EXAMINATION REPORT

Facility Licensee: Arkansas Power & Light Company
P. O. Box 51
Little Rock, Arkansas 72203

Facility Docket No: 50-313

Facility License: DRP-51

Chief Examiner: R. G. Cooley for 9/13/84
R. Smith, Licensing Examiner Date

Approved: R. G. Cooley 9/13/84
R. A. Cooley, Section Chief Date

Summary

Examinations dates were May 3, 4, and June 28, 1984.

Written and oral requalification examinations were administered to six SROs and three ROs. A partial written examinations was given to one of the SRO applicants. Seven operators passed these examinations, and two SROs failed the written examination.

NRC prepared Sections 3, 4, 7 and 8 of the written exam. ANO prepared Sections 1, 2, 5, and 6 of the written exam. NRC administered all sections of the exam to five SROs and one RO. NRC gave six oral exams to four SROs and two ROs.

The SRO who took only Sections 7 and 8 of the SRO written exam is the ANO reviewer for the ANO prepared sections of the examinations.

One of the SRO's was placed in accelerated training and given another written examination on June 28, 1984. This examination was satisfactory. It was regarded by NRC on July 18, 1984, and the grading was found to be appropriate. The other SRO will not renew his license.

1.0 Examination Review Meeting

A meeting was held which included the NRC examiners R. Smith, M. Nevius, M. King and ANO's E. Force and others. The meeting was held to review the exminations. The following includes the license's comments and the examiners resolutions.

1. Question 3.4
   Comment: Answer c. should be reactor building and cooling.
   Resolution: This answer is acceptable.

2. Question 3.6
   Comment: Delete last sentence of answer "B". Also used to bypass failed channel.
   Resolution: This part deleted.

3. Question 3.7
   Comment: Change answer "C" last step to state P7A-open steam supply valve from affected OTSG.
   Resolution: This answer is acceptable.

4. Question 4.2
   Comment: Use reference Procedure 1109.09 also.
   Resolution: The examiner considers this reference procedure should be used generally to exercise the control rods not to determine operability.

5. Question 4.3
   Comment: May be answered that CV-1410 cannot be opened at greater than 320 psig and will shut at 385 psig and have to be reset.
   Resolution: Review of reference ANO 1 STM-1-05 page 1 and Procedure 1104.04 page 5. The answer key as written is correct. 290 and 385 psig respectively.

6. Question 4.5
   Comment: Answer, determination of transient Xe and Sm by a computer program not by operator calculation.
   Resolution: Although these calculations are done by a computer, an operator would use the information.

7. Question 4.12
   Comment: The statement part of answer "C" go to LOCA ESAS procedure not required as part of answer.
   Resolution: This is acceptable.

8. Question 4.16 and 7.3
   Comment: Answer "C" delete "also stop HPI pumps."
   Resolution: This will be deleted.

9. Question 7.9
   Comment: by examiner: Change loop B to loop A.

10. Question 7.14 deleted by examiner.

11. Question 8.1
   Comment: May need to change question to reflect the need for answer "C".
   Resolution: Answer C will be deleted. If the question is used in the future the weight should be reduced.
   Resolution: This change will be made.

2.0 Exit Interview

Attendees

ANO

B. A. Baker, Operations Manager
S. J. McWilliams, Unit 1, Operations Superintendent
E. Force, Operations Training Manager.

USNRC

R. Smith
M. M. Nevius

EG&G

M. King

At the conclusion of the examinations, discussions were held between the ANO personnel and the NRC examiners. The unevaluated results of the oral examinations was provided to the licensee.

The following observations were discussed:

There is a weakness in calculation of heat balance problems. This resulted in not using the steam table to evaluate plant conditions.

Set points for the ICS run backs were not known.

Reasons for the ^{16}N monitors not known.

3.0 Overall Program Evaluation

Facility: ANO Unit 1
Examiner: R. Smith, M. King
Dates of Evaluation: May 1984
Areas Evaluated: XX Written XX Oral ___ Simulator

Written Examination

1. Evaluation of Facility Examination Results: N.A.
2. Evaluation of Facility Examination Administration: Satisfactory
3. Evaluation of NRC Examination Results (if given): Satisfactory
4. Evaluation of NRC-facility grading comparison: N.A.

Oral Examination

1. Overall Evaluation: Satisfactory
2. Number Observed: None Number Conducted: Six

Simulator Evaluation

1. Overall Evaluation: Not Applicable
2. Number Observed: Number Conducted:

Overall Program Evaluation

Satisfactory: XX Marginal: ___ Unsatisfactory: ___

Pass ratio for NRC-administered written examinations below 80%.

Submitted:	Forwarded:	Approved:
R. Smith 6/19/84	R. G. Cooley 9/13/84	[signature] 9/13/84
Examiner	Section Chief	Branch Chief

SENIOR REACTOR OPERATOR ANNUAL REQUALIFICATION EXAM

Course Number AA21004-003

Facility: ANO-1

Exam Number 4

Date Administered: 5-4-84

Applicant: _____
Last, First Middle

INSTRUCTIONS TO APPLICANT:

Use bottom of sheet for the answers. Write answers on one side only. If additional space is necessary, use provided paper. Points for each question are indicated in parenthesis to the left of 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 Cat. Value	Category
25	25			5. Theory of Nuclear Power Plant Operations, 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.

_____
Candidate Signature

Approved training E.D. Wentz for E.A. Force

Approved operations C.F. Baker

5.1 Xenon is a poison in the core that is of great concern when operating the reactor.

(1.0) A. What two ways is Xenon produced?

(1.0) B. What two ways is Xenon removed?

REF: ANO Reactor Theory Training Manual
OBJ: AA-21005-000, AA-51007-000, AA-61008-000
ANS:

(1.0) A. Directly from fission and decay of tellurium or iodine.

(1.0) B. Decay and burnup (neutron absorption).

5.2 (2.0)

How and why does Beff change over core life?

β_{eff}

REF: ANO Reactor Theory Manual
OBJ: 21005-000, 51007-000, 61008-000
ANS:

(1.0) Decreases over core life.

(1.0) Due to plutonium buildup which has a smaller βeff.

5.4

(1.0) a. What two isotopes are primarily responsible for the Doppler Coefficient of reactivity?

(1.0) b. What is the origin of each of these isotopes?

REF: ANO-1 Rx Theory Manual
OBJ: AA-21005-001
ANS:

(1.0) a. U-238 and Pu-240

(1.0) b. U-238 is naturally occurring. Pu-240 comes from Pu-239 + ${}_{o}N^{1}$ and not fissioning.

5.7 (3.0)

The reactor is subcritical with a K-eff of .960, with the source channels indicating 5 cps. Control rods are withdrawn and the counts increase to 60 cps. What is the new K-eff? (Show all work)

REF: ANO-1 Rx Theory Manual
OBJ: AA-21005-000
ANS: (3.0) (Partial credit for proper formula selection).

$$CR_1 (1 - K_1) = CR_2 (1 - K_2)$$

$$\frac{CR_1(1 - K_1)}{CR_2} = 1 - K_2$$

$$\frac{5 (1 - .96)}{60} = 1 - K_2$$

$$.003 = 1 - K_2$$

$$.9967 = K_2$$

4646

5.8 (3.0)

At critical condition 5×10^{-9} amps a positive 2 minute reactor period is extablished. What is Rx power after 3 minutes.

REF: ANO Reactor Theory Training Manual Chapter 14
OBJ: AA-21005-000, 51007-000, 61008-000
ANS: (3.0)

$P = Poe^{t/T}$

$P = (5 \times 10^{-9})e^{\frac{180 \text{ sec.}}{120 \text{ sec.}}}$

$P = (5 \times 10^{-1.5})$? $\cdot e^{1.5} = 4.482 = 10.651$

$P = 2.24 \times 10^{-8}$ amps

$(5 \times 10^{-9})(4.482) = 2.24 \times 10^{-8}$ amps

$(5 \times 10^{-9})(10.651) =$

5.9 True or False

(.25) a. The primary concern when fuel clad reaches 1800°F is fuel pellet melt and release of fission products. T F

(.25) b. It is most effective to use main feedwater to feed the OTSGs when initially establishing natural circulation cooling in the RCS. T F

(.25) c. It is possible to establish natural circulation cooling using only one OTSG. T F

(.25) d. Rated flow from one HPI pump is sufficient for core heat removal during HPI cooling after a trip. T F

REF: B&W MCD, Lesson 8
OBJ: AA-21008-008
ANS:

(.25) a. False
(.25) b. False
(.25) c. True
(.25) d. True — about 27 min after trip

5.16

Concerning Reactor Power Imbalance:

(.5) a. Define reactor power imbalance?

(.5) b. List one cause of reactor power imbalance.

(.5) c. Why do we limit maximum reactor power imbalance?

REF: ANO Maneuvering Ops. Manual
OBJ: AA-21005-011
ANS:

(.5) a. Reactor power imbalance is the power in the top half of the core minus the power in the bottom half of the core expressed as a percentage of rated power.

(.5) b. Factors affecting core imbalance include full length control rod control rod position, axial power shaping rod position, xenon distribution and moderator temperature axial distribution.

(.5) c. Imbalance is limited based on the more restrictive of the two thermal limits of DNBR or KW/ft. This maintains the integrity of the fuel cladding and prevents fission product release by preventing overheating of the cladding under normal operating conditions.

5.18 (2.0)

Why does a dropped rod (near center of the core) have a rod worth significantly larger than the group rod worth would imply?

REF: ANO Reactor Theory Manual
OBJ: AA-21005-000
ANS: (2.0)

The "worth" of a control rod is proportional to the neutron flux near the control rod. A single dropped control rod is not in competition for neutrons with other control rods. This increased neutron flux increases the single rod worth above that expected (implied) from the group rod worth.

5.25 (2.0)

What are the two primary factors which make nucleate boiling such an efficient heat transfer process?

REF: ANO Heat Transfer Handbook
OBJ: 21007-000, 51008-000, 61009-000
ANS:

(1.0) 1. Agitation of stagnant film layer.

(1.0) 2. Latent heat of steam bubbles is transferred to fluid.

5.28 (.5)

A centrifugal pump is operating at 1750 rpm, 45 kw power, and is pumping into a closed system at 400 gpm with a discharge head of 20 psi. IF the pump speed is increased to 2625 rpm, which of the following most accurately depicts the effect?

(circle the correct answer)

A. The power required will increase to 101 kw.
B. The flow will increase to 900 gpm.
C. The power required will increase to 68 kw.
D. The discharge head will increase to 45 psi.

REF: ANO Heat Transfer Handbook
OBJ: 21007-000, 51008-000, 61009-000
ANS: (.5)

D 44 psi
600 gpm
144 KW

5.32 (2.0)

Reactor power is reduced from 75% to 50% by borating. Control rod position does not change. Would you expect power imbalance to change in a negative or positive direction? Why?

REF: ANO Reactor Theory Manual
OBJ: 21005-000, 51007-000, 61008-000
ANS: (1.0) for how, (1.0) for why

As you reduce power, T_H which is in the top of the core decreases and adds positive reactivity there. T_C which is in the bottom of the core increases adding negative reactivity. Power in the top of the core increases relative to power in the bottom of the core. Since imbalance is power in the top minus power in the bottom, it will change in a positive direction.

5.39

For the steam-feedwater cycle (secondary system) at ANO-1, at which component do the following occur?

(.5) A. The largest drop in enthalpy.

(.5) B. The largest drop in temperature.

(.5) C. The largest decrease in energy.

REF: ANO Heat Transfer Handbook
OBJ: 21007-000, 51008-000, 61009-000
ANS: (.5 each)

A. Condenser
B. Turbine
C. Condenser

5.40 (1.5)

Brittle fracture is an event which will occur in all material. What three conditions contribute to failure by brittle fracture?

REF: ANO Reactor Theory Manual
OBJ: AA-21005-000, 51007-000, 61008-000
ANS: (.5 each)

A flaw must exist.
Sufficient stress.
Less than nil ductility transition temperature.

5.41 (1.0)

When a steam bubble is present in the reactor vessel head, pressurizer level is no longer an indication of RCS inventory. Using the pressurizer level and RCS pressure indications, how would the operator know a steam bubble exists some where besides the pressurizer?

REF: ATOG
OBJ: 21007-00, 51008-000, 61009-000
ANS: (.5 each)

Pressure ↑ with level ↓

or

Pressure ↓ with level ↑

6.4 (2)

DCP 81-1066 provided an "alternate path" for each RCP seal controlled bleed-off line. Give two reason for this change.

REF: DCP 81-1066 Training Summary
OBJ:
ANS:

(1.0) 1. Maintain controlled bleed-off during containment isolation. (Seal

(1.0) 2. Prevent high dose rates outside containment when high failed fuel conditions exist.

6.7 (2.5)

In the process of commencing a heatup an attempt to start a Reactor Coolant Pump fails. What interlocks associated with this pump could have prevented it from operating? (Assume no other RCP's operating).

List 5 of 7. (Set points not required)

REF: OP 1103.06
OBJ: AA-21002-037
ANS: Any 5 @ .5 each

1. Seal injection
2. Motor cooling (ICW) flow
3. Seal cooling (ICW) flow
4. Motor upper brg oil level
5. Oil lift press.
6. Reverse rotation (return oil flow)
7. Motor lower brg oil level.

6.10 (2.0)

List two cases when CRDM API and RPI will not be equal to each other?

REF: AA-51002-010
OBJ: AA-51002-010-10C
ANS: 2 required (1.0 each)

(1) (2) (3)

Reactor trip and when a rod is mechanically binding and bad reed switch and dropped rod.

6.13 (2.0)

During main turbine startup, the throttle valves are used to control roll up to 1700 RPM. Briefly explain why this is performed in this manner.

REF: AA-51002-013
OBJ: AA-51002-013 2-D
ANS: (2.0)

Steam admission to the HP turbine is distributed around the entire circumference, known as full arc emission, to reduce the thermal stresses to the rotor and casings of the turbine.

6.21 (0.7)

_____ Which of the following will <u>not</u> cause an asymmetric rod runback signal to be sent to ICS?

A. 70% power, a rod 9" out of group average, and the loss of group 1 out limit.

B. 95% power, rod 2 in group 7 falls in and gives both a group 7 in limit and 9" rod fault.

C. Rod 3 in group 1 falls in and sticks at 20% out. This causes a 9" rod fault and power is 50% with no loss of Group 1 out limit.

D. None of the above.

REF: AA-51002-010
OBJ: AA-51002-010-10B
ANS: (.07)

C

6.23 (1.8)

1. What is the actuation coincidence logic for ESAS?

2. According to Tech. Specs. what must be done if one ESAS Analog channel is inoperable?

REF: Tech. Spec. Table 3.5.1-1
OBJ: AA-51002-012 9B
ANS: (.9 each)

1. Two out of three
2. Trip one analog channel

6.26 (2.0)

Describe the flow path provided for collecting seal leakage from a Reactor Coolant Pump.

REF: AA-51002-001
OBJ: AA-51002-001 6A
ANS: (2.0)

Leakage goes through a leakoff measuring device to the T-111. T-111 is emptied by pumps to the quench tank.

6.30 (.5)

MCC B55 and B56 may be supplied from either load center B5 or B6. This transfer is a make before break or a break before make transfer. Circle the correct choice.

REF: AA-51002-007
OBJ: AA-51002-007-31A
ANS: (.5)

break before make

6.31 (1.5)

List the indications available on the Quench Tank.

REF: AA-51002-001
OBJ: AA-51002-001 16A
ANS: (.5 each)

Temperature
Level
Pressure

6.34 (2.0)

What should happen automatically if a CRD programmer motor stops with 3 phases to it's CRDM's energized?

REF: AA-51002-010
OBJ: AA-51002-010-13A
ANS: (2.0)

It should move toward the in direction 1 step so that only 2 phases are energized.

6.35 (3.0)

List six of the eight indications on the Dasey Panel. (Redundant indications count as one answer, i.e. A & B = 1)

REF: STM-1-70
OBJ: AA-51002-009
ANS: (.5 each)

1. OTSG A & B level
2. RCS T cold
3. Main steam pressure A & B
4. RCS pressure
5. Pressurizer level
6. Makeup tank level
7. Intermediate range power
8. Source range

6.37 (1.0)

Two of the three overspeed signals are concerned with a comparison of generated megawatts to reheat pressure. The third is sensing a speed of 103% of normal speed. What actions take place when 103% of normal speed is reached? (Two Required)

REF: AA-51002-013, Att. A, Page 7 of 7, (3)
OBJ: AA-51002-013 9-C
ANS: (1.0)

1. Governor and reheat intercept valves close.
2. Turbine shifts to operator auto and automatically sets 1800 rpm in the reference and setter displays.

Both
Reaction, steam
BTU limits

6.38 (4.0)

List 8 causes of the ICS going into track.

REF: AA-61004-003
OBJ: AA-61004-003-3
ANS: (.5 each)

Cross limits
Reactor trip
Both generator breakers open
Diamond control panel in manual
Turbine control panel not in ICS auto
Reactor/steam generator master in manual
Both feedwater loop demands in manual
Reactor demand station in manual
BTU limits

Runback.

7.4 (2.5)

Match the procedure number to its proper series title.

_____	1. OP 1612.xx	a.	Ops admin. procedures
		b.	Steam System Ops
_____	2. OP 1104.19	c.	Abnormal Ops
		d.	Electrical System Ops
_____	3. OP 1203.01	e.	Auxiliary Systems
		f.	Radiological Controls
_____	4. OP 1904.02	g.	Offsite Dose Projections
		h.	Emergency Plan Implementing
_____	5. OP 1107.01	i.	Emergency Operation

REF: ANO Procedure Index
OBJ:
ANS: (.5 each)

1. F
2. E
3. C
4. G
5. D

7.6 (1.5)

Concerning whole body radiation exposure limits at ANO for personnel with complete exposure records:

a. the basic weekly control limit is _____ mrem.

b. the administrative calendar year limit is _____ mrem.

c. the administrative quarterly limit is _____ mrem.

REF: OP 1622.011
OBJ: AA-21006
ANS: (.5 each)

A. 300 mrem
B. 5000 mrem
C. 2500 mrem

7.10 (2)

List the actions (2) required by Tech. Spec. 6.7 if a safety limit is violated. Include time limits, if applicable.

REF: T.S. 6.7
OBJ: 9.4
ANS: (1.0 each)

A. Place the unit in hot shutdown within one hour.
B. Notify the NRC.

7.11 (1.5)

List the dose equivalent I^{131} radioiodine activity allowed in RCS per T.S. 3.1.4.

REF: T.S. 3.1.4
OBJ: 9.3
ANS: (1.5)

3.5 uci/gm

7.12 (1.5)

Personnel making a Reactor Building power entry may be exempted from having neutron badges based on Reactor Power level. What are three of the four conditions which must be met to put this exemption in effect?

REF: OP 1622.009
OBJ: AA-21006
ANS: Any three @ .5 each

1. S/S and RO are aware that personnel are in the R.B. and exemption is in effect.
2. Reactor power does not exceed 10^{-7} amps.
3. Control rods in "Manual".
4. Portable neutron survey meter in use.

7.14 (2)

During a startup both Intermediate Range channels are reading approximately 5×10^{-11} amps when both Source Range channels fail low. What immediate actions are required?

REF: OP 1203.21
OBJ: AA-21003-004
ANS: (2)

Trip the reactor

7.17 (2)

When establishing a steam bubble in the pressurizer per OP 1103.05 (Pressurizer OPs), what are the indications that a bubble formation has occurred?

REF: OP 1103.05
OBJ: AA-51001-007
ANS: (2)

Approximately a three minute blow (.66) through ERV results in quench tank pressure increase of about 1 psig (.66) and the pressurizer pressure/temperature relationship (.66) exists.

7.23 (2)

The OTSG Tube Rupture section of the Emergency Operating Procedure gives an emergency cooldown rate limit.

a. What is the emergency cooldown rate in °F/hr?

b. Under what conditicns do you use this emergency limit?

REF: OP 1202.01
OBJ: AA-21003-001
ANS: (1.0 each)

A. 240°/hr
B. Leak is greater than HPI capacity.

7.27 (2)

If, during a reactor/turbine trip, the subcooling margin is lost in the RCS, all RCPs should be tripped immediately.

a. If the RCPs are not tripped immediately, what is the time limit that changes this requirement?

b. What should you do if the time limit is exceeded?

REF: OP 1202.01, Page 4
OBJ: AA-51003-001
ANS: (2)

A. 2 minutes
B. Trip one RCP each loop

7.28 (2)

Per T.S. 3.1.1.6, all RCPs and decay heat removal pumps may be de-energized for up to _____ hour(s) provided no operations are permitted that would cause dilution of the Reactor Coolant System concentration and core outlet temperature is maintained at least _____ °F below saturation.

REF: T.S. 3.1.1.6
OBJ: 9.3
ANS: (1.0 each)

A. 1
B. 10

7.29 (2)

During a power escalation at approximately 16% power the following conditions are observed:

- rapid increase in RCS temperature, pressure and pressurizer level
- rapid increase in main steam pressure
- megawatt output zero

What are your required immediate actions?

REF: OP 1203.18
OBJ: AA-21003-004
ANS: (1.0 each)

1. Verify turbine trip.
2. Reduce reactor power to within turbine bypass valve capacity.

7.30 (1)

If natural circulation is lost during a loss of subcooling margin and RCP services cannot be restored, the Emergency Operating Procedure (OP 1202.01) recommends "bumping" an RCP. How are the pump start interlocks bypassed for the pump "bump"?

REF: OP 1202.01
OBJ: AA-21003-001
ANS: (1)

Use the manual close pushbutton inside the RCP breaker cabinet (local close button).

7.31 (2)

The radiation level 1 foot from a Hot Spot is 2R/hr. What will the level be at 5 feet from the source?

REF: OP 1612.006
OBJ: AA-21006
ANS: (2)

80 mR/hr

7.32 (1)

When deborating with the reactor subcritical and the boronometer out of service the RCS boron concentration should be verified by chemical analysis at least every predicted _____ PPM change.

REF: OP 1103.04
OBJ: AA-51001-007
ANS: (1)

30 ppm

8.1 (1.5)

NRC exposure limits as stated in 10 CFR 20 include a quarterly recommended maximum of 1250 mRem. This limit may be exceeded only if three conditions or limits are maintained. List the three conditions that may allow exposures in excess of 1250 mRem per quarter.

A.

B.

C.

REF: 10 CFR 20, Sec. 20.101(b), (1), (2), & (3)
OBJ: 5.0
ANS: (.5 each)

A. May not exceed 3 rem/quarter
B. May not exceed 5(N-18)
C. Complete occupational exposure history (NRC-4)

8.4 (1)

During the progress of a site emergency, before the DEC arrives in the control room, you receive a call from a news reporter who has heard a problem exists and wants some information concerning the site emergency. Assuming you are the acting DEC at the time, and have full knowledge of the situation in progress, you should: (OP 1000.21, 6.4.1)

A. Tell him what the current situation is.
B. Tell him he will have to wait until the DEC arrives for information.
C. Tell him to call the General (Plant) Manager's office.
D. Assure him everything is alright.
E. Tell him to call the emergency response center.

REF: OP 1903
OBJ: 2.0
ANS: (1)

C or E

8.6 (1.0)

When an event occurs, such as security alert, which Shift Supervisor (Unit I or II) is responsible for responding to the event?

REF: OP 1015.11
OBJ: 4.0
ANS: (1.0)

The Shift Supervisor to whom the security alert was first reported.

8.7 (2)

Per the hold and caution card procedure (1000.27) what 4 conditions require an independent review of tagout, lineup, and installation?

REF: OP 1000.27
OBJ: 4.10
ANS: (.5 each)

1. Safety-related systems
2. Radiological system
3. Extensive tagout
4. Potentially hazardous system

   (a. > 150 psia or > 200°F)

8.8 (1.0)

When a request for a Hold Card is presented to the S/S that will result in entering an action statement of T.S., what must the S/S do prior to authorizing the Hold request? (OP 1000.27, 6.3.3)

REF: OP 1000.27, 6.3.3
OBJ: 4.10
ANS: (1.0)

Prior approval of the Operations Superintendent or Operations Manager must be obtained.

8.20 (2)

During handling of irradiated fuel, Tech. Spec. 3.8 requires certain containment building isolation requirements be in effect. List 2 of the 4 isolation requirements.

REF: T.S. 3.8.6
OBJ: 9.3
ANS: (Any 2 @ 1.0 each)

1. At least one door on the personnel hatch shall be closed.
2. At least one door on the emergency hatch shall be closed.
3. The equipment hatch shall be in place with a minimum of 4 bolts securing it.
4. Isolation valves in lines containing auto-containment isolation valves shall be operable or at least 1 shall be closed.

8.21 (1)

Tech. Spec. 3.1.3.1 states that reactor coolant temperature must be above 525°F (except for physics testing) before the reactor can be made critical. What is the bases for the 525°F?

REF: T.S. 3.1.3
OBJ: 9.3
ANS: (1)

At the beginning of core life, the moderator temperature coefficient may be slightly positive. Calculations show that above 525°F the positive moderator coefficient is acceptable.

8.26 (3)

The rod position limits versus power are based upon three (3) criteria. What are they?

REF: Unit 1 Tech. Spec.
OBJ: AA-21001-001
ANS: (1.0 each)

1. Ejected rod
2. ECCS power peaking (LOCA)
3. Shutdown margin

8.29 (.5)

What must be done when Caution card instructions conflict with requirements specified in procedures? (OP 1000.27, 4.2.2)

REF: OP 1000.27, 4.2.2
OBJ: 4.10
ANS: (.5)

Change the affected procedure.

8.35 (2.0)

In accordance with OP 1903.10, the Shift Supervisor has five responsibilities that are the same during UE, A, and SE emergency action levels. These five basic responsibilities are: (OP 1903.10, 6.2.1.A, 7.2.1.A, 8.2.1.A) (one is given, list the other four).

A. Assure the appropriate procedures are being implemented to mitigate the consequences of the unusual event, alert, site emergency.

B.

C.

D.

E.

REF:
OBJ: 6.0
ANS: (.5 each)

B. Implement EAL notifications & record
C. Monitor plant conditions to upgrade AL as necessary
D. Direct IRO until DEC arrives
E. Direct OPS personnel & unit operations

8.36 (3.0)

In Procedure 1015.01, the Shift Supervisor is given the specific authority to order power reduction or plant shutdown if continued operation of the unit will result in: (List any three of the four cases)

REF: OP 1015.01
OBJ: 1.2
ANS: (Any three @ 1.0 each)

A. Immediate equipment damage
B. Danger to station personnel
C. Violation of operating license or Tech. Spec. requirements
(Violation of LCO is also an acceptable answer to this question.)
D. unnecessary automatic trip.

8.37 (1.0)

If a temporary jumper and bypass has been installed in the instrument air system that cross connects Unit One and Unit Two, who must authorize restoration of the instrument air system to normal?

REF: OP 1000.28, Section 6.5.2
OBJ: 4.0
ANS: (1.0)

Unit I and Unit II Shift Supervisors.

8.41 (1.0)

At the beginning of your shift as Shift Supervisor, how much of the station log are you required to review?

REF: OP 1015.01
OBJ: 4.4
ANS: (1.0)

All entries back to your last shift or 7 days, whichever is shorter.

8.43 (4.0)

T.S. 3.1.6 describes the ANO-1 RCS leakage limits. Fill in the blanks below with the appropriate leakage limits.

1. Total identified leakage _____ gpm. (non-returnable)
2. Unidentified leakage _____ gpm
3. Leakage through any unisolable strength boundary _____ gpm (except OTSG tubes).
4. Returnable leakage _____ gpm.

REF: T.S. 3.1.6
OBJ: 9.0
ANS: (1.0 each)

1. 10 gpm
2. 1 gpm
3. 0 gpm
4. 30 gpm

8.44 (1)

The I-131 dose equivalent of the radioiodine activity in the secondary system shall not exceed _____ mci/gm.

REF: T.S. 3.10
OBJ: 9.3
ANS: (1.0)

0.17

REACTOR OPERATOR ANNUAL REQUALIFICATION EXAM

Course Number AA21004-003

Facility: ANO-1

Exam Number 4

Date Administered: 5-4-84

Applicant: _____
Last, First Middle

INSTRUCTIONS TO APPLICANT:

Use bottom of sheet for the answers. Write answers on one side only. If additional space is necessary, use provided paper. Points for each question are indicated in parenthesis the question. The passing grade requires at least 70% in each category and a final grad of at least 80%.

Category Value	% of Total	Applicant's Score	% of Cat. Value	Category
25	25			1. Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow
25	25			2. Plant Design Including Safety and Emergency Systems.
25	25			3. Instruments and Controls
25	25			4. Procedures-Normal, Abnormal, Emergency and Radiological Control
100	100			TOTALS

FINAL GRADE: _____ %

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

_____
Candidate Signature

Approved training E. D. Worley for E. D. Force

Approved operations A. Baker

1.2 (2.0)

How and why does Beff change over core life?

REF: ANO Reactor Theory Manual
OBJ: 21005-000, 51007-000, 61008-000
ANS:

(1.0) Decreases over core life.

(1.0) Due to plutonium buildup which has a smaller βeff.

1.5 The following pairs of terms sound similar. Explain the difference between the terms, if any.

(.5) a. Fast and prompt neutrons.

(.5) b. Slow and delayed neutrons

(.5) c. Activity and reactivity

REF: ANO Reactor Theory Manual
OBJ: AA-21005-000
ANS:

(.5) a. The term fast neutron refers to its energy level, usually considered a neutron with an enregy of > .1 MEV. Prompt neutrons that are born directly from fissions within a period of 10^{-14} sec. or less.

(.5) b. The term slow neutron refers to its energy level, usually considered a neutron with an energy of < .1 MEV. Delayed neutrons are neutrons that are not born directly from fission. They are born from the decay of fission products. Delayed may be fast.

(.5) c. Activity is a measure of the rate of decay of a material. Reactivity is a measure of how close the reactor is to a critical condition.

1.7 (3.0)

The reactor is subcritical with a K-eff of .960, with the source channels indicating 5 cps. Control rods are withdrawn and the counts increase to 60 cps. What is the new K-eff? (Show all work)

REF: ANO-1 Rx Theory Manual
OBJ: AA-21005-000
ANS: (3.0) (Partial credit for proper formula selection).

$$CR_1 (1 - K_1) = CR_2 (1 - K_2)$$

$$\frac{CR_1(1 - K_1)}{CR_2} = 1 - K_2$$

$$\frac{5 (1 - .96)}{60} = 1 - K_2$$

$$.003 = 1 - K_2$$

$$.9967 = K_2$$

1.8 (3.0)

At critical condition 5×10^{-9} amps a positive 2 minute reactor period is extablished. What is Rx power after 3 minutes.

REF: ANO Reactor Theory Training Manual Chapter 14
OBJ: AA-21005-000, 51007-000, 61008-000
ANS: (3.0)

$P = Poe^{t/T}$

$P = (5 \times 10^{-9})e^{\frac{180 \text{ sec.}}{120 \text{ sec.}}}$

$P = (5 \times 10^{-1 \cdot 5})$

$P = 2.24 \times 10^{-8}$ amps

1.10 (1.5)

If during natural circulation cooldown T_{cold} ceases to follow T_{sat} of the OTSG, what has happened?

REF: ATOG Guidelines Part II, Vol. I
OBJ: AA-21007-000, AA-51008-000, AA-51009-000
ANS: (1.5)

Natural circulation flow is lost.

1.16

Concerning Reactor Power Imbalance:

(.5) a. Define reactor power imbalance?

(.5) b. List one cause of reactor power imbalance.

(.5) c. Why do we limit maximum reactor power imbalance?

REF: ANO Maneuvering Ops. Manual
OBJ: AA-21005-011
ANS:

(.5) a. Reactor power imbalance is the power in the top half of the core minus the power in the bottom half of the core.

(.5) b. Factors affecting core imbalance include full length control rod control rod position, axial power shaping rod position, xenon distribution and moderator temperature axial distribution.

(.5) c. Imbalance is limited based on the more restrictive of the two thermal limits of DNBR or KW/ft. This maintains the integrity of the fuel cladding and prevents fission product release by preventing overheating of the cladding under normal operating conditions.

1.18 (2.0)

Why does a dropped rod (near center of the core) have a rod worth significantly larger than the group rod worth would imply?

REF: ANO Reactor Theory Manual
OBJ: AA-21005-000
ANS: (2.0)

The "worth" of a control rod is proportional to the neutron flux near the control rod. A single dropped control rod is not in competition for neutrons with other control rods. This increased neutron flux increases the single rod worth above that expected (implied) from the group rod worth.

1.23

Indicate by using a "T" for True and a "F" for False whether the following statements are true or false. (.4 each)

_____ a. It is necessary to get a level in the steam generator to have natural circulation.

_____ b. EFW is more efficient in establishing natural circulation than MFW.

_____ c. It is possible that the steam generators can remove heat when the reactor coolant is saturated.

_____ d. It is possible for parts of the reactor coolant system to be subcooled, saturated, and superheated all at the same time.

_____ e. A loss of subcooling can be caused by an overcooling transient.

REF: ATOG Guidelines, Part II, Vol. I, Chapter A
OBJ: 21007-000, 51008-000, 61009-000
ANS: (.4 each)

A. False
B. True
C. True
D. True
E. True

1.25 (2.0)

What are the two primary factors which make nucleate boiling such an efficient heat transfer process?

REF: ANO Heat Transfer Handbook
OBJ: 21007-000, 51008-000, 61009-000
ANS:

(1.0) 1. Agitation of stagnant film layer.

(1.0) 2. Latent heat of steam bubbles is transferred to liquid.

1.31 (1.5)

To meet a Tech. Spec. action statement, the reactor is taken from 100% power to a hot standby condition. What rod motion is necessary to maintain this power level over the next two hours and why? (Assume no changes are made to boron concentration).

REF: ANO Reactor Theory Manual
OBJ: 21005-000. 51007-000
ANS: (1.5)

Rods must be withdrawn to match buildup in Xe.

1.36 (3.0)

During a startup following an extended outage, the control rods (diamond) were in manual and the count rate was noted to be 240 cps. Following an estimated 2.5% ΔK/K reactivity addition by a series of rod withdrawals over a short period of time, a subsequent count rate of 480 cps was observed.

A. What was the shutdown margin prior to the addition of the 2.5% ΔK/K of reactivity?

B. If a series of uninterrupted rod withdrawals results in an addition of a similar amount of reactivity (2.5% ΔK/K), what estimate of Keff is most likely?

1) Definitely less than 1
2) About 1
3) Definitely greater than 1

REF: ANO Reactor Theory Manual
OBJ: 221005-000, 51007-000, 61008-000

ANS:

(1.5) A. 5% ΔK/K

(1.5) B. About 1

1.38

The steam in the OTSGs is superheated and the ICS monitors 4 parameters to establish BTU limits to use for control to maintain this condition.

(1.0) A. What is superheat?

(1.0) B. What 4 parameters are input to BTU limits to maintain superheat?

REF: ANO Heat Transfer Handbook
OBJ: 21007-000, 51008-000, 61009-000
ANS: (1.0 each)

A. Superheat - the increase in temperature of steam above the saturation temperature for that pressure.

B. 1. RCS T_{hot}
2. RCS flow
3. OTSG pressure
4. Temperature of feedwater

2.4 (2.1)

The new P7A turbine driver installed by DCP 82-1050 has a control oil system for controlling speed and a throttle valve that trips on over speed. How is this valve "reset" after an over speed trip?

REF: DCP 82-1050 Training Summary
OBJ:

ANS:

(.7) 1. Close throttle valve handwheel.
(.7) 2. Reset latch (linkage).
(.7) 3. Open throttle valve.

2.5 (1.4)

All switchyard breakers, with the exception of the generator output breakers, are normally controlled by the Pine Bluff dispatcher. List two other locations where switchyard breakers may be controlled from.

REF: AA-51002-007
OBJ: AA-51002-007-7A
ANS:

(.7) The quindar panel, (.7) switchyard control panel.

2.12 (1.0)

OP 1202.01, Actions to correct overcooling, step 2 states: "If RCS temperature drops below 500°F, stop the fourth RC pump." Why is this necessary?

REF: OP 1202.01
OBJ: AA-21003-005
ANS: (1.0)

OP 1202.01, Page 16
Hydraulic lifting of fuel assemblies.

2.16 (3.5)

Describe the series of events that take place in the High Pressure Injection and M/U and Purification System upon an ES Channel 1 and 2 actuation signal. (valve numbers are not necessary)

REF: AA-51002-004
OBJ: AA-51002-004 4.8A
ANS: (.5 each)

Isol. valves in letdown line close.
" " " RCP bleedoff line to MU tank (T4) close.
" " " for normal makeup line close.
" " " for HPI pumps recrc to MU tank (T4) close.
" " " from BWST to outlet header open.
" " " HPI lines open.
Standby ES makeup pump starts.

2.20 (1.5)

What are 3 alternate sources of air to the IA system?

REF: 1203.24, Loss of Instrument Air
OBJ: AA-51002-031. 11A, 18C
ANS: (.5 each)

Unit I service air.
Unit II cross connect.
Breathing air
Pallet air compressor from service air.

2.22 (2.0)

DCP 82-1074 made modifications that cause the DH cooler outlet valves to fail open on an ES signal.

a. How is this accomplished?

b. How is this signal "reset" if the operator wants to throttle the valve after the ES signal has cleared?

REF: DCP 82-1074 Training Summary
OBJ:
ANS: (1.0 each)

a. Solenoid valve will block air supply and vent to atmosphere.

b. Take LPI block valve hand-switch to "open/reset".

2.25 (1.5)

List the indications available on the Quench Tank.

REF: AA-51002-001
OBJ: AA-51002-001 16A
ANS:

(.5) Temperature
(.5) Level
(.5) Pressure

2.29 (2.2)

Give the following information concerning the internal vent valves:

A. Number
B. Location
C. Function

REF: AA-51002-002
OBJ: AA-51002-002-12A
ANS:

(.6) A. 8
(.6) B. In the core support shield
(1.0) C. They prevent a pressure imbalance which might interfere with core cooling following a core inlet pipe rupture.

2.32 (2.0)

During main turbine startup, the throttle valves are used to control roll up to 1700 RPM. Briefly explain why this is performed in this manner.

REF: AA-51002-013
OBJ: AA-51002-013-2D
ANS: (2.0)

Steam admission to the HP turbine is distributed around the entire circumference, known as full arc emission, to reduce the thermal stresses to the rotor and casings of the turbine.

2.35 (1.3)

Why are clamping contactors needed for transferring the power supplies to control rod drive mechanisms?

REF: AA-51002-010
OBJ: AA-51002-010-16A
ANS: (1.3)

Transfer relays cannot take voltage mismatches between two power supplies. Clamping contactors are built to take any voltage mismatch and equalize voltages before transfer relays are operated.

2.36 (1.4)

List two conditions when turbine header pressure is controlled by atmospheric dump valves.

REF: AA-61004-003
OBJ: AA-61004-003-5
ANS: (.7 each)

1. When the selector switch is in atmospheric position.
2. On low vacuum.

2.41 (1.6)

List two reasons why the fuel rods are initially pressurized with helium.

REF: STM-2-01, Pages 17 & 18
OBJ: AA-21002-002
ANS:

(.8) a. Preclude clad collapse during the design life of the fuel.

(.8) b. Improve thermal conductivity of the pellet to clad gap within the fuel rod.

2.42 (1.5)

DCP 81-1066 provided an alternate path for each RCP seal controlled bleed-off line.

A. Where does this "alternate path" lead to?

B. With the hand switch in "Auto" what will cause the solenoid valves in these "alternate path" lines to open?

REF: DCP 81-1066 Training Summary
OBJ:
ANS:

A. Quench tank. (.5)

B. CV-1274 (combined seal return valve) closed (.5) or respective inside isolation valve (individual seal return valve) closed. (.5)

2.43 (2.0)

List 2 ways that the physical construction of a control rod assembly and an axial power shaping rod assembly will be different.

REF: AA-51002-002
OBJ: AA-51002-002-1B
ANS: Two of the three, 1.0 each

1. The female couplings of the APSRA and CRA have slight dimensional differences.
2. APSR have only a lower poison section of 36" instead of a full 134".
3. Regular CRA has both an upper and lower end cap. In an APSRA, the poison section is sealed by both an internal plug and an end plug. The section of tubing above the poison is vented so it is always filled with borated water.

3.2 (.5)

What is the actuation coincidence logic for SLBIC?

REF: M-404
OBJ: AA-51002-024-1B
ANS: (.5)

Two out of four.

3.5 (2.0)

What should happen automatically if a CRDM programmer motor stops with 3 phases to it's CRDM's energized?

REF: AA-51002-010
OBJ: AA-51002-010-13A
ANS: (2.0)

It should move toward the in direction 1 step so that only 2 phases are energized.

3.6 (3)

List six of the eight indications on the Dasey Panel. (Redundant indications count as one answer, i.e. A & B = 1.)

REF: STM-1-70
OBJ: AA-51002-009
ANS: (.5 each)

1. OTSG A & B level
2. RCS T cold
3. Main steam pressure A & B
4. RCS pressure
5. Pressurizer level
6. Makeup tank level
7. Intermediate range power
8. Source range.

3.9 (1.0)

What components are controlled by the RPS cabinet D trip output relay?

REF: AA-51002-010
OBJ: AA-51002-010-12A
ANS: (1.0)

DC hold breakers.
F contactor

3.12 (2.0)

List the 4 signals that will auto start 1DG2 EDG.

REF: STM-1-31
OBJ: AA-51002-016-15A
ANS:

(.5) ES Ch. 1
(.5) ES Ch. 2
(.5) UV A-4
(.5) UV B-6

3.17 (3.0)

List 6 of 10 parameters which will trip a main feedwater pump.

REF: AA-51002-032, OP 1203.12 K09
OBJ: AA-51002-32-23A
ANS: Any six @ .5 each

1. Excessive forward or reverse thrust.
2. Rotor vibration.
3. Turbine overspeed.
4. Low bearing oil pressure.
5. High pump discharge pressure.
6. Manual trip (from control room)
7. Manual trip (local)
8. Low pump suction pressure.
9. Low pump flow (if not bypassed)
10. Low vacuum (exhaust pressure).

3.29 (1.0)

Tech Spec 3.5 requires a one decade overlap between the source and intermediate range channels during a startup. If both intermediate range channels are reading 5×10^{-10} amps, what reading on the startup channels would correspond to "exactly" one decade of overlap?

REF: STM-1-7, LP AA-51002-014, Rev.1
OBJ: AA-51002-014, 14.2B
ANS: (1.0)

5×10^{5} cps

3.30 (2.5)

In the process of commencing a heatup an attempt to start a Reactor Coolant Pump fails. What interlocks associated with this pump could have prevented it from operating? (Assume no other RCP's operating.)

List 5 of 7. (Set points not required)

REF: OP 1103.06
OBJ: AA-21002-037
ANS: (any five @ .5 each)

1. Seal injection
2. Motor cooling (ICW) flow
3. Seal cooling (ICW) flow
4. Motor upper brg oil level
5. Oil lift press.
6. Reverse rotation (return oil flow)
7. Motor lower brg oil level

3.31 (2.0)

The feedwater lo-load block valves open and close automatically. List the conditions required to accomplish this. (Both open and close).

REF: AA-51002-032, OP 1105.04
OBJ: AA-51002-032-26B
ANS: (2.0)

The lo-load block valves open when the associated startup feed valve is > 80% open. The lo-load block valves close when the associated startup feedvalve is < 50% open.

3.32 (2.0)

Briefly describe the interlock which prevents tieing the B5 and B6 buses together under a normal electrical lineup.

REF: AA-51002-007, Figure 7.33, E-106
OBJ: AA-51002-007-30B
ANS: (2.0)

B513 and B613, B5 and B6 tie breakers may both be closed only if one of the feeder breakers, ACB 52-512 or ACB 52-612, B5 and B6 respectively, are open.

3.36 (2.0)

The EHC system has two modes of operation based on the position of the generator output breakers. List the two modes and indicate whether breakers are open or closed to achieve this mode.

REF: AA-51002-013, Page 12
OBJ: AA-51002-013 9-D
ANS: (1.0 each)

Breakers open - speed control
Breakers closed - load control

3.37 (3.0)

In determining RCP seal leakage:

a. What system is normally used and how does it perform its function?

b. What is the backup method?

REF: OP 1103.07
OBJ: AA-51001-007
ANS:

(1.0) A. T-111 (Seal Leakage Collection Tank)

(1.0) By timing the period between the pump shutting off at the low level and starting the pump at the high level. (volume/time = gpm)

(1.0) B. Drinking bird counters (for individual pump and seal leakage).

3.39 (1.0)

Describe how the operator can select which two loop flow instruments will input to ICS for RCS flow?

REF: AA-51002-009
OBJ: AA-51002-009-9.7A
ANS: (1.0)

By connecting one of the two input cables located in the bottom of "A" RPS cabinet.

4.1 (1.5)

When performing a natural circulation cooldown how is RCS pressure reduced?

REF: OP 1203.13
OBJ: AA-21003-004
ANS:

Turn off pressurizer heaters (.75) and surge in and out of the pressurizer (.75) (cycle level).

4.2 (2)

After recognizing a loss of coolant transient what indications would alert the operator to a possible leak in the pressurizer steam space?

REF: 1202.01
OBJ: AA-21003-001
ANS: (2.0)

Increasing pressurizer lever <u>without</u> an increase in RCS temperature, or a change in RCS pressure.

4.4 (2)

Match the condition in the left column with the proper power level from the right hand column according to the Plant Startup Procedure (OP 1102.02) and Approach to Criticality Procedure (OP 1102.08).

1. _____	The power level at which critical data is taken.	a. 2×10^{-6} amps
2. _____	When the power range channels should come on scale.	b. 10%
3. _____	Minimum power level for placing the Diamond panel in "Auto".	c. 10^{-8} amps
4. _____	Final condition in the plant startup procedure OP 1102.02.	d. 20%
		e. 5×10^{-9} amps
		f. 5%

REF: OP 1102.02, 1102.08
OBJ: AA-51001-007 (7.2)
ANS: (.5 each)

1. C
2. A
3. F
4. D

4.5 (2.5)

Match the procedure number to its proper series title.

_____	1. OP 1612.xx	a.	Ops admin. procedures
_____	2. OP 1104.17	b.	Steam System Ops
_____	3. OP 1203.01	c.	Abnormal Ops
_____	4. OP 1904.02	d.	Electrical System Ops
_____	5. OP 1107.01	e.	Auxiliary Systems
		f.	Radiological Controls
		g.	Offsite Dose Projections
		h.	Emergency Place Implementing
		i.	Emergency Operation

REF: ANO Procedure Index
OBJ:
ANS: (.5 each)

1. F
2. E
3. C
4. G
5. D

4.7 (1.5)

Concerning whole body radiation exposure limits at ANO for personnel with complete exposure records:

a. the basic weekly control limit is _____ mrem.

b. the administrative calendar year limit is _____ mrem.

c. the administrative quarterly limit is _____ mrem.

REF: OP 1622.011
OBJ: AA-21006
ANS:

A. 300 mrem
B. 5000 mrem
C. 2500 mrem

4.10 (2)

With the plant at 60% power and one RCP off due to a breaker problem the reverse rotation alarm for the idle pump comes in. The operator observes that the zero speed indication light is off and that there is a slight decrease in RCS flow. What are the required immediate actions?

REF: OP 1203.31
OBJ: AA-21003-004
ANS:

(1.0) 1. Manually trip reactor
(1.0) 2. Stop running RCPs

4.12 (1)

Why must RC pump seal flow be maintained when filling the RC system?

REF: OP 1103.02
OBJ: AA-51001-007
ANS: (1.0)

To prevent out-leakage from carrying dirt into the seals.

4.16 (2)

After maintenance on a pump, a survey in a room in the Reactor Auxiliary building shows a general area radiation level of 30 mR/hr with two Hot Spots of 150 mR/hr and a contamination level of 50,000 dpm/100 cm^2 Beta-Gamma and 2,000 dpm/100 cm^2 Alpha.

a. Should the area be posted as a Radiation Area or High Radiation Area?

b. What is the minimum type clothing required, type A, type B, or type C?

REF: 1622.003
OBJ: AA-21006
ANS:

(1.0) A. Radiation Area
(1.0) B. Type B

4.18 (.5)

What is the appropriate action if the frisker alarm sounds while you are frisking your feet upon exiting a Radiologically Controlled Area?

a. shift frisker to higher scale and continue
b. remove shoes and exit area
c. notify Health Physics
d. move to area with lower background

REF: OP 1612.002
OBJ: AA-21006
ANS: (.5)

C

4.30 (2)

Per T.S. 3.1.1.6, all RCPs and decay heat removal pumps may be de-energized for up to _____ hour(s) provided no operations are permitted that would cause dilution of the Reactor Coolant System concentration and core outlet temperature is maintained at least _____ °F below saturation.

REF: T.S. 3.1.1.6
OBJ: 9.3
ANS: (1.0 each)

A. 1
B. 10

4.34 (1)

When deborating with the reactor subcritical and the boronometer out of service the RCS boron concentration should be verified by chemical analysis at least every predicted _____ PPM change.

REF: OP 1103.04
OBJ: AA-51001-007
ANS: (1)

30 ppm

4.36 (1)

During a heatup from cold shutdown, you may not begin to deborate until:

a. The RCS temperature reaches 525°F.
b. The reactor is made critical.
c. The fourth RC pump is started.
d. One group of safety rods is withdrawn.
e. All four safety groups are withdrawn.

REF: OP 1103.04
OBJ: AA-51001-007
ANS: (1)

D

4.38 (2)

In addition to immediate notification of Health Physics and the appropriate Shift Supervisor, what four actions are required of an individual identifying a radioactive spill?

REF: OP 1612.009
OBJ: AA-21006
ANS: (.5 each)

Stop the spill.
Warn others.
Isolate the area.
Minimize personnel exposure.

4.39 (1.5)

Make up tank recommended maximum pressure and minimum level relationships are provided in OP 1101.01. What is the purpose of these limits?

REF: OP 1102.12
OBJ: AA-51001-007
ANS: (1.5)

Prevent gas entrainment in the makeup pump suction.

4.40 (1.5)

The follow-up actions of the Emergency Operating Procedure (OP 1201.01) defines "adequate subcooling margin" as greater than 50° subcooling. Why do the immediate actions require only 30° subcooling?

REF: 1201.01
OBJ: AA-21003-001
ANS: (1.5)

The subcooling margin is less than 50° during normal power operation.

4.35 (1)

Why does the plant Startup Procedure require a four hour waiting period after RCP seal bleed-off is established?

REF: OP 1102.02
OBJ: AA-51001-007 (7.2)
ANS: (1)

Vents RCP seal cavities.

EQUATION SHEET

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_o + at$

$NPSH = P_{in} - P_{sat}$

$\dot{m} \propto \rho AV$

$\Delta E = 931\ \Delta m$

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

$Q = UA\Delta h$

$Pwr = W_f \Delta h$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

$P = (I\omega V)/(3 \times 10^{10})$

$\Sigma = \sigma N$

$\dot{m} = \rho AV$

$v = s/t$

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

$a = (V_f - V_o)/t$

$w = \theta/t$

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

$A = \lambda N \qquad A = A_o e^{-\lambda t}$

$\lambda = \ell n 2/t_{1/2} = 0.693/t_{1/2}$

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

$I = I_o e^{-Ex}$

$I = I_o e^{-\mu x}$

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

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

$M = 1/(1 - K_{eff}) = CR_i/CR_o$

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

Table 1 - MISCELLANEOUS

			10 CFR 20 Appendix B			
			Table I		Table II	
Material	Half Life	Gamma Energy MEV	Col. 1 Air uc/ml	Col. 2 Water uc/ml	Col. 1 Air uc/ml	Col. 2 Water uc/ml
A-41	1.83 h	1.3	2×10^{-6}	-	4×10^{-8}	-
Ce-141	290 D	2.2	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
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-87	2.8 h	2.9	1×10^{-6}	-	2×10^{-8}	-
La-140	4.0 d	2.5	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
Ni-65	2.5 d	0.93	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
Pu-239	2.4×10^{4} y	0.013	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-9}
St -90	28 y	--	3×10^{-10}	4×10^{-6}	3×10^{-11}	3×10^{-7}
Xe-135	9.2 h	0.25	4×10^{-6}	-	1×10^{-7}	-

Table 2. NEUTRON FLUX DOSE EQUIVALENTS

Neutron Energy (MEV)	Number of Neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm^2)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm^2/sec)
Thermal	970×10^6	670
0.02	400×10^6	280
0.5	43×10^6	30
10.0	24×10^6	17

Table 3. LINEAR ABSORPTION COEFFICIENTS IN CM^{-1} UNITS

Energy (MEV)	Water	Concrete	Fe	Pb
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