of U^{235} Neutrons released from cosmic radiation, Source neutrons + photo nuts — 1 5

79-056

-H

H2. $T = \frac{\beta - \rho}{\lambda \rho}$ $SUR = \frac{26}{T}$ ASSUME $\lambda = .08$, $\beta = .0069$

$26 = \frac{.0069 - \rho}{.08\rho}$ $1 = \frac{26}{T}$ $T = 26$

$.08\rho 26 = .0069 - \rho$

$\therefore + 2.08\rho = .0069 - \rho$ $\rho = .0022 \frac{\Delta k}{k}$

$\rho + 2.08\rho = .0069$

$\rho(1 + 2.08) = .0069$

$\rho = .0022$

(a) JUST CRITICAL HEIGHT 10^{-8} 12% GRP 6-7

$3\% \times 1.38''/\% = 4.14$ INCHES

4.14 INCHES ÷ 30 IN/MIN = .138 MIN + No takes ~3 min

(b) .138 MIN × 60 SEC/MIN = 8.28 sec INSERTION

(c) POWER COEFF 1.14×10^{-4} ΔK/°F

532°F

19.3

551.3

$\frac{.0022 \frac{\Delta k}{k}}{.000114 \frac{\Delta k}{k}/°F} = 19.3°F$ TEMP CHANGE

TAVE 551.3 ≈ 20% F.P.

79-C57

(d) No. because as the core ages β effective is lowered due to the build up of Pu^{239}. β eff changes from ≈ .0069 to ≈ .51. Applying the Inhour equation, we can show that as β is lowered, and with

H2(d) the same reactivity insertion the period decreases and SCR gets higher

H3a SEE FIG 28

H3(b) The curve shifts in the manner shown because at higher temperatures the moderating effect of water is less so it provides more time for the fast and epithermal neutrons. Since the rod worth is dependent upon the amount of flux it "sees" the worth increases.

H4 The plot would be less conservative because by not allowing the count rate to increase to its new equilibrium value, the 1/M meter is higher than actual and will predict criticality at a higher number of assemblies than actual.

79-058

H5. The temperature coefficient will be slightly positive at BOL due to the heavy boron concentration at BOL. This is the time of concern because with a positive temperature coefficient it means an increase in Reactor power will raise temperature which in turn inserts more positive reactivity. This results in a more rapid power rise than is desirable.

The coefficient is positive because as the coolant becomes less dense the lowering of the boron atoms in a volume of coolant is more of a positive insertion than the negative insertion from the water becoming less dense. — 1.0

EOL?

I

I1 (a) Purge only 8 hrs / week
HP supervisor, SHIFT SUPERVISOR + Unit Supv APPROVAL
Monitors available charts
Samples of contaminants

-.5

(b) Stack HPR 2[illegible], RBldg purge HPR 225, 226,
CONTAINMENT AIR MONITOR, HP-R227

(c) to Provide deluge to charcoal filters in case of fire.

(d) <.5PSI

I2 (a) $CC = \frac{\frac{900}{5} - 16}{.15} = 1093$ CPM

The Gauge must be decontaminated before returning to the instrument shop.

79-060

(b) 100 cm² is enough area to cover the Front of a 4" Pressure gauge. In order to properly smear it additional smears samples are needed on the back and edges of the gauge. The highest smear reading will determine the decontamination requirements for the Gauge

5

I

I 3. (a) 0 PRESSURE BOUNDARY LEAKAGE

1 GPM UNIDENTIFIED

1 GPM TOTAL PRIMARY TO SECONDARY (CAUSE UNK)

27 GPM IDENTIFIED AND CONTAINED

8 GPM SEAL RETURN LEAKAGE.

(b) The reactor building sump is pumped to the contaminated drain tank. It is transferred to UNIT #1 for processing with the miscellaneous waste evaporator and if in spec is released to the river.

(c) FUEL BRIDGE MONITOR

OPERATING FLOOR MONITOR

HPR 227 CONT AIR SAMPLER

I 4 Yes, the may use the tool as long as the section is pinned to the coupling to prevent unscrewing, likewise for the cap with the hook. H/P must be present to survey as the keys are raised, the tool Top end must be tied off to prevent dropping into the pool.

Stream from tool

79 C61

I

I5 (a) 8800 curies H/P Chem dept is responsible for the limit. Ops. [illegible] —, 5

(b) The limit insures that if the tank ruptures the average yearly release rate will not be exceeded expense —, 5

79-062

J

J1 (a) Hydrazine is added to the coolant to aid in oxygen scavenging between 200°F – 300°F < 450 Tave. It is added if O^2 is greater than .1 ppm during startup.
LiOH is added for pH control when Boron is not present in the coolant

b Hydrazine is an eye and skin irritant and alkali. It handled with Plastic suit, rubber gloves and a face shield on.
Handling
LiOH is a strong caustic powder and should be handled as above including a respirator to prevent inhalation of powder fines.
When LiOH is mixed with water the reaction produces heat, so plenty of water should be used when mixing. Disposal are Regulated

J2 (a) The pressurizer vent is opened to the reactor coolant drain tank for a time and the non condensible gas is collected there.
Purge outside VCT

(b) If the heaters are not powered, pressure control becomes more difficult because the spray has less effect to...

79 063

J.2.b if the bubble were saturated steam. In a transient condition the pressure transients are more rapid and more severe due to the 'hard' bubble for the same season. The non condensible gas prevents the expansion and contraction of the steam bubble by normal means so the pressure transients get large.

J3 (a) The procedure was changed to limit the temperature for boron dilution to > 525°F
1/M Plot required

(b) The Reactor shall not be critical with Tc < 525°F

BASE: 1. It assures operation with a bubble in the pressurizer
2. It assures operation within accident analysis limits
3. It assures operation with temp coefficient within design limits
4. It assures Instrumentation operation within design ranges.

Rx Press > NDT.

4

79-064

J

J-4. (a) The operator observes the ΔTc indication on the control console. If the ICS is in auto, the ΔTc ratio circuit in the FEEDWATER controller performs this task. If one or both feed water loop demand stations are in manual the operator must ratio feedwater to the generators.

(b) If the Tc leg temperatures get too wide a spread or ΔT, the flux will tend to tilt higher in the side with the coldest Tc due to the increased moderation effect from the colder water.

J5. a). 1. Low pressure Trip
2.

b) Due to the unanticipated criticality
Trip the reactor
close the turbine Bypass valves.
emergency borate.
ISOLate lot down

79-065

J

J-5 c. the systems that respond would be RPS Lo Press trip, ECCS actuation 1600 PSI

—1.0

Feed water lat. long @ < 585 + OTSG go long

79 066

K

1. (a) -1.0

(b) -1.0

(c) Grapple interlock prevents unlatching an assembly unless the hoist is down and at no load.

K2 (a) allow the assymetric rod rumback to take place, to less than 60% power. Run reactor power back in manual to match turbine load.

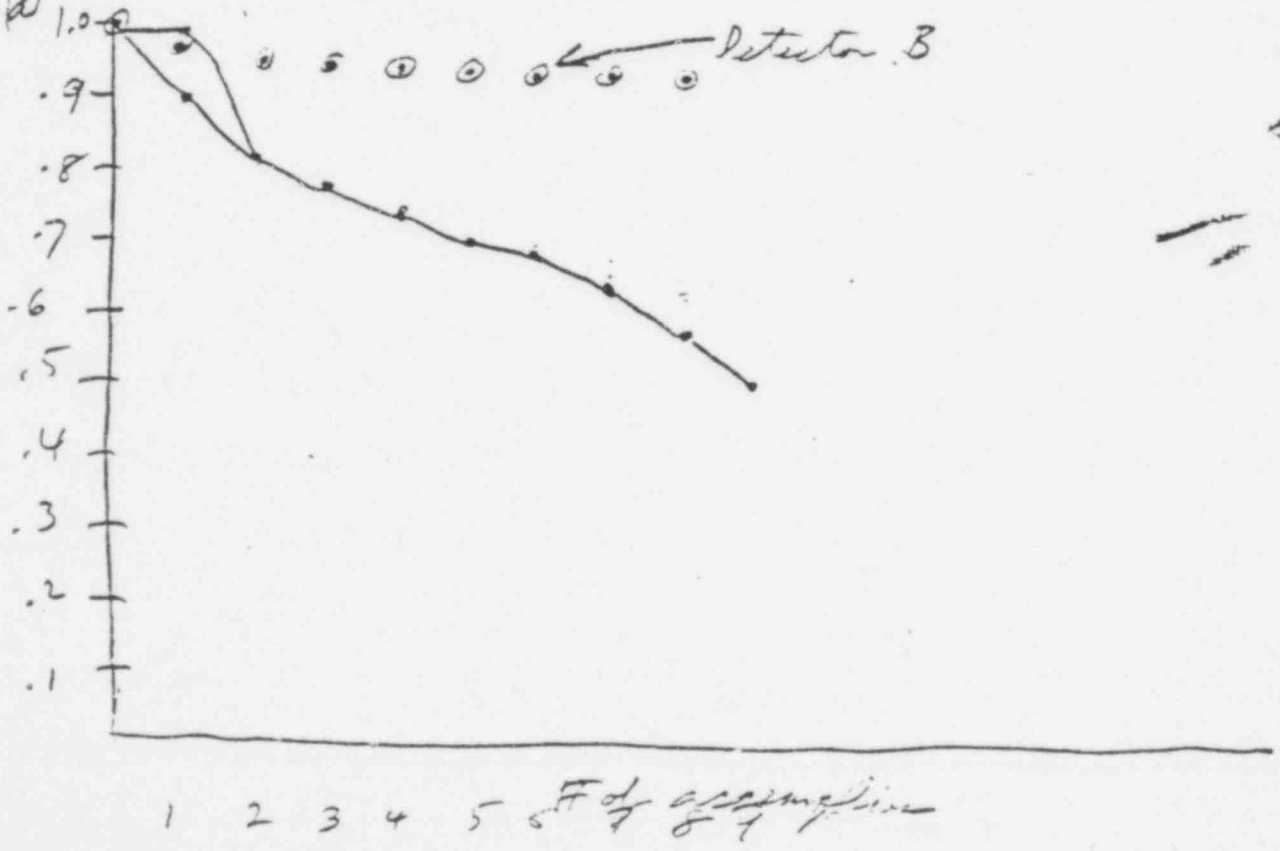
79-067

(b) The assymetric rumback prevents exceeding Kw/ft limits in parts of the core away from the dropped rod. If the reactor demand station is in manual it will not respond to ICS commands, and a manual rumback is necessary to prevent a high pressure reactor trip.

K

K2c Quadrant power tilt would be limiting issue with the rod all the way in the axial imbalance would not be affected too much. The greatest effect is in the quadrant power tilt because of the flux depression in the affected quadrant causes the radial peaks in the unaffected quadrant to go higher — Xenon begins to worsen ∴ rods go out.

K3(a)



3

3

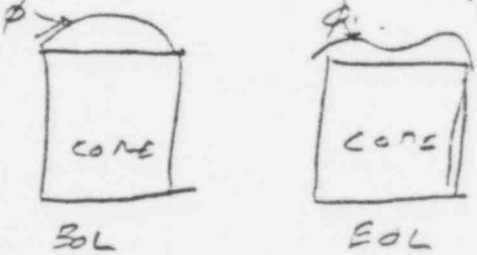
K

K3 b The B detector plot does not show any effect of fuel addition after the addition of the first assembly because there is no additional fuel placed between it and the source. To get a change in 1/M more fuel must be placed between the detector and the source.

The A detector plot shows an increasing multiplication of the source neutrons as more fuel is added to the core.

K4 a) in the transient mode .5 – 10% /min
in the control mode < .5% /min.

b) Control rods are interchanged to obtain the same worth in groups as the flux shifts to the outside of the core as it ages.



Second front. 39.66

1.0

79-069

K

Sm build. — 1.0

K5 The shape of the curve in the first 100 FPD is a result of the LBP rods burning out slower than Pu^{239} builds in causing the lip in the first 60 days of life. As the Pu^{239} builds in the $\Delta K/K$ change 1 day of burnout in LBP rods gets less so Kexcess comes back up and gets linear at the core ages.

79 070

L

L-1 a RCS Pressure 2750 PSI — 1.0

RBLDG PRESS 60 PSI Axial imbalance Radial Pres.

RC FLOW / IMB / POWER 1.05 FLOW-IMB

RX POWER 105.5% DNBR limits

b) LOOP PRESS INST TRIP @ 2355 — 3

4 PSI BLDG ISOL / 30 PSI X BUILDING SPRAY ACTIVATION

RC FLOW / IMB / POWER MONITOR AND TRIP FUNCTION GEN.

NI 5,6,7,8 HI POWER TRIP

c) Keff < .99

TAVE > 280 °F

REACTOR 0.0% POWER

L-2 (a) A control is a switch or part of a system that can affect reactivity

Diamond Panel

Borate/Dilute controller.

2

(b) A designated licence trainee may operate controls under the direction of a licensed operator or as directed by R.O

79-071

L

L 2 c) He may resume his duties after suitable evaluation of performance by plant supervisor. He may be subject to reexamination by ARC. + medical

L-3 a) SHIFT FOREMANS LOG —.8
CRO LOG — Check off list, reviews computer
AUXILLIARY OPS SHIFT READINGS etc.
NIGHT OR SUPPLEMENTAL INSTRUCTION BOOK

B) ON coming shift reads procedure revisions 2
SOP, TCN, LIFTED LEAD & JUMPER LOG,
REVIEWS CRO LOG S/F LOG. protected operations
The off going shift needs a man for men and license for license transfers to be completely relieved

No other letter —.2

c) i 2 SRO 1 in Rx bldg 1 in CONT RM
RO IN CONT ROOM

ii 2 RO IN CONT RM —
1 SRO IN CONT RM (S/F on 45) —.2
on site acc. operations

79 072

L

L4(a) 1. Commence EMERGENCY BORATION

2. LINE UP BWST TO DH PUMPS

3. Sample RCS

4. Begin bleed and feed to remove NAOH from DH and RCS SYSTEM

(b) 1. Apply additional heat trace,

2. if not vented in 1 HOUR commence SID to HSB

Reason

c) Close an upstream valve and repair the fracting leak.

Reason.

79-073

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

Facility Three Mile Island - Unit 2

Reactor Type PWR - B&W

Date Administered 8/17/77

Examiner J. J. Buzy

Applicant

1630

Instructions to Applicant:

Use separate paper for the answers; staple question sheet on top of the answer sheets. Points for each question are indicated in parenthesis after the question. An overall score of 70% or greater is passing.

Category Value	% of Total	Applicant's Score	% of Cat. Value	
14	13.5	12.8	91	A. Principles of Reactor Operation
14	13.5	10.6	76	B. Features of Facility Design
17	16	12.5	74	C. General Operating Characteristics
16	15	12.8	80	D. Instruments and Controls
16	15	15.6	98	E. Safety and Emergency Systems
16	15	11.4	71	F. Standard and Emergency Operating Procedures
13	12	9.7	75	G. Radiation Control and Safety
106		85.4		

Final Grade 81 %

79-074

A. PRINCIPLES OF REACTOR OPERATION (14)

A. 1. a) What is meant by the term "delayed neutron fraction"? (1.0)

b) How and why does the delayed neutron fraction change during core lifetime? (1.5)

A. 2. The TMI procedure for approach to criticality requires the operating staff to plot a one over M (1/M) during rod withdrawal.

a) What data is required for the 1/M plot? (0.5)

b) How is the data utilized? Note: a sketch may be used as part of your answer. (1.5)

A. 3. Assume your reactor is on a stable .8 DPM startup rate as power level reaches 2×10^{-11} on the intermediate range monitor. (Time is "0").

a) Plot the trace on Figure A1 until the power level reaches 10^{-8}. (1.5)

b) After a two-minute "hold" to take data at 10^{-8} the operator withdraws the control rods to obtain a 1 DPM startup rate. Plot this trace for 5 minutes; include the period of rod motion. Explain any changes during the five minutes. (1.5)

c) Assume the reactor was at 10^{-6} at 3 minutes on figure A1 and a reactor trip occurred. Plot and discuss the resulting trace for the remaining period of time on figure A1. (1.0)

A. 4. Xenon conditions include periods when xenon is at equilibrium and at peak conditions.

a) What is meant by equilibrium xenon? (1.0)

b) How does peak xenon develop? (1.5)

c) Assume a plant startup and power escallation is in progress at the time of peak xenon. How does this differ from a power escallation after a one-week shutdown? Note: a sketch may be used as part of your answer. It is not necessary to include values for xenon. (1.5)

A. 5. Water is used as a coolant in your reactor. List three other functions of water in the reactor. (1.5)

B. FEATURES OF FACILITY DESIGN (14)

B. 1. The nuclear services closed cooling water (NSCCW) system provides cooling water for the nuclear components during normal operation and also provides cooling for components during a loss of coolant accident.

a) List those components which use the NSCCW during normal operation. List the components (i) Inside and (ii) Outside the reactor building. (2.5)

b) What components are supplied during a LOCA? Note: if components appear in part A, mark them with an asterisk*. (1.0)

B. 2. Condensate and feedwater are heated in a number of heat exchanges before water enters the steam generators. Sketch a one-line diagram of the combined systems from the condenser until it leaves the last heat exchanger. Include all pumps and source of heat for each heat exchanger for one string. (2.5)

B. 3. The fire protection system at your facility consists of a number of pumps located in unit one and two. The fire main supplies a number of hydrants, hosereel stations, a wet pipe sprinkler and a deluge system.

a) List all pumps which supply the fire main; include capacity and when each pump will start. (2.0)

b) Explain the difference between the wet pipe sprinkler and the deluge water systems. (1.0)

B. 4. One of the components associated with the reactor coolant system is the R. C. drain tank.

a) List the equipment which discharges to the drain tanks. (1.0)

b) What limits apply to the tank? Include the reasons for these limits. (1.5)

c) If the drain tank level is too high, where may the operators discharge the excess liquid? (0.5)

B. 5. One of the Limits and Preventions require that systems containing liquids should be free of air before they are operated to prevent water hammer.

a) What is water hammer and why should plant operators be concerned about water hammer? (1.0)

b) Does water hammer occur only with systems containing liquid and air? Explain your answer. (1.0)

79-076

C. GENERAL OPERATING CHARACTERISTICS (17)

C. 1. The once-through steam generators (OTSG) at your facility will produce superheated steam during power operation.

a) With the aid of a simple sketch, explain how superheat is accomplished in the OTSG. (1.5)

b) How does superheat vary from 15 to 100% power? A sketch may be used as part of your answer. (1.0)

C. 2. The following are two of the limitations and precautions in the Unit Startup procedure. Provide the value and reason for each of the limitations.

a) Do not attempt to start a reactor coolant pump when power is greater than _____. (2.0)

b) During startup and shutdown when reactor power is less than _____ percent, the OTSG water level shall be maintained between _____ and _____. (2.0)

C. 3. Unless specified by the reactor engineer, group 8 (APSR) will be positioned about 32% withdrawn prior to an approach to criticality.

a) With the aid of a sketch, indicate how the APSRs worth varies between 0 - 100% withdrawn. (Include approximate reactivity values) (1.5)

b) Explain when it is necessary to move the APSRs (i) in and (ii) out. (2.0)

C. 4. Two of the limits and precautions for the control rod drives concern the gas concentration in the RCS and the cooling water to the mechanism.

a) What are the sources of gas in the R.C.S.? (1.0)

b) Why is gas concentration a factor for the CRDMs? (1.0)

c) Is it necessary to maintain a minimum concentration of gas in the RCS during power operation? Explain your answer. (1.0)

d) The temperature of cooling water to the CRDM may vary from 85 - 105°F. Is there a preferred temperature range? Explain. (1.0)

C. 5. Assume rated power conditions and a trip occurs to a reactor coolant pump.

a) Provide the initial steady state values for parameters listed in figure C5. (1.0)

b) Show the response to these parameters until conditions stabilize. Assume the reactor does not trip. (2.0)

D. INSTRUMENTS AND CONTROL (16)

D. 1. Refer to the transient in question C.5. Discuss the action of the control system(s) for each of the following parameters:

a) Load MWe (1.5)

b) Pressurizer level (1.5)

c) Feedwater flow A & B (2.0)

D. 2. The intermediate channel utilizes a compensated ion chamber (CIC).

a) With the aid of a simple sketch, explain the operating principle of a CIC. (1.0)

b) Is compensation required at 100%, 15%, or lower power levels? Explain your answer. (1.0)

CAN A CHANGE IN COMPENSATION RESULT IN EXCESSIVE

c) ~~Can compensation change~~ the "overlap" requirements between the other channels? Explain. (1.0)

D. 3. The pressurizer electromatic relief value (RC-2) may be operated in the manual or automatic mode. Discuss how the valve may be operated in each mode. A simple sketch may be used as part of your answer. (2.0)

D. 4. Unit 2 of TMI utilizes a boron feed and bleed PERMISSIVE controller.

a) What are the input signals to the controller? (1.0)

b) What are the output signals of the controller? (1.5)

c) When is the controller utilized? (0.5)

D. 5. Two of the alarms on the Diamond Control panel are the (i) motor rotation fault and the (ii) asymmetric monitor.

a) Discuss the purpose of each alarm. (1.5)

b) What immediate action is required by the operating staff for each alarm? (1.5)

79-078

E. SAFETY AND EMERGENCY SYSTEMS (16)

E. 1. The power distribution system at TMI-2 contains two DC buses, 2-1DC and 2-2DC.

a) Use a one-line diagram to show what components supply these busses and their source(s) of power. Include any cross ties between these buses and supplies. (2.0)

b) If a station blackout occurs, what loads are supplied by the D.C. bus until the emergency diesel generators begin to supply power? (1.5)

E. 2. List the conditions that will cause a reactor trip with four R.C. pumps in service. Include present set points. (2.5)

E. 3. Assume a loss of coolant accident (LOCA) occurs. The LOCA increases reactor building pressure at 2PSI/minute and doubles each minute (2, 4, 8, etc.). Utilize this rate for the following:

a) What automatic action(s) occur during the first four minutes? (1.0)

b) What instruments will the operator observe to assure initial and continuing operation of equipment? (2.5)

c) What is the postulated peak reactor building pressure in the design basis LOCA? (0.5)

E. 4. Three Mile Island Unit 2 is provided with a feedwater latching system.

a) List the instrumentation associated with this system and explain the logic that will actuate the system. (1.5)

b) List the automatic action that will occur when this system is actuated. Assume rated power operation. (2.0)

E. 5. Assume a primary to secondary leak develops in one of the OTSG. The leak begins at one GPM and doubles every 5 minutes (1, 2, 4, 8, etc.)

a) List the systems that will alert the operator. Attempt to arrange them in order of increasing leak rate. (1.0)

b) When the operators have identified the leaking OTSG, should they trip the reactor or begin an orderly shutdown? Explain the reason for your answer. (1.5)

F. STANDARD AND EMERGENCY OPERATING PROCEDURES (16)

F. 1. Assume your unit is at the power level cutoff point and waiting to meet the requirements before increasing power. All systems are in automatic. A malfunction occurs in the circulating water system and vacuum begins to decrease at 1" Hg/min.

a) What is the power level cutoff point and when may power be increased above this level? (1.5)

b) How will the ICS respond as vacuum decreases? (1.0)

c) What immediate action is required by the operator (assume vacuum continues to decrease)? (1.0)

d) List the heat sink(s) available if corrective action can not restore vacuum. (1.0)

F. 2. One of the Limits and Precautions of the Decay Heat/Injection Pumps states "When operating in the ES mode with suction on the building sump, pump discharge must be throtled to _____ GPM to limit runout. Do not throttle below _____GPM as this may result in cavitation and inadequate cooling."

a) What are the above flow rates? (0.5)

b) What is pump runout and what are the consequences if the pump continues to operate in this condition? (1.5)

c) What is cavitation and how would the operator observe this condition on the D.H./Injection pumps? (1.5)

F. 3. During reactor startup, limits are imposed on the amount of reactivity which may be added above and below the estimated critical position.

a) What are these limits and how does the operator convert them to rod position? Assume an ECP of 50% on Group 6/7. (1.5)

b) What action(s) are required if these limits are exceeded? (1.5)

F. 4. In the event of a reactor trip, list the manual actions required by the TMI-2 emergency procedure. (3.0)

F. 5. In the event of an unanticipated criticality:

a) What symptons would alert the operating staff? (1.0)

b) What immediate action is required by the operator? (1.0)

G. RADIATION CONTROL AND SAFETY (13)

G. 1. Assume you have been working in a contaminated area. After you remove your protective clothing you monitor yourself before leaving the area.

a) Should an ionization or GM device be used? Explain. (1.0)

b) What type of radiation will the instrument detect? (0.7)

c) What is the criteria for determining if a person is contaminated? (0.8)

G. 2. After working in area for two hours, you discover your dosimeter is off scale and you leave the area. A survey indicates a hot spot on a drain line reads 1200 mr/hr gamma at two feet. Your distance from the line was about five feet.

a) Estimate the dose which you may have received. (1.5)

b) If your previous exposure to the quarter was 900 mr, what exposure limits may have been exceeded? (1.0)

c) With the aid of a simple sketch, explain the operating principle of a pocket dosimeter. (1.0)

G. 3. Three of the classified areas in the Radiation Protection Manual at TMI are (i) controlled area (ii) radiation area and (iii) high radiation area.

a) Define each area; include any limits. (1.5)

b) May the NRC examiner enter each area? Explain your answer. (1.0)

G. 4. In the event of a radioactive spill, one of the basic rules is to administer aid to anyone who is injured. What other basic rules apply? (2.0)

G. 5. During a refueling outage you are in the reactor building on the main fuel handling bridge. A spent fuel element drops into the core.

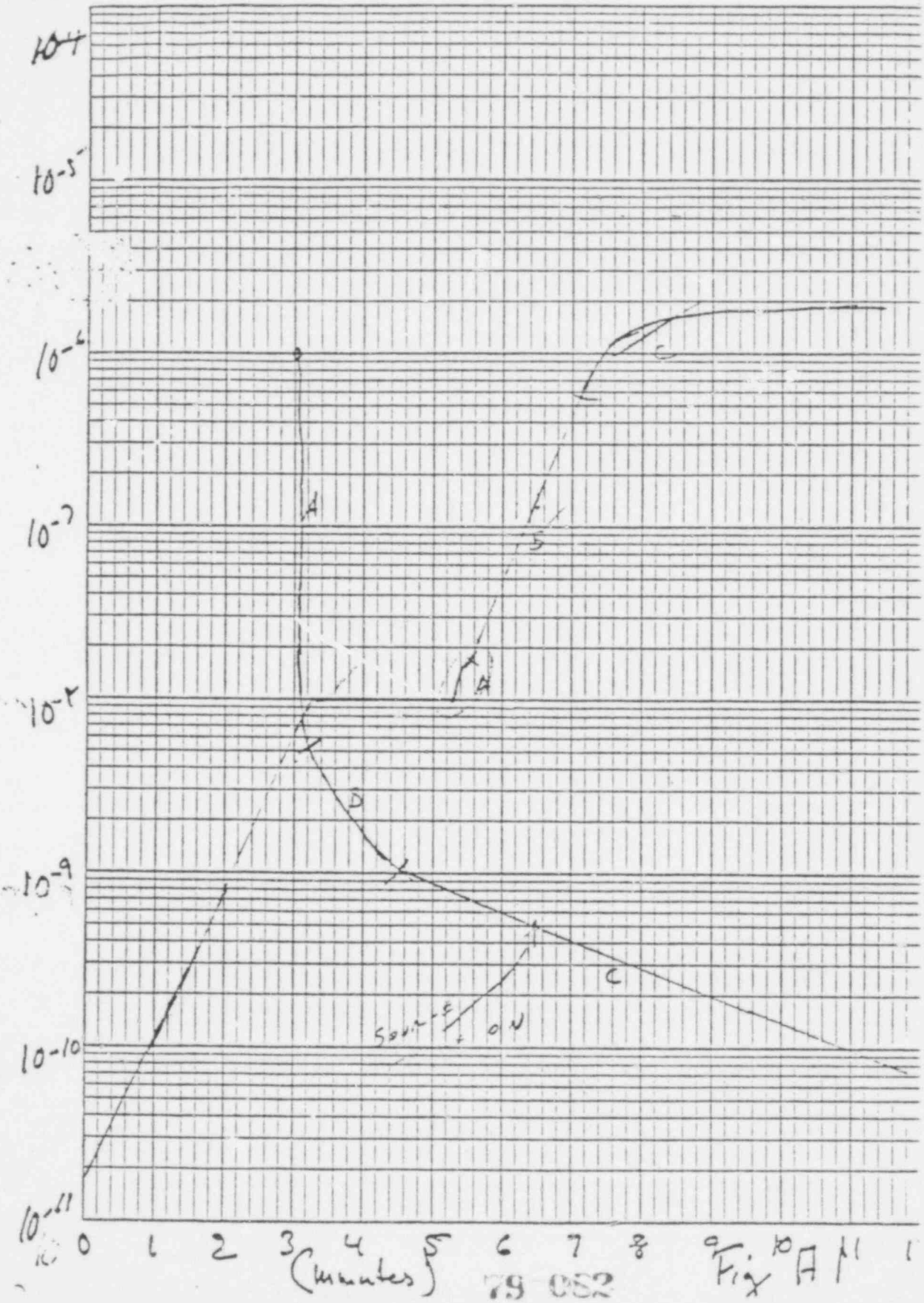
a) What instrumentation will alert the personnel in the reactor building of any release of fission products? (1.0)

b) What automatic action(s) may occur if radiation levels exceed preset limits? (1.0)

c) What actions are required by the control room staff? (0.5)

DEL

DATE



K&E BIEMI-LOGARITHMIC 359-94
KEUFFEL & ESSER CO.
7 CYCLES X 90 DIVISIONS

79 082

Fig A

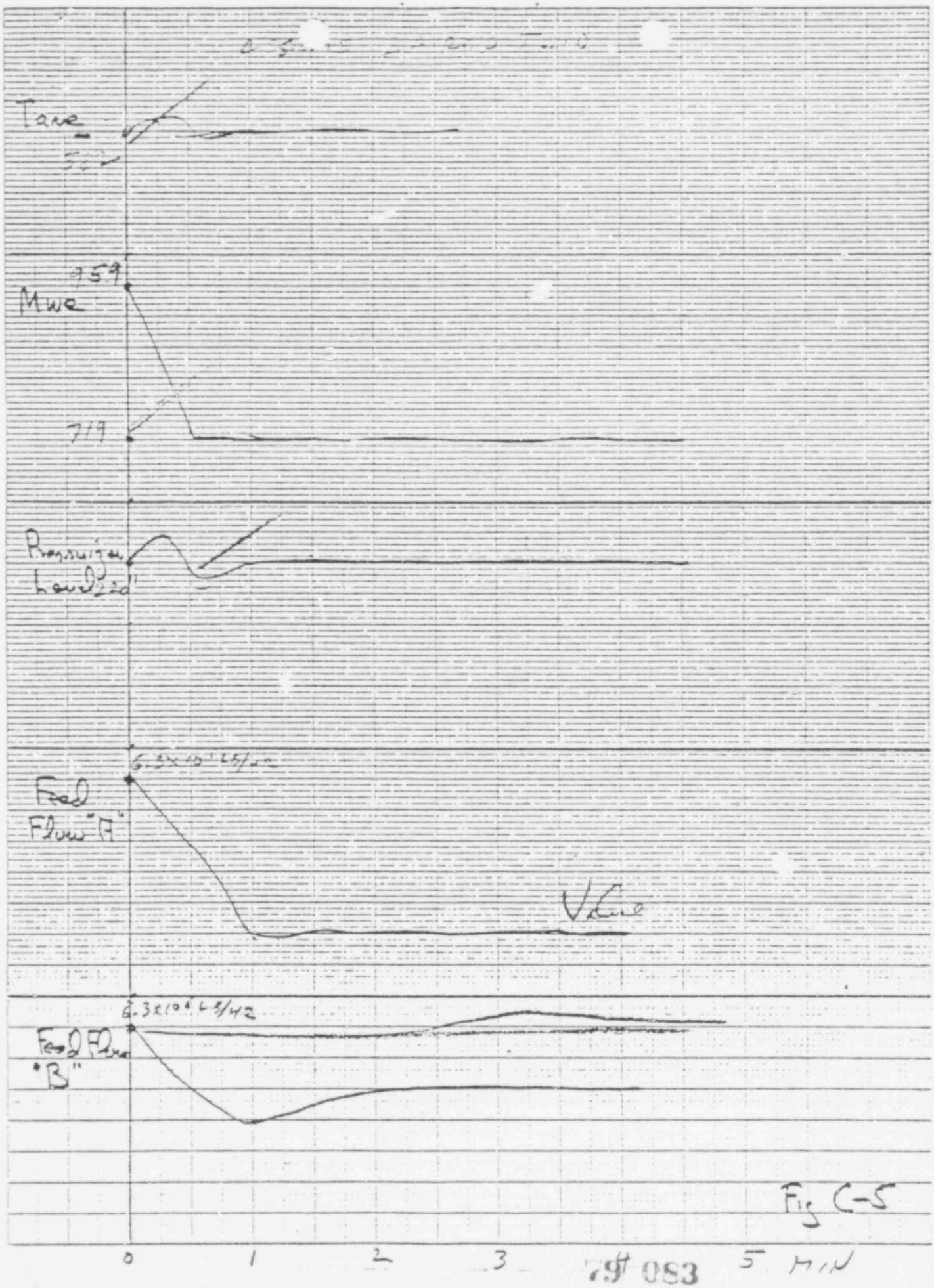


Fig C-5

FIGURE 28: CONTROL ROD GROUPS 5,6 & 7 Revision 0
REACTIVITY WORTH (532°F, 2155 psig, 0% F.P. 08/14/77

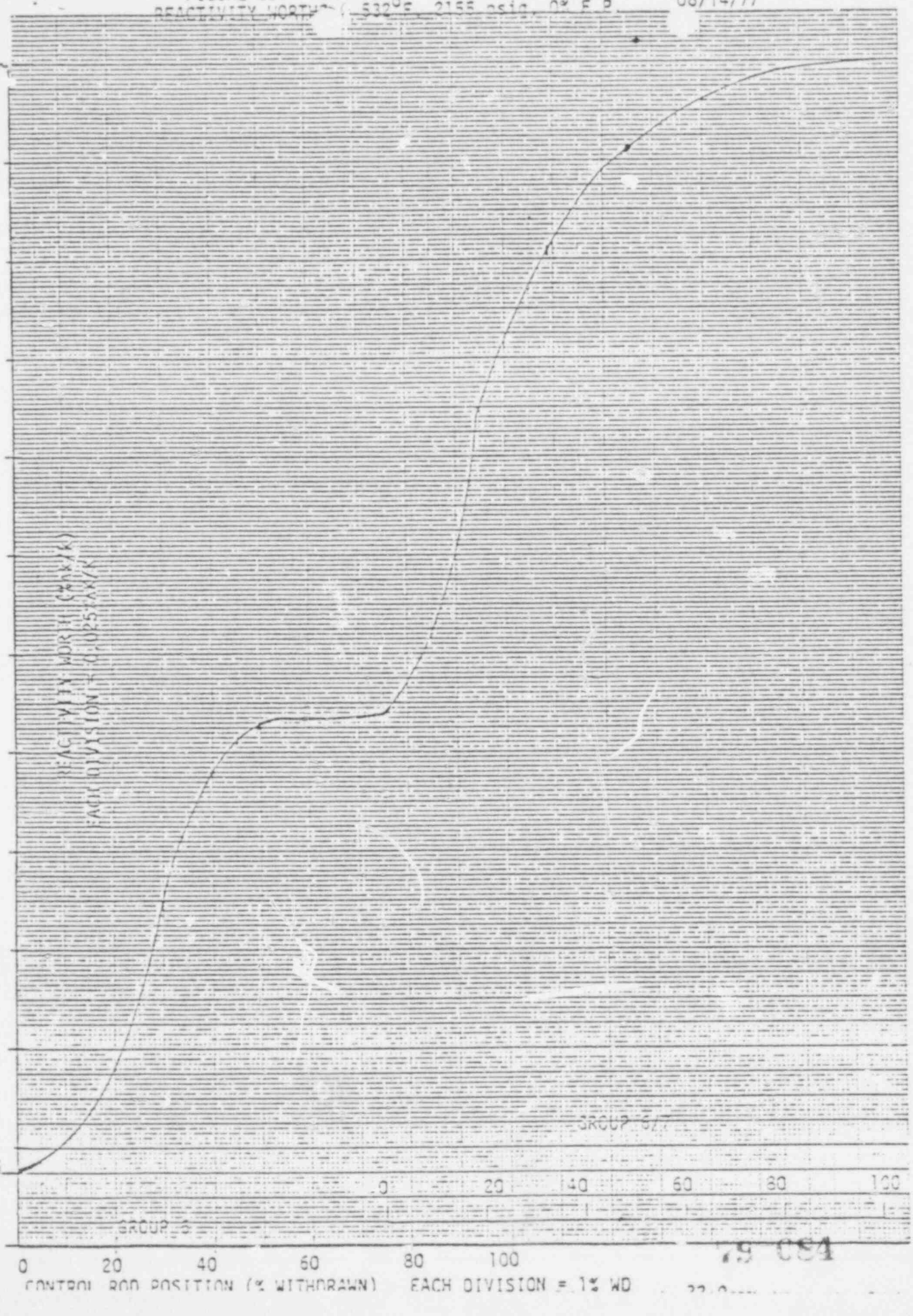


Table 1. MISCELLANEOUS 10 CFR 20 Appendix b

Material	Half-Life	Energy MEV per disintegration	Table I Col I Air μc/ml	Table I Col II Water μc/ml	Table II Col I Air μc/ml	Table II Col II Water μc/ml
A-41	1.83 h	1.3	2×10^{-6}	e	4×10^{-8}	
Co-60	5.3 y	2.5	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
I-131	8.1 d	0.36	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
Kr-85	10.8 y	0.04	1×10^{-5}		3×10^{-7}	
Ni-65	2.5 h	0.59	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
Pu-239	2.4×10^{4} y	0.008	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
Sr-90	28 y		1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-6}
Xe-135	9.2 h	0.25	4×10^{-6}		1×10^{-7}	
Any single radionuclide with $T_1 > 2$ hr which does not decay by α or spontaneous fission			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}

Neutron Energy (MEV)	Neutrons per cm^2 equivalent to 1 rem	Average flux to deliver 100 mrem in 40 hours
Thermal	970×10^{6}	670
0.02	400×10^{6}	280
0.5	43×10^{6}	30
10	24×10^{6}	17

LINEAR ABSORPTION COEFFICIENTS (cm^{-1})

Energy (MEV)	Water	Concrete	Iron	Lead
0.5	0.090	0.21	0.63	1.7
1.0	0.067	0.15	0.44	0.77
1.5	0.057	0.13	0.40	0.57
2.0	0.048	0.11	0.33	0.51
2.5	0.042	0.097	0.31	0.49
3.0	0.038	0.088	0.30	0.47

FORMULAS AND CONVERSIONS

$$r/hr = \frac{6CE}{d^2} \qquad I_x = I_0 e^{-\mu x} \qquad I_x = \frac{I_0}{d^2} \qquad N = N_0 e^{-\lambda t}$$

$$T = \frac{\beta - \rho}{\lambda \rho}$$

$$T_i = \frac{0.693}{\lambda} \qquad p = \frac{\Sigma \phi V}{3\times10^{10}} \qquad \rho = \frac{1}{Tk} + \sum \frac{\beta_i}{1+\lambda T} \qquad T = \frac{l}{\rho - \beta}$$

$$T = \frac{l^*}{\rho} + \frac{\beta - \rho}{\lambda \rho}$$

1 gal = 3.78 liters
1 in = 2.54 cm
1 yr = 3.15×10^{7} sec.

1 kg = 2.21 lbs
1 gm/cm^3 = 62.4 lbs/ft^3
1 ft^3 = 7.48 gal

$N_A = 6.03\times10^{23}$
$\pi = 3.14$
$e = 2.72$

A1. a) Delayed neutron fraction is that portion of the neutrons produced from fission that appear sometime after fission has taken place. 2

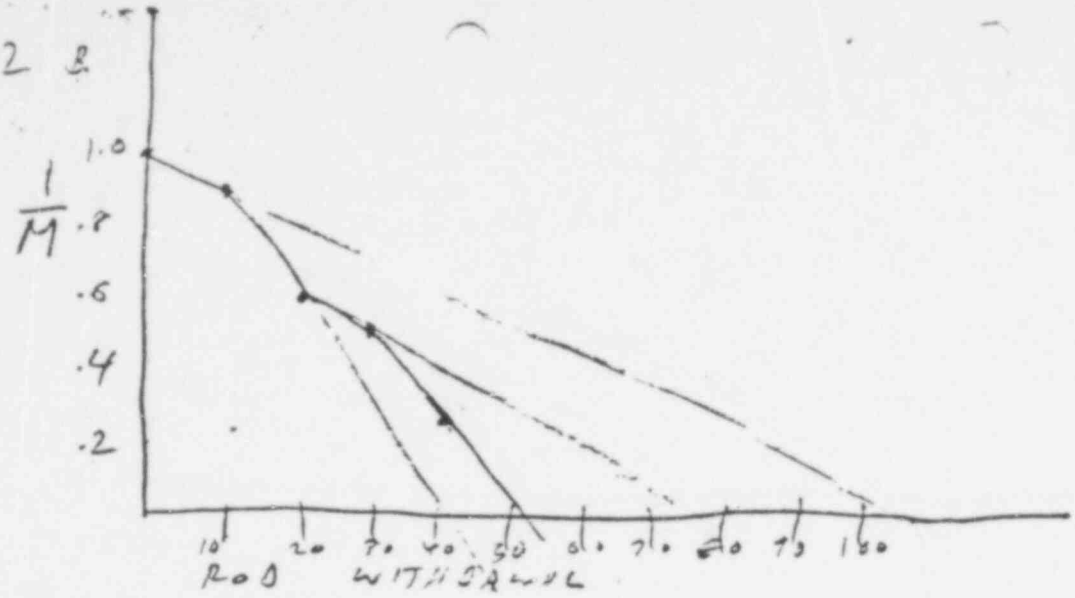
b) The delayed neutron fraction is reduced as the core ages due to the build up of Pu^{239}. ... Pu^{239} displays a lower delayed neutron fraction than U^{235} so as it builds in, the average delayed neutron fraction is less as the core ages 3

βU^{235} .0069 βPu^{239} .003 Ref. Cole of U^{235}

A2 a) A) Base count rate 2

B) ROD INDEX or AMOUNT WITHDRAWN of C.R.

A2 B



$\frac{1}{M}$

$\frac{1}{M} = \frac{\text{BASE COUNT}}{\text{COUNTS AT POSITION}}$

B.C 10

10% 11

20% 15

30% 18

40% 22

The 1/m plot is used as a means of predicting criticality.

17

A3 B, Assuming 45% withdrawn on cp 5 the operator inserts .0019 %Δk/k in part A of the trace and a prompt jump of ≈ 150PM results. After rod motion a steady 10PM rate is in part b of the trace. Power level continues to rise until the point where sensible heat is being added, in part c of the trace. The doppler coefficient in U^{235} fuel adds negative reactivity as the temperature increases and the reactor power levels off.

A

A 3 (c) As the rods move into the core the drop in power is shown in part A of the trace. The short time delayed neutron precursors decay in part 'B' of the trace.
The long-time precursors decay in part C of the trace results in an ≈ -.3 DPM SUR.

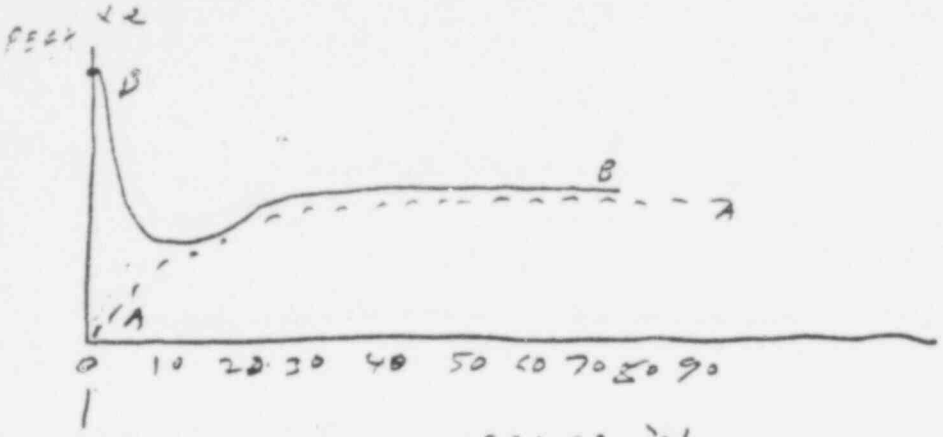
A 4. (a) Equilibrium Xenon is reached ≈ 48 hours after startup when Xenon production is equal to Xenon burnout by neutron absorption + Xenon decay to Ce^{135}

(b) Peak Xenon occurs from the decay of Iodine^{135} after fission ceases. Xenon is produced directly from fission and from the decay of Te^{135} to I^{135} to Xe^{135}. I^{135} decays with 6.2 hr half life so after fission ceases the residual I^{135} decay causes the Xe^{135} inventory to increase to a peak and then decay as the Xe^{135} decays.

79 C88

A.

A 4(c)



Curve A shows a startup after a one week shutdown. when the core is xenon free. the Xenon builds in and reaches equilibrium ≈ 48 hours after startup.

curve B shows the xenon transient from the peak as the power is raised. The xenon invent goes below its equilibrium value and then to equilibrium.

A.5 1. Water is a neutron moderator
2. Water is a reflector for neutrons
3. Water is the solvent for the control Boron.

79-089

B

a) -1,2

B1 (a) i RCP UPPER BRG OIL COOLER
RCP LOWER BRG OIL COOLER
RCP MOTOR AIR COOLER
S/G DRAIN COOLER Sa

ii M/U PUMP OIL COOLER *
M/U PUMP MOTOR AIR COOLER *
INSTRUMENT AIR COMPRESSOR *
INSTRUMENT AIR AFTER COOLER *
WASTE LIQUID EVAPORATOR
[illegible] *
SPENT FUEL COOLING HX
WASTE GAS COMPRESS.

Sand Pit.
Sturgeon mfg
* NSCCW
* Rx Bldg.
* " " Parker

b) -,6

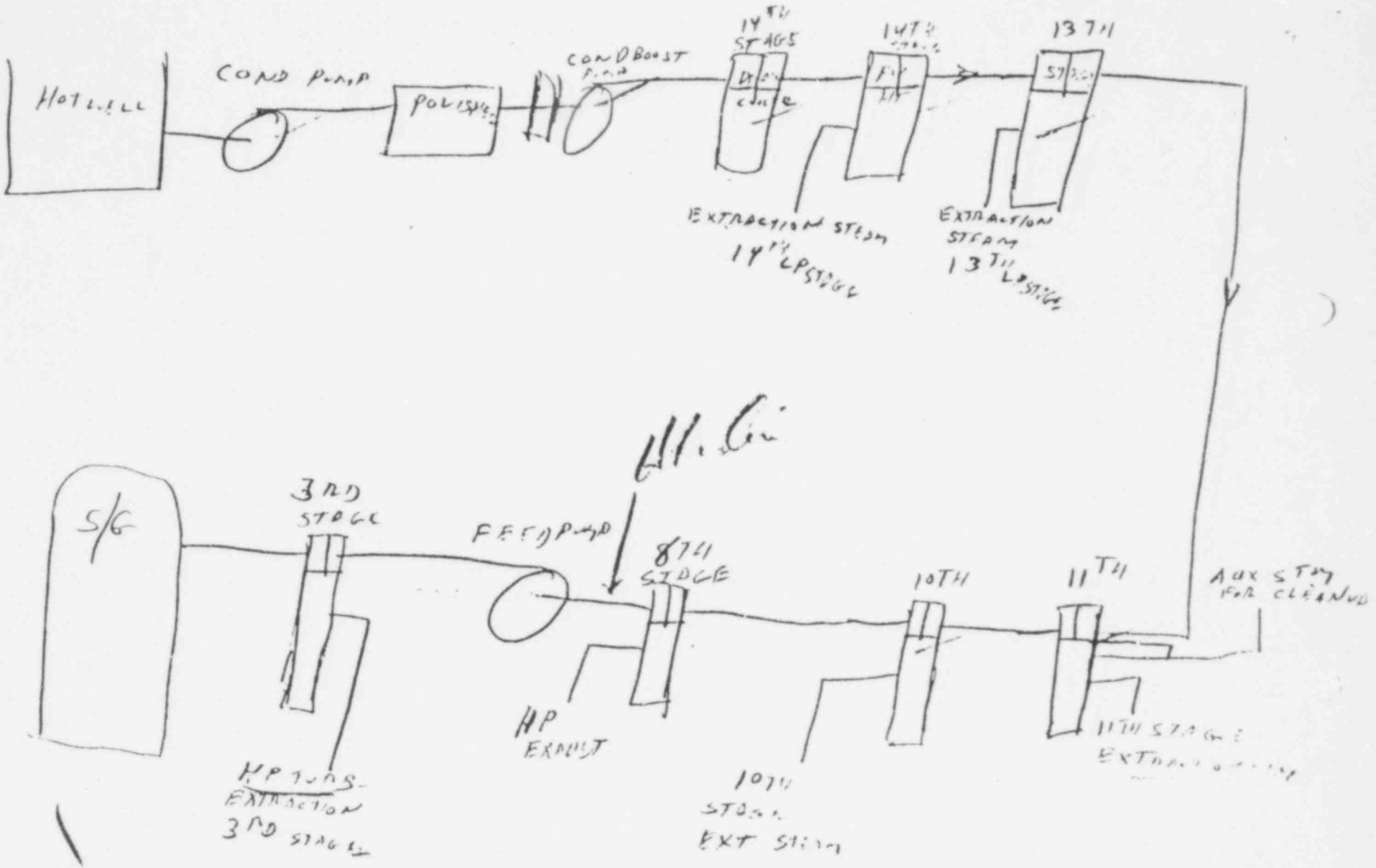
B2 NEXT PAGE

B3 (A) UNIT 1) 1 ELECTRIC 2500 GPM MANUAL OR AUTO 90 PSI
1) 1 DIESEL 2500 GPM MANUAL OR AUTO 85 PSI
UNIT 1) 1 DIESEL 2500 GPM MANUAL OR AUTO 70 PSI
UNIT (2) 1 DIESEL 2500 GPM MANUAL OR AUTO 80 PSI

B a wet pipe sprinkler is pressurized at all times and activates when a wooden metal strip melts and releases an individual sprinkler head.

A deluge system is activated by a heat sensor to trip a latch type clapper valve and pressurize a spray nozzle system

79 090


HOTWELL
COND PUMP
POLISHER
COND BOOST PUMP
14TH STAGE
13TH
EXTRACTION STEAM 14TH LP STAGE
EXTRACTION STEAM 13TH LP STAGE
11.6
S/G
3RD STAGE
FEED PUMP
8TH STAGE
10TH
11TH
AUX STM FOR CLEANUP
HP EXHAUST
HP TURB EXTRACTION 3RD STAGE
10TH STAGE EXT STEAM
11TH STAGE EXTRACTION

T50-62

B4 (a) PRESSURIZER ELECTROMATIC RELIEF
PRESSURIZER CODE SAFETYS
RCP ATMOSPHERIC SEAL CHAMBER DRAINS
+ 3 more

-.5

(b) 75 - 85% FULL TO provide quench water for pressurizer relief lift
≈ 5 psi, N^2 Pressure to inert the tank atmosphere. — Cond Tap Pan

-.5

(c) the liquid may be pumped to the RCBTs or the miscellaneous waste hold up tank

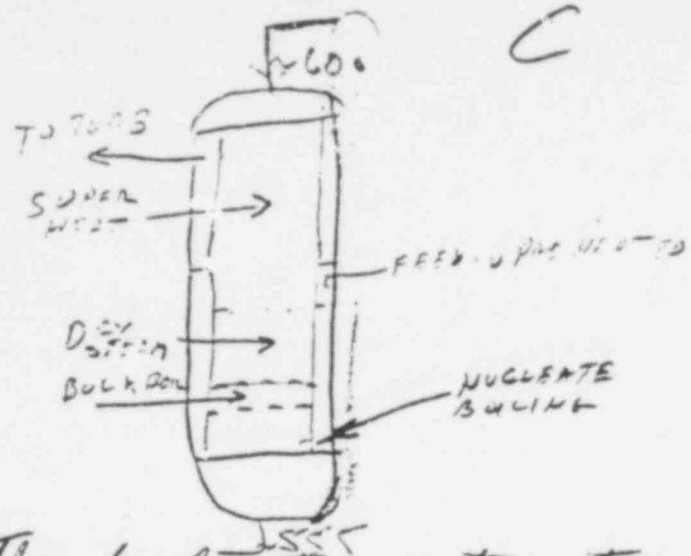
B5 A. Water hammer is the movement of a volume of water through an essentially empty pipe at a high velocity. When the water meets an obstruction the sudden stop causes a "hammer" effect and can cause damage to equipment.

79 092

B. No. Water hammer can result from the too rapid admission of steam to a cold steam pipe. The steam provides the driving force for the water or condensate.

C

C1a



2

The feedwater enters the S/G and recieves its final preheat at the aspirating ports. It then travels to the bottom of the wrapper where nucleate boiling begins. It enters the tube bundle and rises to where bulk boiling and finally steam is produced. The rest of the exposed tube bundle produces super heat.

5

C1B The super heat decreases as Power is increased from 15% due to the increase in mass flow. As mass flow increases the S/G pressure decreases and the level rises accordingly. The rise in S/G level reduces the area of the tube bundle available for super-heat.

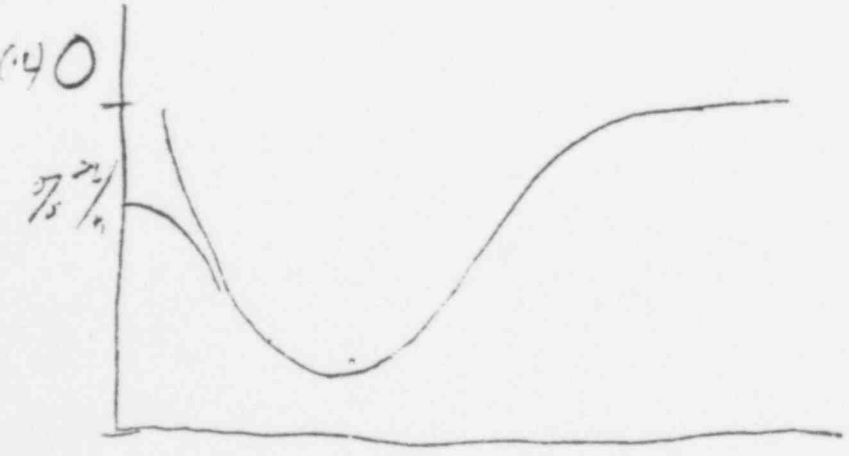
79-093

C

C 28 Do not start an RCP when power is greater than 30% because the ICS Feedrate / ΔT_c Ratio circuit cannot respond well enough to hold ΔT_c within design limits. If ΔT_c gets > 10° flow will be out of spec., also +/- limit in the cold side of the meter.

C 29 When reactor power is < 5% the S/G level is maintained 96-99% because of the feed nozzle requirement to remain flooded. Reloading the feednozzle prevents thermal gradient type of stress on the nozzle.

C-30 (40)



79-084

C

20

C-3 B i Inward motion is used to compensate for outward motion of the control rods. Outward motion of the control rods allows the flux to move to the top of the core so moving the APSR rods inward lets the flux remain where it is and still increase power no on and maintain a balanced flux. Flux Depression

ii Outward motion of APSR compensates for inward motion of control rods. As the control rods move in the flux is depressed into the core bottom, moving the APSR out reduces the amount of flux depression and maintains the balance.

3

C-4 A 1. H_2 blanket in M/V Tank O_2 +00

2. Free H_2 produced from N_2 - H_2O dissociation.

3. IODINE FROM FISSION PRODUCT DECAYS.

make up H_2O

79-095

(B) Gas pockets in the CRDMs reduce the tripping dashpot effect of primary coolant rushing to fill the void left by the lead screw. Without the dashpot effect damage could result on a reactor trip.

C

C-4 (c) A minimum gas concentration is maintained @ 40 cc/kg H_2. The hydrogen is used to scavenge any free O_2 produced from the CH_3 H_2O reaction. recombine —, 3

(D) Yes. The ideal range is cool enough to provide adequate cooling and not cold enough to cause condensation in the CNDM. range? 2

C-5B ASSUME RCP 2A TRIPPED

b) —, 6

D

D-1(a) Upon tripping an RCP the ULD gets a RUNBACK signal to runback at 50% /min and to 75% power. The ULD signal runs the feed system, the turbine and the Reactor back to 75%. Herbert Pucci —, 1

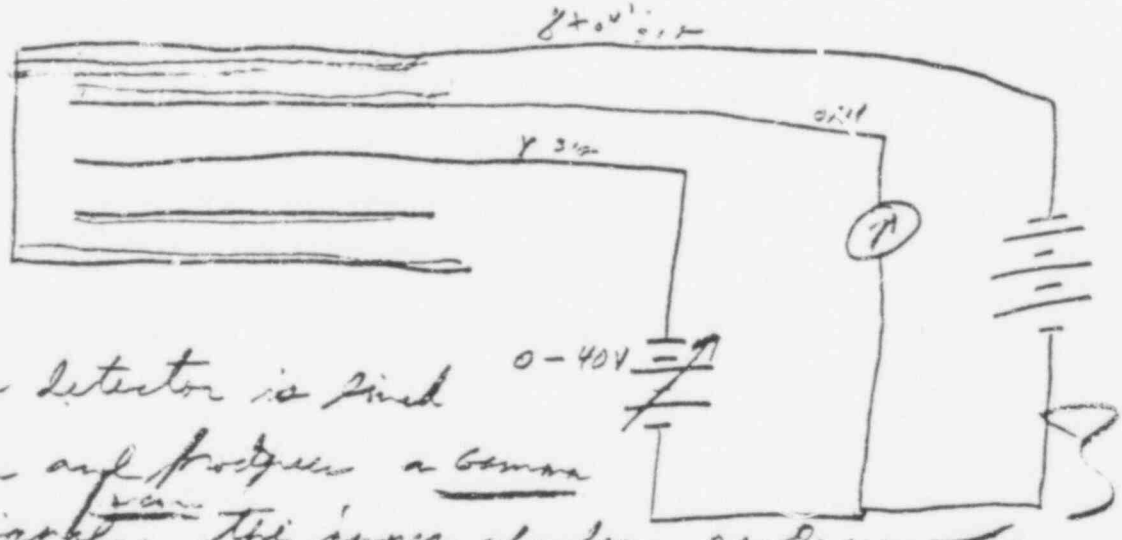
(b) Pressurizer level is controlled by its level controller closing down on MU-V17 until the level restores to normal then MU-V17 is returned to its normal position

79-096

D

D-1c The feedwater total flow is matched to ≥ 75% by the signal from the reactor water controller. As the feed is reduced the flow signal to each Feedwater Bypass station is conditioned by the ΔTc ratio circuit to additionally reduce flow to the affected (A) S/G and feed the unaffected (B) S/G more. This ratio process keeps the ΔTc between loops ∠5°.

D 2(a)



The outer detector is filled with Boron and produces a Gamma + Neutron signal. The inner chamber produces a gamma only signal of opposite polarity that electrically cancels out the gamma portion of the signal from the outer chamber. The resulting neutron signal is fed to the instrument.

78-057

D

D2 B Compensation is required at lower power levels because at higher power the signal from neutrons is so large the gamma ~~becomes~~ negligible. Then only a lower

D2C Yes undercompensation results in a higher than normal reading on the intermediate range. This can reduce the True overlap between the source and intermediate range by cutting off the source range prematurely.
Overcompensation results in a lower than normal indication on the intermediate range. This affects the ability of the intermediate range to indicate within the last 2 decades of the source range and again reduces the overlap.

3 The auto mode allows the valve to open at its setpoints (2255 psi normal) (550# in NDTT) The manual mode will open the valve anytime. The valve is prohibited from random changes by a key switch. The key is kept in the control room under the shift foreman control. The NDTT mode is interlocked. RCS Temp must be < 275°F To be in NDTT Mode Mode Press > 500 < 275 will open

79-058

D

D4 (a) INPUTS ROD GRP 1-4 ALL OUT, GRP 5 >35% <75% PWR
actual power -.3

(B) OUTPUTS TO MUV 9, MUV 10, MUV-8, SPECH FLOW
CONTROLLER permits + alarms -.8

(c) When batch or continuous bleed and feed are required, to place rods in the operating or transient bands. >15% -.3

D5

1. Motor Fault warns the operator of undesired motion or erroneous motion of the rods with respect to the commanded direction
Oper. Response; attempt to move in the desired direction manually or stop the rod motion. If a continuous out motion is in progress and cannot be stopped Trip the reactor.

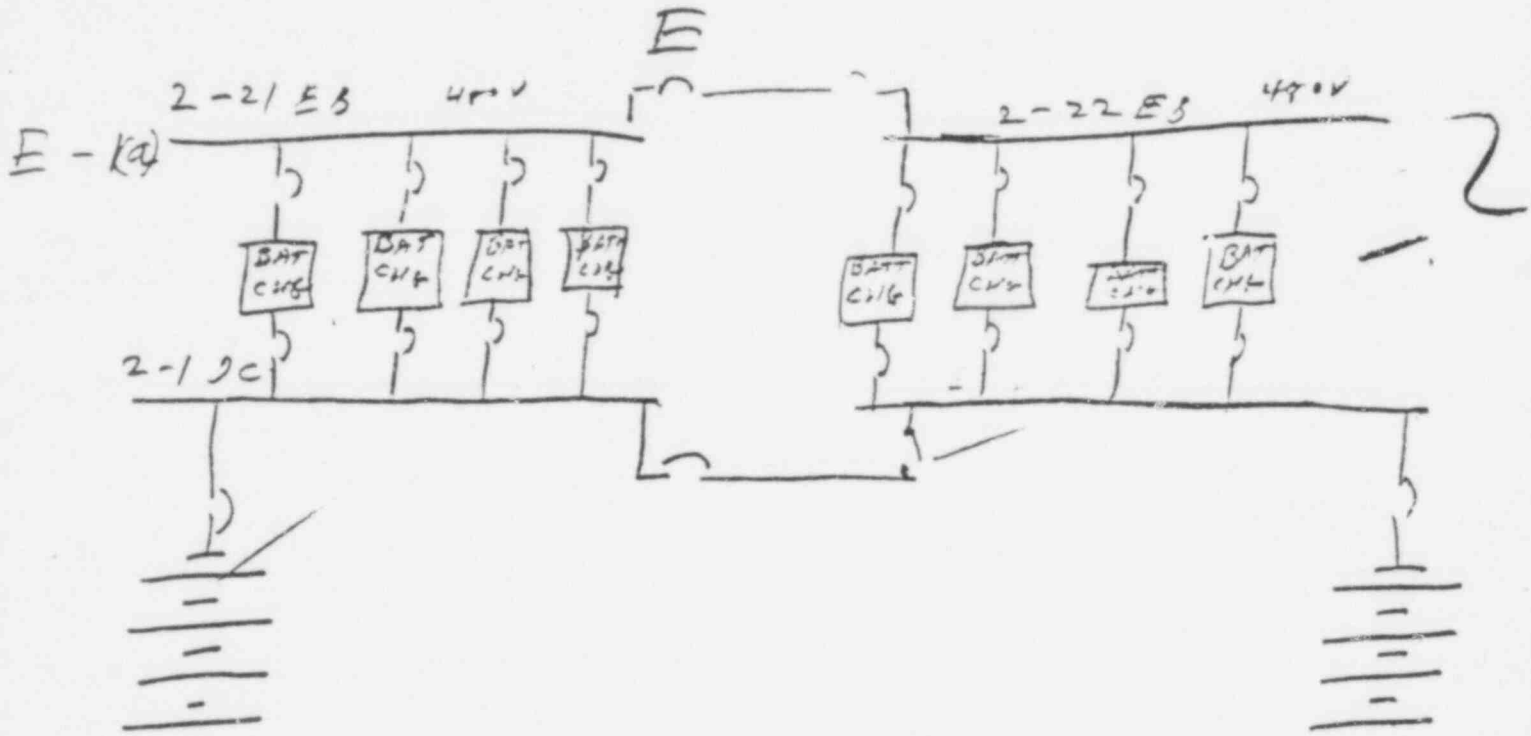
79-099

11. Assymetric Monitor warns the operator of a rod >6.5% misaligned from group position. AUTO RUNBACK TO 60% 3
operator response. allow the runback to continue, when stabilized with manual attempt to realign the rod if unable to realign,

D

D-5 II Declare it inoperable.

E



E-1 (B) DC LIFT PUMPS RCP's (4)
DC TURB SEAL OIL
DC SG FEED LUBE OIL
DC TURB LUBE OIL
EMERGENCY LIGHTING
1-V, 2-V, 3V, 4V, 5V INVERTERS (INSTRUMENTATION & COMPUTER)

E

E 2 Hi FLUX >105.5 %

FLUX/PUMP 12570

Hi PRESS 2355

Ø/FLOW/IMB 1.05 < FLOW · IMB

VARIABLE LOW PRESS 10.9 TX TH − 4550

LO PRESS ~~1950~~ 1800 PSI

TH > 619°F

Hi RB PRESS ~~4~~ PSIG

MANUAL PUSH BUTTON

E 3(a) Reactor trip 4PSI

RX BUILDING ISOLATION

BUILDING SPRAY SYS LINEUP C.C.

SAFETY INJ @ 16.0 IN RCS

E

E-3 B The operator should monitor

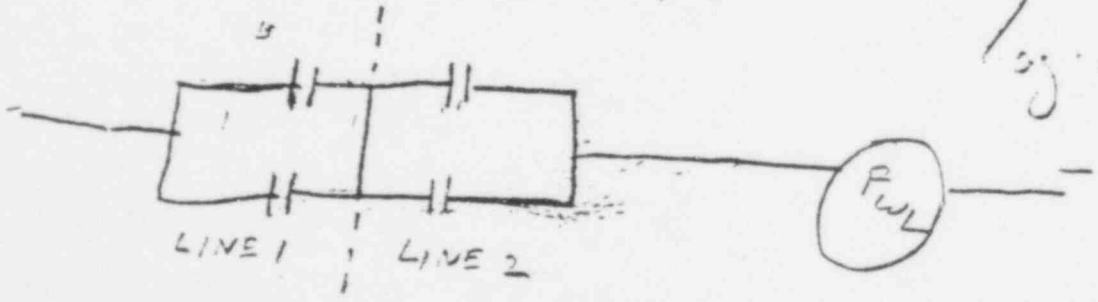
1. HPSI and building isolation indicator panels
2. REACTOR POWER SOURCE + INT. RNG
3. RPI
4. BUILDING PRESS
5. Reactor Build SUMP
6. BWST LEVEL NaOH TNK LEVEL
7. CORE FLOOD TANK LEVEL
8. HPSI LEG FLOW RATES
9. LPSI PUMP FLOW
10. CONT TEMPERATURE
11. RCS PRESS AND TEMP.
12. BUILD SPRAY FLOW

2

(C) 60 PSI peak press Tang ~56

E-4(a) 2 Pressure switches on each steam line set at 585 PSI

Logic



79 102

E

E-4a the diagram is for one steam generator (the other S/G circuit is identical.) To actuate feedwater latch one switch on each steam line must be closed and feedwater latch takes place.

(b) FW-V 19 A OR B
FW-V 17 A OR B
FW-V 25 A OR B
FW-V 30 A OR B
} CLOSE

MS-V 4 A OR B
MS-V 7 A OR B
} CLOSE

PLANT RUNBACK [illegible]

E.5(a) RM-V 7 48 Vacuum pump RAD MONITOR
MU-V 17 MAKEUP FLOW INCREASES
REDUCED FEED FLOW TO AFFECTED SIDE
LOWERING MU Tank level at an increasing rate

79-103

E

E-5b Do not trip the reactor, the best solution is as rapid a reduction in load as possible) OFF-LINE with out lifting secondary safties, then transfer temp control to Turb bypass valves and SHUT down the reactor and begin cooldown.

F

F 1 (a) 92%. The power level cutoff may be exceeded if operation is between 87 & 97% for the previous 2 hours or Xenon is 90% of its equilibrium value ± 6 Δ I.

(b) The ICS will try to recover the lost load from the reduction in efficiency due to the low vacuum. ICS will raise Tave to help raise reactor pressure. Reactor master will move rods out, i.e. Pressure ↑ SG Feed control will increase feed flow. 3

(c) Start additional circ pumps and/or vacuum pumps, reduce load, to (pressure ↓

F

F1(d) CONDENSER, WITH TURB BYPASS (CUT OFF @ 18" VACUUM)
ATMOSPHERIC STEAM DUMP
Feed + Bleed Steam Generators with CST (
Feed S/Gs with NUC RIVER (BAD WAY TO GO, LAST RESORT) Safeties, Stm Driven F. pump

3300 3000
F2 (a) 3000 750 —, 3

(b) Runout is when the pump has so much flow through put that the suction pressure is below normal and cavitation may occur. no overload of motor 1,0

(c) cavitation is caused when the NPSH is low enough to cause void formation or steam flashing in the eye of the impeller. This will eventually burn out the pump. 2

the indication is wildly fluctuating flow and pump amperage & press

79-105

F

F3(a) ±.5% ΔK/K LOW 34% — HIGH ~~AR~~ 0

The operator adds +.5% and finds the lower limit and subtracts -.5% and finds the upper limit by plotting reactivity versus rod index on the rod worth curve

(b) If the upper limit is exceeded and the reactor is not critical the rods must be driven to the lower limit to assure 1% SHUTDOWN and recalculate, ECP only to -.5%

If the reactor appears to be going critical before the lower limit is exceeded, drive the regulating rods in until 1% shutdown is achieved and recalculate, ECP

F. 4

VERIFY HEADER PRESS 1010#

TRIP REACTOR MANUALLY

VERIFY TURBINE + GEN TRIP IF NOT TRIP, Oil [illegible]

CLOSE MU-V376

79-106

START MU-P1A + OPEN MU-V165 MAINTAIN PRESS LEVEL 100"

VERIFY ALL RODS EXCEPT ~~GRP~~ 8 IN

IF PRESS LEVEL GETS TO 80" START 3RD MU PUMP

OPEN MU-V16 C-D, VERIFY HEATERS OFF

IF LEVEL GETS TO 20" INITIATE HPI no open DH-

IF >10% REACTOR PWR 1 MIN. AFTER TRIP EMERG BORATE.

F

F 4. IF FW STATIONS INHAND RUN BACK INHAND TO MAINTAIN SG LEVEL.

F 5 (a) Increasing count rate with no rod motion
Positive SUR below ECP lower limit.
Possible SUR Rod inhibit

(b) Drive rods in to achieve 1% shutdown
if necessary trip the reactor notify shift
supervisor. no deduction —.5

G

G-1 (a) GM should be used because it is the
most sensitive to low level radiation
(b) Beta or Gamma

(c) >2000 CPS ABOVE BACKGROUND —.8

1000 DPM/100 Beta
100 " 2

G

G2 (a) $R_1(D_1)^2 = R_2(D_2)^2$

$4800 = R_2 25$

$R_2 = 192 \text{ MR/HR} \times 2_{HR} =$ **384 MR EXPOSURE**

(B) EXCEEDED QUARTERLY DOSE 1¼ / DOSIMETER

TMI ADMIN LIMIT 300 MR/WEEK + 1000 QTR

The dosimeter is charged and the quartz fiber is fixed to the outside. The static charge is discharged by radiation and the amount of radiation is read on the scale.

G3 (a) i controlled area MAY be >1000 DPM/100 CM² >.4 MR/HR >10 DPM α Potential of

ii RADIATION AREA >5 MR/HR or 100 MR in 40 HRS

NEED RWP TO WORK THERE

iii HIGH RADIATION AREA >100 MR/HR (

POSTED RWP SPECIFIES USE OF DIRECTREAD INSTRUMENT.

(b) Only if necessary and depending on the level of training in TMI HP procedures escort may or may not be required

Ref: RWP 79-108

G

G-4 Report the spill to HP + C.Rm
Contain the spill as Best you can
try not to contaminate your self
Barricade the area and post it
Warn others around it

4

G-5 (a) Fuel bridge radiation monitor,
containment air sample HPR 227

(b) HPR 225, HPR 226 SHUT DOWN RB
PURGE
Fuels close

5

(c) SOUND RB evacuation alarm
Declare RB local Radiation emergency
Charts.

5^2

3

79-109