August 4, 2015

Dr. Paul M. Whaley, Associate Director
Nuclear Engineering Teaching Lab
University of Texas at Austin
NETL-PRC Bldg 159
10100 Burnet Rd
Austin, TX 78758

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-15-02, UNIVERSITY OF TEXAS AT AUSTIN

Dear Dr. Whaley:

During the week of July 6, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of Texas at Austin TRIGA reactor facility. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed with you, and Mr. Michael Krause at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations*, Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mrs. Paulette Torres at (301) 415-5656, or via email at Paulette.Torres@nrc.gov.

Sincerely,
/RA/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-602

Enclosures:
1. Examination Report No. 50-602/OL-15-02
2. Facility Comments on the Written Examination with NRC Resolution
3. Written Examination with Facility Comments Incorporated

cc: Mr. Michael Krause, Reactor Supervisor
cc: w/o enclosures: See next page

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DISTRIBUTION: w/ enclosures:
PUBLIC PROB r/f RidsNrrDprProb Resource RidsNrrDprPrlb Resource

ADAMS Accession No: ML15208A274 **NRR 079**

OFFICE	NRR/DPR/PROB	NRR/DPR/PROB	NRR/DPR/PROB
NAME	PTorres	NParker	KHsueh
DATE	07/23/2015	07/28/2015	08/04/2015

OFFICIAL RECORD COPY

University of Texas Docket No. 50-602

cc:

Governor's Budget and
Planning Office
P.O. Box 12428
Austin, TX 78711

Bureau of Radiation Control
State of Texas
1100 West 49th Street
Austin, TX 78756

Dr. William Powers, Jr., President
University of Texas at Austin
Nuclear Engineering Teaching Laboratory
Austin, TX 78758

Mr. Roger Mulder
Office of the Governor
P.O. Box 12428
Austin, TX 78711

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

Dr. Steven Biegalski, Director
University of Texas
Pickle Research Campus, Bldg 159
10100 Burnet Road
Austin, TX 78758

U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-602/OL-15-02

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: University of Texas at Austin TRIGA Reactor

EXAMINATION DATES: July 6, 2015

SUBMITTED BY: ***/RA/*** 07/23/15
Mrs. Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of July 6, 2015, the NRC administered an operator licensing examination to one Senior Reactor Operator Instant (SROI) license candidate. The candidate passed all applicable portions of the examination.

REPORT DETAILS

1. Examiner: Mrs. Paulette Torres, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	N/A	1/0	1/0
Operating Tests	N/A	1/0	1/0
Overall	N/A	1/0	1/0

3. Exit Meeting:

Mrs. Paulette Torres, Chief Examiner, NRC
Dr. Paul Whaley, Associate Director
Mr. Michael Krause, Manager, Reactor Supervisor

The facility licensee agreed to email their comments on the written examination that were incorporated in the examination report (see Enclosure 2).

FACILITY COMMENTS ON THE WRITTEN EXAMINATION WITH NRC RESOLUTION

QUESTION B.05 [1.0 point]
Per procedure HP-006, a restricted area is defined as an area _____.

a. Where radioactive materials are used and/or stored.

b. In which airborne radioactive materials exist in concentrations in excess of DAC.

c. Where radiation exposure rates would result in a dose equivalent in excess of 5 mrem in 1 hour at 30 centimeters from the radiation source.

d. Where radiation exposure rates would result in a dose equivalent in excess of 100 mrem in 1 hour at 30 centimeters from the radiation source.

Answer: a
REF: HP-006, Section II. A., pg. 4 of 8

Facility comments: HP 006 clearly states the answer you expected based on the answer key however situations or radiation environments created by those answers listed in answers b, c & d would also clearly be situations encountered in areas where radioactive materials are used or stored so technically all answers might be alleged as correct especially when one also considers the statement in HP006 and the corresponding 10CFR20 definition stating “Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.” Since clearly Airborne radiation areas, and areas exposing individuals to dose equivalents in excess of 5 or 100 mrem in 1 hour at 30 cm as listed in answers b, c, & d would also be controlled as restricted areas, a single best answer to this question from multiple correct answers may not be obvious .

Facility Recommendation: Consider revising this question to have a single explicit answer and not multiple answers which are also appropriate.

NRC Resolution: The NRC agrees with the facility comment and question B.05 will be deleted from the examination.

QUESTION B.06 [1.0 point]
Per procedure MAIN-1, which ONE of the following is a Manual Mode condition?

a. Transient rod air off requirement.

b. Transient rod function as a normal rod.

c. “Fire” button for transient rod applies air to drive only if drive is down.

d. Rod withdrawal prohibit signal prevents operation of rods if minimum neutron source level is not present.

Answer: b
REF: MAIN-1, Section II. B. D.2, 2.4, pg. 5 of 40

Facility comments: Exam Answer key lists b as correct answer and references procedure page 5 of 40. If you look on the same referenced page it also lists answers c and d explicitly in addition to answer b for the Manual Mode therefore answers b, c, or d are all correct.

Facility Recommendation: Consider revising this question to have a single explicit answer and not multiple correct answers in the selection choices.

NRC Resolution: The NRC agrees with the facility comment and question B.06 will be deleted from the examination.

QUESTION B.14 [1.0 point]
Which ONE is a condition of a Notification of Unusual Event?

a. Criticality alarm

b. Fire in building

c. Natural disaster

d. Measure dose rate

Answer: d
REF: PLAN-E, procedures\plan\planE-a1.doc

Facility comments: Answers provided do not include sufficient qualifying conditions listed in right column of emergency classification document referenced, as written answers b, c or d could all be a Notification of Unusual Event (NUE) depending on qualifying conditions which were not provided in the question as stated instead of the single answer specified in the answer key.

Facility
Recommendation: Reword answers to include NUE qualifying conditions such as: for NUE there must be a sustained Fire in building damaging reactor systems or threatening radioactive materials vs the Non Rx Specific level with the qualifier of lasting 15 minutes or less; For a NUE the Natural disaster (phenomenon) qualifier states damaging building, utilities, or reactor systems vs the Non Rx Specific which indicates the disaster is only nearby, threatening or impending; For the Measures dose rates a NUE must qualify with <=20 mrem/hr at operations boundary from unknown radiation source.

NRC Resolution: The NRC agrees with the facility comments and question B.14 will be deleted from the examination.

QUESTION C.05 [1.0 point]
Experiments with the _____ include irradiations of small samples and the exposure of materials to a collimated beam of neutrons or gamma rays.

a. Central Thimble

b. Rotary Specimen Rack

c. Pneumatic Specimen Tube

d. Beam Tubes

Answer: a
REF: SAR 8.1.1, pg. 8-1

Facility comments: For MARK II TRIGA'S such as ours with experimental beam line configurations such as columated thermal or cold beam ports both answers a and d are correct as the question is written. MARK 1 TRIGA'S do not have horizontal beam ports so the central thimble for them is the only correct answer. At the time the SAR was written the eventual configuration of beam line experiments at Texas was not yet decided and so their explicit use later in the facility life was possibly not mentioned in this section as an alternative to the center tube which is really only a beam if compressed air is applied to the center tube thus blowing the water from it to a elevation just above the top grid plate…..

Facility
Recommendation: Revise question or accept both answers a and d as correct.

NRC Resolution: The NRC will accept both "a" and "d" as correct answers for question C.05.

QUESTION C.07 [1.0 point]
Which ONE is true about the HVAC Operation Q Mode?

a. No air recycle.

b. Room air change controlled by Stack Exhaust velocity.

c. Room air pressure controls Exhaust Fan speed.

d. Dampers shut, fans off.

Answer: c
REF: SAR Figure 7-3, pg. 7-6

Facility comments: This question was taken from a note on a diagram in the SAR which was made prior to final tuning / balancing and control features of the HVAC system being made and does not uniquely represent the integrated function single function which is used.

Facility Recommendation: Remove this question as the provided answer does not represent current facility design, pressure is maintained by a combination of variable fan speed control and variable supply and exhaust damper position control…..

NRC Resolution: The NRC understands that the information/reference (SAR Figure 7-3) provided does not represent current facility design. Question C.07 will be deleted from the examination.

QUESTION C.14 [1.0 point]
Which ONE of the following responses correspond to the Watchdog circuit failure input signal?

a. Indication on the CRT monitor only

b. Indication on the CRT monitor and scram

c. Indication on the CRT monitor and interlock

d. Indication on the CRT monitor, scram and interlock

Answer: b
REF: SAR 6.1.5, pg. 6-13 and TS 3.2.3 (f), pg. 15

Facility comments: The suggested answer to this question is b which is correct unless the individual taking the exam is an instrumentation and controls developer who recognizes that the subsequent watchdog scram must be acknowledged prior to being able to restart the reactor and this acknowledgement is from an I&C standpoint a interlock hence the I&C background person would accurately chose answer c instead of answer b as listed in the answer key. This question is not deemed to be an issue for non I&C individuals but for those who are examined they will

accurately from their understanding of the system logic provide answer c…

Facility Recommendation: Revise question wording or answers so as not to penalize answers from I&C experts vs general operator candidates.

NRC Resolution: This question is based on the TS 3.2.3 minimum safety channels of operation where the watchdog trip is a scram. In addition, the watchdog trip is not listed in TS Table 3.2.2 as a minimum safety interlock. The correct answer for question C.14 is “b”.

QUESTION C.17 [1.0 point]

Which ONE of the following beam ports is classified as a Tangential beam port?

a. Beam Port 1

b. Beam Port 2

c. Beam Port 3

d. Beam Port 5

Answer: b
REF: SAR Table 7-2, pg. 7-26

Facility comments: The answer to this question is a problem of semantics in that the specified answer, BP-2 is indeed a tangential beam port, however one can also see that beam ports 1 and beam port 5 are indeed tangential beam ports relative to the core and are just aligned to be in line to become a through port, however in terms of their orientation and radiation beam characteristics these are just as much a tangential beam port as beam port 2. This semantic terminology issue was not addressed specifically in the SAR and leads to a situation where really answers a, b & d are all correct answers to the asked question.

Facility Recommendation: Revise question wording to exclude through port or accept multiple stated answers.

NRC Resolution: The NRC understands the facility comments. Question C.17 will be deleted from the examination.

U. S. NUCLEAR REGULATORY COMMISSION
NON-POWER REACTOR LICENSE EXAMINATION

FACILITY: University of Texas at Austin

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 07/07/2015

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
17.00 ~~20.00~~	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
18.00 ~~20.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
55.00 ~~60.00~~		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

(***** END OF CATEGORY A *****)

B. NORMAL/EMERG PROCEDURES & RAD CON

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

~~B05 a b c d ___~~ deleted per facility comment

~~B06 a b c d ___~~ deleted per facility comment

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

~~B14 a b c d ___~~ deleted per facility comment

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

(***** END OF CATEGORY B *****)

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

~~C07 a b c d ___~~ deleted per facility comment

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

~~C17 a b c d ___~~ deleted per facility comment

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

6. Mark your Answers on the Answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and Answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your Answer is on your Answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

EQUATION SHEET

$$\dot{Q} = \dot{m} c_P \Delta T = \dot{m} \Delta H = UA\Delta T$$

$$P_{\max} = \frac{(\beta - \rho)^2}{(2\alpha \ell)}$$

$$\lambda_{eff} = 0.1 \text{sec}^{-1}$$

$$P = P_0 \; e^{t/\mathrm{T}}$$

$$SCR = \frac{S}{-\rho} \cong \frac{S}{1 - K_{eff}}$$

$$\ell^* = 1 \times 10^{-4} \text{ sec}$$

$$SUR = 26.06 \left[\frac{\lambda_{eff} \rho + \dot{\rho}}{\overline{\beta} - \rho} \right]$$

$$CR_1 (1 - K_{eff_1}) = CR_2 (1 - K_{eff_2})$$

$$CR_1 (-\rho_1) = CR_2 (-\rho_2)$$

$$P = \frac{\beta(1 - \rho)}{\beta - \rho} P_0$$

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_2}{CR_1}$$

$$P = P_0 \; 10^{SUR(t)}$$

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

$$SDM = \frac{1 - K_{eff}}{K_{eff}}$$

$$\mathrm{T} = \frac{\ell^*}{\rho - \overline{\beta}}$$

$$\mathrm{T} = \frac{\ell^*}{\rho} + \left[\frac{\overline{\beta} - \rho}{\lambda_{eff} \rho + \dot{\rho}} \right]$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

$$\rho = \frac{K_{eff} - 1}{K_{eff}}$$

$$DR = DR_0 \, e^{-\lambda t}$$

$$DR_1 \, d_1^{\,2} = DR_2 d_2^{\,2}$$

$$DR = \frac{6 Ci \, E(n)}{R^2}$$

$$\frac{(\rho_2 - \beta)^2}{Peak_2} = \frac{(\rho_1 - \beta)^2}{Peak_1}$$

DR – Rem, Ci – curies, E – Mev, R – feet

1 Curie = 3.7 x 10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

QUESTION A.01 [1.0 point]
Which one of the following processes results in an increase in the atomic number?

a. Alpha emission

b. Beta emission

c. Gamma emission

d. Positron emission

QUESTION A.02 [1.0 point]
You've just increased power at a research reactor. As a result fuel temperature increased from 100°C to 120°C. For this reactor the fuel temperature coefficient (α_{tf}) is -0.01% k/k/°C, and the average rod worth for the regulating rod is 0.05% k/k/inch. How far and in what direction must you move the regulating rod to compensate? (Assume all other factors which could affect reactivity remain unchanged.)

a. 2 inches inward

b. 2 inches outward

c. 4 inches inward

d. 4 inches outward

QUESTION A.03 [1.0 point]
The term "microscopic cross section" is defined as:

a. The average distance travelled by a neutron between interactions in a material.

b. An indication of energy loss per collision.

c. The probability of neutron interaction per centimeter of travel in a material.

d. The effective cross sectional area of a single nucleus presented to an oncoming neutron.

QUESTION A.04 [1.0 point]
If Beta for U-235 is 0.0065 and Beta effective is approximately 0.007, how does this difference affect reactor period in the reactor period equation, $T=(\beta-p)/\lambda p$? This difference produces a _____ for a given addition of reactivity with Beta effective.

a. Longer period

b. Shorter period

c. Stable period

d. Decay constant (λ) increase

QUESTION A.05 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.925. Which ONE of the following is the MINIMUM reactivity ($\Delta K/K$) that must be added to produce prompt criticality? Given $\beta_{eff}=0.007$

a. 0.012

b. 0.047

c. 0.054

d. 0.088

QUESTION A.06 [1.0 point]
Which one of the following correctly describes the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

a. DRW is the slope of the IRW curve at a given location.

b. DRW is the area under the IRW curve at a given location.

c. DRW is the square root of the IRW curve at a given location.

d. There is no relationship between DRW and IRW.

QUESTION A.07 [1.0 point]
Xenon-135 is formed directly as a fission product and by decay of _____.

a. Iodine-135

b. Tellurium-135

c. Cesium -135

d. Barium-135

QUESTION A.08 [1.0 point]
What is the effect of delayed neutrons on the neutron flux decay following a scram from full power?

a. Adds negative reactivity creating a greater shutdown margin.

b. Adds positive reactivity due to the fuel temperature decrease following the scram.

c. Limits the final rate at which power decreases to a -80 second period.

d. Decreases the mean neutron lifetime.

QUESTION A.09 [1.0 point]
During a fuel loading of the NETL core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward unity.

b. Decreases toward unity.

c. Increases toward infinity.

d. Decreases toward zero.

QUESTION A.10 [1.0 point]
Which ONE of the following factors in the "six factor" formula is the MOST affected by the control rods?

a. Fast fission factor

b. Reproduction factor

c. Thermal utilization factor

d. Fast non leakage probability

QUESTION A.11 [1.0 point]
The first pulse has a reactivity worth of $1.20 which results in a peak power of 200 MW. If the second pulse has a peak power of 5000 MW, the corresponding reactivity worth is:
Given: =0.0070

a. $1.50

b. $1.75

c. $2.00

d. $2.50

QUESTION A.12 [1.0 point]
Which ONE of the following statements best describes on how moderator temperature affects the core operating characteristics?

a. Increase in moderator temperature will decrease the neutron multiplication factor due to the resonance escape probability decrease.

b. Increase in moderator temperature will decrease the neutron multiplication factor due to the reproduction factor increase.

c. Increase in moderator temperature will increase the neutron multiplication factor due to the resonance escape probability increase.

d. Increase in moderator temperature will increase the neutron multiplication factor due to the fast non leakage probability decrease.

QUESTION A.13 [1.0 point]
An experiment worth 13 cents of negative reactivity is added to a reactor that is initially critical at a power of 1000 Watts. Assuming there is no automatic system response, operator action, or any other reactivity effects, calculate the power level 2 minutes after the reactivity insertion. Given: β_{eff}= 0.0070 and λ_{eff}= 0.05 sec-1.

a. 2 Watts

b. 406 Watts

c. 500 Watts

d. 750 Watts

QUESTION A.14 [1.0 point]
Which ONE of the reactions below is an example of a photoneutron source?

a. $_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

b. $_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

c. $_{1}H^{2} + \gamma \rightarrow {}_{1}H^{1} + n$

d. $_{4}Be^{9} + \alpha \rightarrow {}_{6}C^{12} + n$

QUESTION A.15 [1.0 point]
Thermal neutrons are:

a. Neutrons possessing thermal energy rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. Neutrons produced a significant time (on the order of seconds) after its initiating fission took place.

d. Neutrons whose energies have been reduced to < 1 eV values.

QUESTION A.16 [1.0 point]
Which ONE of the following describes a "prompt critical" reactor condition?

a. T = ℓ^*/ρ

b. $\rho = 0$

c. T = ∞

d. T = - 80 sec

QUESTION A.17 [1.0 point]
Which ONE of the following is the definition of the Fast Fission Factor?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission.

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission.

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission.

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission.

QUESTION A.18 [1.0 point]
The effective delayed neutron fraction ($\overline{\beta}_{eff}$) is defined as:

a. The fraction of neutrons at thermal energies which were born delayed.

b. The fraction of all fission neutrons that are born as delayed neutrons.

c. The weighted average of the total delayed neutron fractions of the individual types of fuel.

d. Relates the average delayed neutron fraction to the effective delayed neutron fraction.

QUESTION A.19 [1.0 point]
Which ONE of the following explains the response of a SUBCRITICAL reactor to equal insertions of positive reactivity as the reactor approaches criticality? Each insertion causes a:

a. SMALLER increase in the neutron flux resulting in a LONGER time to stabilize.

b. LARGER increase in the neutron flux resulting in a LONGER time to stabilize.

c. SMALLER increase in the neutron flux resulting in a SHORTER time to stabilize.

d. LARGER increase in the neutron flux resulting in a SHORTER time to stabilize.

QUESTION A.20 [1.0 point]
Which ONE of the following describes the difference between a moderator and reflector?

a. A reflector increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

b. A reflector increases the neutron production factor and a moderator increases the fast fission factor.

c. A reflector decreases the thermal utilization factor and a moderator increases the fast fission factor.

d. A reflector decreases the neutron production factor and a moderator decreases the fast non-leakage factor.

********** End of Section A **********

QUESTION B.01 [1.0 point]
Per procedure ADMN-6, who shall authorize the approval of a special experiment? The signature of the Supervisory operator and _____.

a. Class A operator

b. Class B operator

c. Class C experimenter

d. Designated Nuclear Reactor Committee member

QUESTION B.02 [1.0 point]
Per procedure HP-002, a gamma radiation survey shall be performed weekly in _____.

a. All restricted areas

b. All non-restricted areas

c. The reactor room

d. The exterior of walls and roof of the NETL

QUESTION B.03 [1.0 point]
In support of ALARA, the NETL public dose limit is set to _____ per year.

a. 0.1 rem

b. 5.0 rem

c. 50 mrem

d. 1000 mrem

QUESTION B.04 [1.0 point]
NETL Technical Specifications defines Reactor Shutdown as:

a. All rods are fully inserted and the reactor console is secured.

b. The reactor is subcritical by at least $1.00 in the reference core condition with the reactivity of all installed experiments included.

c. The reactor console is secured and no work is in progress involving core fuel, core structure, installed controlled rods or control rod drives.

d. The reactor is subcritical by at least $1.00 of reactivity and the reactor console is secure.

~~**QUESTION B.05 [1.0 point]** deleted per facility comment~~
~~Per procedure HP-006, a restricted area is defined as an area _____.~~

~~a. Where radioactive materials are used and/or stored.~~

~~b. In which airborne radioactive materials exist in concentrations in excess of DAC.~~

~~c. Where radiation exposure rates would result in a dose equivalent in excess of 5 mrem in 1 hour at 30 centimeters from the radiation source.~~

~~d. Where radiation exposure rates would result in a dose equivalent in excess of 100 mrem in 1 hour at 30 centimeters from the radiation source.~~

~~**QUESTION B.06 [1.0 point]** deleted per facility comment~~
~~Per procedure MAIN-1, which ONE of the following is a Manual Mode condition?~~

~~e. Transient rod air off requirement.~~

~~f. Transient rod function as a normal rod.~~

~~g. "Fire" button for transient rod applies air to drive only if drive is down.~~

~~h. Rod withdrawal prohibit signal prevents operation of rods if minimum neutron source level is not present.~~

QUESTION B.07 [1.0 point]
Which ONE is true for the Area Radiation Monitors?

a. Particulate collection

b. Alarm set point shall be a measurement value equal to or less than 100 mr/hr.

c. The monitor shall sample reactor room air within 5 meters of the pool at the pool access level.

d. If not operable, operating the reactor with the auxiliary air purge system shall be limited to a period of ten days.

QUESTION B.08 [1.0 point]
"The maximum excess reactivity shall be 4.9% ΔK/K." This is an example of a:

a. Safety Limit.

b. Limiting Safety System Setting.

c. Limiting Condition of Operation.

d. Surveillance Requirement.

QUESTION B.09 [1.0 point]
Which ONE of the following detectors is a gas monitor that provides monitoring of the air being exhausted from the reactor room during reactor operation?

a. Eberline RMS II

b. Ludlum 333-2

c. PRM Ar-1000

d. Victoreen 450B

QUESTION B.10 [1.0 point]
Per OPER-1, which ONE of the following irradiation facilities records shall be recorded in the Radiation Work Permit (RWP) as required by the RWP?

a. Beam Port Exposure (BP)

b. Central Thimble (CT)

c. Three Element Cutout Irradiator (3L)

d. Pneumatic Transfer System (PNT)

QUESTION B.11 [1.0 point]
Which ONE of the following is the Technical Specification limit for the pool water conductivity?

a. 5.00 μmhos/cm

b. 5.25 μmhos/cm

c. 6.50 μmhos/cm

d. 7.00 μmhos/cm

QUESTION B.12 [1.0 point]
Which ONE of the following abnormal conditions corresponds to an abnormal pool high level?

a. Beam port leak

b. Heat exchanger secondary to primary leak

c. Pool liner leak

d. Purification pump leak

QUESTION B.13 [1.0 point]
An individual receives a Total Effective Dose Equivalent of 25 rem or greater due to a release of radioactive material. This is an example of _____ to the Bureau of Radiation Control (BRC) and the Nuclear Regulatory Commission (USNRC).

a. Immediate notification

b. 24 hour notification

c. 30 day notification

d. No notification to the BRC and the USNRC needed

~~**QUESTION B.14 [1.0 point]**~~
~~Which ONE is a condition of a Notification of Unusual Event?~~

~~a. Criticality alarm~~

~~b. Fire in building~~

~~c. Natural disaster~~

~~d. Measured dose rate~~

QUESTION B.15 [1.0 point]
The Reactor Thermal Power Calibration depends on the pool constant that is a function of the pool water _____.

a. Conductivity

b. Level

c. Volume

d. pH

QUESTION B.16 [1.0 point]
SURV-7 references a _____ yearly pulse to provide data to verify that the peak power, energy release and fuel temperatures are within acceptable limits.

a. $1.00

b. $2.00

c. $3.00

d. $4.00

QUESTION B.17 [1.0 point]
10 CFR 20 defines the "Derived Air Concentration (DAC)" as:

a. The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI.

b. The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

c. The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

QUESTION B.18 [1.0 point]
If the Nitrogen-16 diffuser pump was not in use, what type of dose would increase?

a. Alpha

b. Beta

c. Gamma

d. Neutron

QUESTION B.19 [1.0 point]
Per Technical Specifications, which ONE of the following safety channels its safety system function is a scram on demand?

a. Pulse Power

b. Magnet Current

c. Manual Scram Console Button

d. Watchdog Trip Microprocessor Scan Rate

QUESTION B.20 [1.0 point]
You are currently the licensed operator at the control of the reactor. Which ONE of the following violates 10 CFR Part 55.53 “Conditions of licenses”?

a. Last license medical examination was 26 months ago

b. Last requalification operating test was 11 months ago

c. Last quarter you were the licensed operator for 6 hours

d. Last requalification written examination was 13 months ago

********** End of Section B **********

QUESTION C.01 [1.0 point]
The start-up source used in the NETL reactor is a _____ source.

a. Am-Li

b. Am-Be

c. Sb-Be

d. Pu-Be

QUESTION C.02 [1.0 point]
In order to prevent radiation streaming through the gap between the beam tube and shielding plug, _____ is incorporated into each beam port.

a. A step.

b. An inner shield plug and an outer shield plug.

c. A lead-filled shutter and a lead-lined door.

d. A removable cover plate.

QUESTION C.03 [1.0 point]
There are small holes at various positions in the top grid plate. These holes are provided in order to:

a. Ensure unimpeded coolant flow through the core.

b. Ensure proper alignment of the top and bottom grid plates.

c. Permit insertion of wires or foils into the core to obtain flux data.

d. Allow thermocouple leads from instrumented fuel elements to pass out of the core.

QUESTION C.04 [1.0 point]
Which ONE of the following statements correctly describes the ELECTROMAGNET in the rod drive mechanism for the regulating rod?

a. Engages a rack attached to the magnet draw tube.

b. Is attached to the lower end of the draw tube and engages an iron armature.

c. Drives a pinion gear and a 10-turn potentiometer via a chain and pulley gear mechanism.

d. Is used to provide rod position information.

QUESTION C.05 [1.0 point]
Experiments with the _____ include irradiations of small samples and the exposure of materials to a collimated beam of neutrons or gamma rays.

a. Central Thimble

b. Rotary Specimen Rack

c. Pneumatic Specimen Tube

d. Beam Tubes

QUESTION C.06 [1.0 point]
Which ONE of the following detectors is used to detect the amount Ar-41 released to the environment?

a. NONE, Ar-41 has too short a half-life to require environmental monitoring.

b. Area Radiation Monitors

c. Particulate Air Monitor

d. Gaseous Air Monitor

~~**QUESTION C.07 [1.0 point]** deleted per facility comment~~
~~Which ONE is true about the HVAC Operation Q Mode?~~

~~e. No air recycle.~~

~~f. Room air change controlled by Stack Exhaust velocity.~~

~~g. Room air pressure controls Exhaust Fan speed.~~

~~h. Dampers shut, fans off.~~

QUESTION C.08 [1.0 point]
Two sections of graphite are inserted in the stainless steel clad, one above and one below the fuel element to:

a. Absorb thermal neutrons.

b. Absorb fission product gases.

c. Increase fast neutron flux.

d. Serve as reflectors for the core.

QUESTION C.09 [1.0 point]
What kind of detector feeds the NP-1000?

a. Fission chamber

b. Ion chamber

c. Geiger-Mueller

d. Scintillation

QUESTION C.10 [1.0 point]
If the reactor operator activates the NM-1000 Rod Withdrawal Prohibit signal, “RWP1”, by removing the neutron source, the reactor operator:

a. Will scram the reactor.

b. Can move control rods up, but not down.

c. Can move control rods down, but not up.

d. Cannot move control rods either up or down.

QUESTION C.11 [1.0 point]
Which ONE of the following pressure settings in the heat exchanger is designed to prevent leakage of primary pool coolant into the secondary chilled water system?

a. The pressure of the shell side outlet is higher than the pressure of the tube side inlet.

b. The pressure of the shell side outlet is lower than the pressure of the tube side inlet.

c. The pressure of the shell side outlet is equal to the pressure of the tube side inlet.

d. Setting up the pressure difference cannot prevent the contamination.

QUESTION C.12 [1.0 point]
The gas supply for the Pneumatic system is _____.

a. Compressed Air

b. CO_2

c. Helium

d. Oxygen

QUESTION C.13 [1.0 point]
Which ONE of the following correctly describes the characteristic of the standard UT TRIGA fuel elements used at the NETL reactor?

a. The uranium content is 8.5% enriched to a nominal 19.7% Uranium -235 and a zirconium-hydride atom ratio of nominal 1.4 hydrogen to zirconium.

b. The uranium content is 8.5% enriched to a nominal 20% Uranium -235 and a zirconium-hydride atom ratio of nominal 1.4 hydrogen to zirconium.

c. The uranium content is 8.5% enriched to a nominal 19.7% Uranium -235 and a zirconium-hydride atom ratio of nominal 1.6 hydrogen to zirconium.

d. The uranium content is 8.5% enriched to a nominal 20% Uranium -235 and a zirconium-hydride atom ratio of nominal 1.6 hydrogen to zirconium.

QUESTION C.14 [1.0 point]
Which ONE of the following responses correspond to the Watchdog circuit failure input signal?

a. Indication on the CRT monitor only

b. Indication on the CRT monitor and scram

c. Indication on the CRT monitor and interlock

d. Indication on the CRT monitor, scram and interlock

QUESTION C.15 [1.0 point]
Which ONE of the following is not a direct function accomplished by the purification system?

a. Corrosion control.

b. Radioactivity control.

c. Maintain optical clarity of pool water.

d. Dissipate heat generated in the reactor.

QUESTION C.16 [1.0 point]
Which ONE of the following modes of operation the reactor scrams on Peak Neutron Flux or energy?

a. MANUAL MODE

b. AUTO MODE

c. PULSE MODE

d. SQUARE WAVE MODE

~~**QUESTION C.17 [1.0 point]**~~ deleted per facility comment
~~Which ONE of the following beam ports is classified as a Tangential beam port?~~

~~a. Beam Port 1~~

~~b. Beam Port 2~~

~~c. Beam Port 3~~

~~d. Beam Port 5~~

QUESTION C.18 [1.0 point]
Per Technical Specification 3.3.3, a set point of the Continuous Air Monitor (Particulate) will initiate the isolation signal for the air ventilation system. If the Continuous Air Monitor (Particulate) is not available, the _____.

a. Area Radiation Monitor (Pool Level) will provide an automatic signal to isolate the ventilation system.

b. Area Radiation Monitor (Pool Level) will be used to manually isolate the ventilation system.

c. Continuous Air Monitor (Argon-41) will provide an automatic signal to isolate the ventilation system.

d. Continuous Air Monitor (Argon-41) is available to provide information for manual shutdown of the HVAC.

QUESTION C.19 [1.0 point]
Which ONE of the following is a control rod interlock?

a. Above reactor power of 1 kW, the transient rod cannot be operated in the PULSE mode.

b. Only one standard rod at a time can be withdrawn in the PULSE mode.

c. Control rods cannot be withdrawn unless the count rate is greater than 1.2 CPS in the SQUARE WAVE mode.

d. Two control rods cannot be withdrawn at the same time above 1 kW in the MANUAL mode.

QUESTION C.20 [1.0 point]
Which ONE of the following is the purpose of the Safety Plate?

a. Retain any debris resulting from an accident which has directly involved the fuel elements.

b. Preclude the possibility of control rods falling out of the core.

c. Provides accurate lateral positioning for the core components.

d. Provides a “well” for the rotary specimen rack.

********** End of Section C **********
********** End of the Exam **********

A.01
Answer: b
REF: DOE Fundamentals Handbook, Vol. 1, Module 1, pg. 24

A.02
Answer: d
REF: DOE Fundamentals Handbook, Vol. 2, Module 3, pg. 26
-0.0001k/k/°C * 20°C = -0.002k/k. To compensate must add +0.002k/k.
(0.002k/k) / (0.0005%k/k/inch) = 4 inches in the positive (outward) direction.

A.03
Answer: d
REF: Burns, Section 2.5, pg. 2-36 to 2-47

A.04
Answer: a
REF: Burns, Example 3.4.3, pg. 3-32, 3-33
In the reactor period equation, T=(β-p)/λp, if Beta effective is used instead of Beta for U-235, the term (βeff-p) is larger giving a longer period.

A.05
Answer: d
REF: From k=0.925 to criticality (k=1), ρ = (k-1)/k = -0.081 Δk/k or 0.081 Δk/k needs to be added to reach criticality. From criticality to JUST prompt, ρ = β_{eff} is required, so minimum reactivity = 0.081+0.007= 0.088.

A.06
Answer: a
REF: DOE Fundamentals Handbook, Vol. 2, Module 3, pg. 51-52

A.07
Answer: a
REF: Burns, Section 8.2, pg. 8-3 and Figure 8.1, pg. 8-6

A.08
Answer: c
REF: Burns, Section 4.10.12, pg. 4-32 to 4-33

A.09
Answer: d
REF: Burns, Section 5.4, pg. 5-14 to 5-17

A.10
Answer: c
REF: Burns, Section 3.2.2, pg. 3-18 to 3-20

A.11
Answer: c
REF: ρ =ρ($)*β; ρ1=$1.20*0.007= 0.0084 Δk/k
(Peak1 /Peak2)*(0.0084-.007)2 = (ρ1- β) 2
0.000049=(ρ1- β) 2 ;0.007= ρ1- β or ρ1=0.007+0.007= 0.014 Δk/k or $2.0 or
Peak2 (ρ$1-$1) 2 = Peak1*(ρ$2-$1)2
(ρ$1-$1.0) 2 = (5000/200)*($1.20-$1.0)2
ρ$1-$1.0 = $1.0, ρ$1 = $2.0

A.12
Answer: a
REF: Burns, Section 3.2.2, pg. 3-18 to 3-20

A.13
Answer: c
REF: Given: β_{eff}= 0.0070 and λ_{eff}= 0.05 sec^{-1}
Then converting negative $0.13 to Δk/k→ -0.13*0.0070 = -0.00091
(0.007-(-0.00091))/((0.05)*(-0.00091)) = -173.4 sec
$P = P_0 e^{t/\tau}$ = 1000 e $^{(120/-173)}$ = 499.7 Watts or 500 Watts

A.14
Answer: c
REF: Burns, Section 5.2.2, pg. 5-3

A.15
Answer: d
REF: DOE Fundamentals Handbook, Vol. 1, Module 2, pg. 23

A.16
Answer: a
REF: Burns, Table 4.3, pg. 4-17

A.17
Answer: c
REF: DOE Fundamentals Handbook, Vol. 2, Module 3, pg. 3

A.18
Answer: a
REF: DOE Fundamentals Handbook, Vol. 2, Module 4, pg. 12

A.19
Answer: b
REF: DOE Fundamentals Handbook, Vol. 2, Module 4, pg. 1-9

A.20
Answer: a
REF: Burns, Section 2.8.9, pg. 2-63

B.01
Answer: d
REF: ADMN-6, Section II. A. 3.1, pg. 3 of 4

B.02
Answer: a
REF: HP-002, Section II. A. 3. a, pg. 4 of 8

B.03
Answer: c
REF: HP-003, Section II. F., pg. 5 of 7

B.04
Answer: b
REF: TS 1.19, pg. 9

~~**B.05**~~
~~Answer: a~~ deleted per facility comment
~~REF: HP-006, Section II. A., pg. 4 of 8~~

~~**B.06**~~
~~Answer: b~~ deleted per facility comment
~~REF: MAIN-1, Section II. B. D.2, 2.4, pg. 5 of 40~~

B.07
Answer: b
REF: TS 3.3.3.c, pg. 17

B.08
Answer: c
REF: TS 3.1.1, pg. 13

B.09
Answer: c
REF: MAIN-4, Section I. B., pg. 2 of 9

B.10
Answer: a
REF: OPER-1, oper1-a12.doc

B.11
Answer: a
REF: TS 3.3.1.c, pg. 16

B.12
Answer: b
REF: OPER-4, Abnormal Conditions A. 2. b., pg. 1 of 6

B.13
Answer: a
REF: PLAN-0, Section II. D., pg. 7 of 7

~~**B.14**~~
~~Answer: d deleted per facility comment~~
~~REF: PLAN-E, procedures\plan\planE-a1.doc~~

B.15
Answer: c
REF: SURV-2, Section I. B., pg. 2 of 6

B.16
Answer: c
REF: SURV-7, Section II, pg. 2 of 3

B.17
Answer: a
REF: 10 CFR 20.1003

B.18
Answer: c
REF: SAR 7.4.1.1, pg. 7-15 to 7-19
Nitrogen-16 is produced by (n,p) reaction of Oxygen-16 (due to neutron interactions with oxygen-16 in the primary coolant and neutron-activated dust particulates). The hazard is due to high energy gamma (6.13 MeV and 7.11 MeV). N-16 is produced within the coolant passing through the core of the reactor. To decrease the N-16 gas that becomes airborne, water above the core may be over stirred using diffuser pumps. This increases the transport time of the short-lived (t1/2 = 7.13 sec) N-16 from the core to the surface of the pool and allows additional decay time.

B.19
Answer: c
REF: TS 3.2.3, pg. 15

B.20
Answer: a
REF: 10 CFR Part 55.53
- 55.53(i) – the licensee shall have a biennial medical examination.
- 55.53(h), 55.59(c) – annual operating tests
- 55.53(e) – the licensee shall actively perform the functions of a licensed operator for a minimum of 4 hours per calendar quarter.
- 55.53(h), 55.59(c)(1) – ”The requalification program must be conducted for a continuous period not to exceed 2 years”

C.01
Answer: b
REF: SAR 4.4.6, pg. 4-64

C.02
Answer: a
REF: SAR 8.1.4.3, pg. 8-4

C.03
Answer: c
REF: SAR 4.4.3, pg. 4-57

C.04
Answer: b
REF: SAR 4.4.8.2, pg. 4-67

C.05
Answer: a and d correct per facility comments
REF: SAR 8.1.1, pg. 8-1

C.06
Answer: d
REF: SAR 9.5, pg. 9-10

~~**C.07**~~ deleted per facility comment
~~Answer: c~~
~~REF: SAR Figure 7-3, pg. 7-6~~

C.08
Answer: d
REF: SAR 4.4.5, pg. 4-61

C.09
Answer: b
REF: SAR Figure 6-1, pg. 6-3

C.10
Answer: c
REF: MAIN-1, Section 3.3 (8)(a), pg. 19
SAR 6.1.4, pg. 6-12 “There is no interlock inhibiting the “DOWN” direction of the control rods except in the case of the regulating rod while in the AUTO mode”.

C.11
Answer: a
REF: SAR 5.2.1, pg. 5-9 and table 5-1

C.12
Answer: b
REF: OPER-1-a7.doc, pg. 1 of 1

C.13
Answer: c
REF: TS 5.3.1, pg. 25

C.14
Answer: b
REF: SAR 6.1.5, pg. 6-13 and TS 3.2.3 (f), pg. 15

C.15
Answer: d
REF: SAR 5, pg. 5-1 & SAR 5.1.4, pg. 5-6

C.16
Answer: c
REF: SAR 6.1.2, pg. 6-6
SAR 6.1.5 (e), pg. 6-13
SAR 6.1.6, pg. 6-14 & 6-16

~~**C.17** deleted per facility comment~~
~~Answer: b~~
~~REF: SAR Table 7-2, pg. 7-26~~

C.18
Answer: d
REF: TS 3.3.3 (a) & (b), pg. 17

C.19
Answer: a
REF: TS 3.2.2, pg. 14

C.20
Answer: b
REF: SAR 4.4.4, pg. 4-59