November 24, 2014

Dr. Jay F. Kunze, Reactor Administrator
Idaho State University
833 South Eighth Street
Pocatello, ID 83209

SUBJECT: EXAMINATION REPORT NO. 50-284/OL-15-01, IDAHO STATE UNIVERSITY

Dear Dr. Kunze:

During the week of October 27, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Idaho State University AGN reactor. 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 at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Section 2.390 of Title 10 of the *Code of Federal Regulations*, 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 the examination, please contact Phillip T. Young at (301) 415-4094 or via email at Phillip.Young@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. 50-284

Enclosures:
1. Examination Report No. 50-284/OL-15-01
2. Written Examination

cc: Adam Mallicoat, Reactor Supervisor, Idaho State University

cc: w/o enclosures: See next page

Dr. Jay F. Kunze, Reactor Administrator November 24, 2014
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ADAMS ACCESSION #: ML14308A540 **NRR-074**

OFFICE	DPR/PRTB/CE	DPR/IOLB/OLA	DPR/PROB/BC
NAME	PYoung	CRevelle	KHsueh
DATE	11/06/2014	11/07/2014	11/24/2014

OFFICIAL RECORD COPY

cc:

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

EXAMINATION REPORT NO: 50-284/OL-15-01

FACILITY: Idaho State University

FACILITY DOCKET NO.: 50-284

FACILITY LICENSE NO.: R-110

SUBMITTED BY: **/RA/** **11/03/2014**
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of October 27, 2014, the NRC administered operator licensing examinations to two Reactor Operator candidates. All candidates passed the examinations and will be issued a license to operate the Idaho State University reactor.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	0/0	2/0
Operating Tests	2/0	0/0	2/0
Overall	2/0	0/0	2/0

3. Exit Meeting:

Adam Mallicoat, Idaho State University
Phillip T. Young, NRC, Examiner

The NRC Examiner thanked the facility for their support in the administration of the examinations and noted how well the candidates were prepared.

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

FACILITY: Idaho State University AGN-201M Reactor

REACTOR TYPE: AGN-201M

DATE ADMINISTERED: 10/28/2014

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
18.00	33.3			A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
15.00	33.3			B. Normal and Emergency Operating Procedures and Radiological Controls
13.00	33.3			C. Facility and Radiation Monitoring Systems
46.00	100.0			TOTALS

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

_____
Candidate's Signature

Enclosure 2

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.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

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

$$\lambda_{eff} = 0.1\ seconds^{-1}$$

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

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

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

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

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}}$$

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

$$P = P_0\, e^{\frac{t}{T}}$$

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

$$DR = \frac{6CiE(n)}{R^2}$$

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

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

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

1 Curie = 3.7×10^{10} dis/sec

1 Horsepower = 2.54×10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

ºF = 9/5 °C + 32

ºC = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

Section A - Reactor Theory, Thermodynamics and Facility Operating Characteristics

Question A.001 [1.0 point] {1.0}

With the reactor on a constant positive period, which ONE of the following power changes will take the SHORTEST time?

a. 5% power - from 1% to 6% power.

b. 10% power - from 10% to 20% power.

c. 15% power - from 20% to 35% power.

d. 20% power - from 40% to 60% power.

Answer: A.01 d.
Reference: $P = P_{oet}/T$

Question A.002 [1.0 point] {2.0}

What is the normal AGN-201 neutron startup source for a startup when the reactor has only been shut down for a few hours?

a. Gamma produced from Po results in a neutron from Li-10

b. Spontaneous fission from U-238

c. Beta produced from fuel results in a neutron from C-12

d. Alpha produced from Ra results in a neutron from Be-9

Answer: A.02 d.
Reference: Safety Analysis Report, dated November 23, 1995, pg. 48.

Question A.003 [1.0 point] {3.0}

The reactor is initially subcritical with a K_{eff} of 0.94. Two (2) safety rods worth a total of 2.4% delta k/k are inserted into the core. Which ONE of the following is the new K_{eff}?

a. 0.950

b. 0.954

c. 0.962

d. 0.971

Answer: A.03 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 336.
Initial reactivity = (0.94 - 1)/0.94 = -0.0638 delta k/k; + .024 delta k/k added by safety rods
Final reactivity = -.0638 + .024= -0.0398 delta k/k; K_{eff} = 1/(1 - [-0.0398])= 0.9617

Question A.004 [1.0 point] {4.0}

A reactor is operating at criticality. Instantaneously, all of the delayed neutrons are suddenly removed from the reactor. The K_{eff} of the reactor in this state would be approximately:

a. 1.007

b. 0.993

c. 0.000

d. 1.000

Answer: A.04 b.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 340.

Question A.005 [1.0 point] {5.0}

Which ONE of the following is the direct source of delayed neutrons in the fission process?

a. Decay of the fission product daughters

b. Spontaneous fissioning of the fission products

c. Absorption by ^{238}U

d. Fissioning of ^{235}U

Answer: A.05 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 87.

Question A.006 [1.0 point] {6.0}

Which condition below describes a critical reactor?

a. $K = 1; \Delta K/K = 1$

b. $K = 1; \Delta K/K = 0$

c. $K = 0; \Delta K/K = 1$

d. $K = 0; \Delta K/K = 0$

Answer: A.06 b.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition.

Question A.007 [1.0 point] {7.0}

A reactor with a negative fuel temperature reactivity coefficient is critical at full power. A control rod is removed and the power decreases to a lower steady-state value. The reactivity of the reactor at the lower power level is zero because:

a. the positive reactivity due to the fuel temperature decrease balances the negative reactivity due to the control rod removal.

b. the negative reactivity due to the fuel temperature decrease balances the negative reactivity due to the control rod removal.

c. the positive reactivity due to the fuel temperature increase balances the negative reactivity due to the control rod removal.

d. the negative reactivity due to the fuel temperature increase balances the negative reactivity due to the control rod removal.

Answer: A.07 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 365.

Question A.008 [1.0 point, 0.25 each] {8.0}

Match each term in column A with the correct definition in column B.

	Column A	Column B
a.	Prompt Neutron	1. a neutron in equilibrium with its surroundings.
b.	Fast Neutron	2. a neutron born directly from fission.
c.	Thermal Neutron	3. a neutron born due to decay of a fission product.
d.	Delayed Neutron	4. a neutron at an energy level greater than its surroundings.

Answer: A.08 a. = 2; b. = 4; c. = 1 d. = 3
Reference: Standard NRC Question

Question A.009 [1.0 point] {9.0}
Given the following data, which ONE of the following is the closest to the half-life of the material?

TIME	ACTIVITY
0	2400 cps
10 min.	1757 cps
20 min.	1286 cps
30 min.	941 cps
60 min.	369 cps

a. 11 minutes
b. 22 minutes
c. 44 minutes
d. 51 minutes

Answer: A.09 b.
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, Enabling Objective 2.5. $A = A_0 e^{-\lambda T}$ (22 minutes).

Question A.010 [1.0 point] {10.0}
Which of the following does NOT affect the Effective Multiplication Factor (K_{eff})?

a. The moderator-to-fuel ratio.
b. The physical dimensions of the core.
c. The strength of the installed neutron source.
d. The current time in core life.

Answer: A.10 c.
REF:

Question A.011 [1.0 point] {11.0}
The neutron interaction in the reactor core that is MOST efficient in thermalizing fast neutrons occurs with the:

a. Hydrogen atoms in the polyethylene molecules
b. Carbon atoms in the polyethylene molecules
c. Uranium atoms in the fuel
d. Oxygen atoms in the fuel

Answer: A.11 a.
REF:

Section A - Reactor Theory, Thermodynamics and Facility Operating Characteristics

Question A.012 [1.0 point] {12.0}
The total amount of reactivity added by inserting or withdrawing a control rod from a reference height to any other rod height is called?

a. differential rod worth
b. shutdown reactivity
c. integral rod worth
d. reference reactivity

Answer: A.12 a.
REF:

Question A.013 [1.0 point] {13.0}
For most materials the neutron microscopic cross-section for absorption F_a generally …

a. increases as neutron energy increases
b. decreases as neutron energy increases
c. increases as target nucleus mass increases
d. decreases as target nucleus mass increases

Answer: A.13 b.
REF:

Question A.014 [1.0 point] {14.0}
Reactor power is rising on a 30 second period. Approximately how long will it take for power to double?

a. 35 seconds
b. 50 seconds
c. 70 seconds
d. 100 seconds

Answer: A.14 c.
REF: P = POEt/T
—> ln(2) = time ÷ 100 seconds –> time = ln (2) x 100 sec. 0.693 x 100 ≈ 0.7 x 100 ≈ 70 sec.

Question A.015 [1.0 point] {15.0}
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an ***INCREASE*** in the number of neutrons during the cycle.

a. Thermal utilization factor (f).
b. Resonance escape probability (p).
c. Thermal non-leakage probability ($£_{th}$).
d. Reproduction factor (η).

Answer: A.15 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

Question A.016 [1.0 point] {16.0}
The effective neutron multiplication factor, K_{eff}, is defined as:

a. absorption/(production + leakage)
b. (production + leakage)/absorption
c. (absorption + leakage)/production
d. production/(absorption + leakage)

Answer: A.16 d.
Reference: DOE Fundamentals Handbook, Module 3, page 8.

Question A.017 [1.0 point] {17.0}
Given a mother isotope of $(_{35}Br^{87})^{*}$, identify each of the daughter isotopes as a result of α, β^+, β^-, γ, or n, decay.

a. $_{33}As^{83}$
b. $_{34}Se^{87}$
c. $_{35}Br^{86}$
d. $_{35}Br^{87}$
e. $_{36}Kr^{87}$

Answer: A.17 a. = α; b. = β^+; c. = n; d. = γ; e. = β^-
Reference: STD NRC question.

Question A.018 [1.0 point] {18.0}

The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

Answer: A.18 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

END OF SECTION A

Section B. - Normal & Emerg Operating Procedures & Radiological Controls

Question B.001 [1.0 point] {1.0}
A radiation survey of an area reveals a general radiation reading of 1 mRem/hr. However, a small section of pipe (point source) reads 10 mRem/hr at one (1) meter. Which ONE of the following is the posting requirement for the area, in accordance with 10 CFR Part 20?

a. "CAUTION - RADIATION AREA"
b. "CAUTION - HIGH RADIATION AREA"
c. "CAUTION - RADIOACTIVE MATERIAL"
d. "CAUTION - AIRBORNE RADIOACTIVITY AREA"

Answer: B.01 b.
Reference: 10 CFR 20.1003
For a point source, 10 mrem/hr at 100 cm (1 meter) = 111.1 mrem/hr at 30 cm.

Question B.002 [1.0 point] {2.0}
As a licensed reactor operator at the AGN-201 facility, who is allowed to operate the controls of the reactor under your direction?

a. A local college newspaper reporter who wants to write a story on the safety of nuclear reactors.
b. A new student participating in a nuclear engineering laboratory course.
c. A health physicist who is trying to gain a certified health physicist (CHP) license.
d. An NRC inspector trying to make sure that all set points of the reactor are the same as those in the technical specifications.

Answer: B.02 b.
Reference: General Operating Rules, Revision 4, dated September 19, 1994. and 10 CFR 55.13

Question B.003 [1.0 point] {3.0}
A licensed reactor operator (RO) and a certified observer (CO) are in the reactor room, with a Senior Reactor Operator (SRO) on call while the reactor is operating. The RO is required to leave due to a family emergency. Identify whether each of the following scenarios is ALLOWED (**ALL**) or NOT ALLOWED (**NOT ALL**) per technical specifications?

a. The CO takes over control of the reactor and the SRO remains on call.
b. The SRO takes over operation of the reactor, the CO may leave the control room
c. The SRO takes over operation of the reactor, and the CO remains in the control room.
d. The SRO comes to the control room and directs the actions of the CO who operates the reactor.

Answer: B.03 a. = NOT ALL; b. = NOT ALL; c. = ALL; d. = ALL
Reference: Technical Specification 6.1.11

Question B.004 [1.0 point] {4.0}
Which ONE of the following defines a CHANNEL CHECK?

a. Connection of output devices for the purpose of measuring the response to a process variable.

b. Adjustment such that the output responds within standards of accuracy and range to known inputs.

c. Introduction of a signal into a channel to verify it is operable.

d. A qualitative verification of acceptable performance by observation of channel behavior.

Answer: B.04 d.
Reference: Technical Specification 1.4

Question B.005 [1.0 point] {5.0}
What type of radiation detector is used for surveying contaminated areas?

a. Ionization chamber

b. Proportional counter

c. Geiger-Mueller tube

d. Scintillation detector

Answer: B.05 c.
Reference: General Radiation Protection Practice.

Question B.006 [1.0 point] {6.0}
Which ONE of the following items will ALLOW a reactor operator to continue to operate the reactor? (Assume today is the three year anniversary of receiving your RO license)

a. Last physical examination was 3 years ago.

b. Written exam administered by Reactor Supervisor was 10 months ago.

c. 2 hours on the console last quarter performing the functions of a licensed operator.

d. Performing one startup over the past year.

Answer: B.06 b.
Reference: Reactor Operator Requalification Program for the Idaho State University Reactor. And 10 CFR Part 55.53

Question B.007 [1.0 point] {7.0}
Which ONE of the following federal regulations establish procedures and criteria for the issuance of licenses to operators and senior operators?

a. 10 CFR 20
b. 10 CFR 50
c. 10 CFR 55
d. 10 CFR 73

Answer: B.07 c.
Reference: 10 CFR 55.1(a)

Question B.008 [2.0 point, 0.5 each] {9.0}
Identify each of the following statements as a Safety Limit (SL), a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

a. The core thermal fuse shall melt when heated to a temperature of about 120°C resulting in core separation and reactivity loss greater than 5% dk/k.

b. The shutdown margin with the most reactive safety or control rod fully inserted and the fine control rod fully inserted shall be at least 1% dk/k.

c. The maximum core temperature shall not exceed 200°C during either steady-state or transient operation.

d. The reactor room shall be considered a restricted area whenever the reactor is not secured.

Answer: B.08 a. = LSSS; b. = LCO; c. = SL; d. = LCO
Reference: per the Technical Specifications, Safety Limit (SL), Limiting Safety System Setting (LSSS), and Limiting Conditions for Operation (LCO) are as defined in 10 CFR 50.36

Question B.009 [2.0 point, 0.5 each] {11.0}
Identify whether each of the experiments listed below is Allowed (AL), required Double Encapsulation (DE), or is not allowed (NA) by technical specifications.

a. An experiment containing 22 grams of explosive material.

b. An experiment containing liquid fissionable material.

c. An experiment, calculated upon failure to release an approximate total dose equivalent of 0.02 mSv (1 mrem) for a period of two hours starting at the time, as a result of any airborne pathway.

d. An experiment containing a material corrosive to reactor components.

Answer: B.09 a. = NA; b. = DE; c. = AL; d. = NA
REF: Technical Specifications §§ 3.3.b, 3.3.a, 3.3.c(1) and 3.3.a

Question B.010 [1.0 point] {12.0}
Per the emergency plan the *EMERGENCY PLANNING ZONE (EPZ)* is …

a. rooms 19 and 20.

b. rooms 20 and 23.

c. rooms 15, 16, 18, 19, 20, 22, 23 and 24

d. the entire Lillibridge Engineering Laboratory basement.

Answer: B.10 b
Reference: Emergency Plan, 2.0 DEFINITIONS, 2.8

Question B.011 [1.0 point] {13.0}
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of one (1) foot, and is 0.1 mrem/hour at a distance of twenty (20) feet. At one (1) foot what percentage of the source consists of beta radiation?

a. 20%

b. 40%

c. 60%

d. 80%

Answer: B.11 c
Reference: 10CFR20. At 20 feet, there is no beta radiation. Gamma at 20 feet = 0.1 mrem/hour, gamma at 1 foot = 40 mrem/hour. Therefore beta at 1 foot = 60 mrem/hour = 60%.

Question B.012 [1.0 point] {14.0}
Which one of the following is the correct value and reason for the minimum shield water temperature in the technical specifications?

a. 15°C. To limit the final power reached during a reactor excursion prior to the fuse melting.

b. 10°C. To limit the final power reached during a reactor excursion prior to the fuse melting.

c. 15°C. To limit the potential positive reactivity addition associated with a decrease in temperature.

d. 10°C. To limit the potential positive reactivity addition associated with a decrease in temperature.

Answer: B.12 c.
Reference: Technical Specifications § 3.2, p. 10

Question B.013 [1.0 point] {15.0}
Which ONE of the following is the power level above which the thermal column door must be closed?

a. 0.01 watts

b. 0.05 watts

c. 0.1 watts

d. 0.5 watts

Answer: B.13 d.
Reference: Technical Specifications § 3.4

END OF SECTION B

Question C.001 [1.0 point] {1.0}
Which ONE control rod listed below will NOT instantaneously eject from the core in the event of a SCRAM?

a. Coarse.
b. Fine.
c. Safety 1.
d. Safety 2.

Answer: C.01 b.
Reference: Technical Specifications only define the Shim/Safety rods as scrammable

Question C.002 [1.0 point] {2.0}
Which ONE of the following **IS** the location of a fixed radiation area monitor?

a. Radiation Counting Laboratory.
b. Observation Classroom.
c. Above the Reactor.
d. Control console.

Answer: C.02 d.
Reference: Technical Specifications – 3.4

Question C.003 [1.0 point,] {3.0}
What type of detector is used for the Low temperature switch?

a. A simple bi-metallic thermal switch
b. A precision platinum wound resistance temperature detector (RTD)
c. A chromel-alumel (Type K) thermocouple.
d. A copper-constantan (Type T) thermocouple

Answer: C.03 a.
Reference: ISU Safety Analysis Report (SAR) § 4.3.4, Interlock System.

Question C.004 [1.0 point] {4.0}
What material is typically placed in the glory hole to ensure the reactor stays in a sub-critical mode when no one is present?

a. Boron.
b. Beryllium.
c. Cadmium.
d. Polyethylene.

Answer: C.04 c.
Reference: OP-1-AGN-201, VII Reactor Shut Down – step c.2

Question C.005 [1.0 point] {5.0}
The detector used for the shield tank water level signal is a:

a. manometer.
b. float switch.
c. pressure switch.
d. differential pressure switch.

Answer: C.05 b.
Reference: ISU Safety Analysis Report (SAR) § 4.3.4, Interlock System.

Question C.006 [1.0 point] {6.0}
What design feature insures that the thermal fuse melts before the rest of the reactor core? The thermal fuse …

a. fuel has double the density of fuel pellets as the rest of the core.
b. fuel has double the ratio of U^{235} to U^{238} atoms as the rest of the core.
c. moderator has twice the density of polyethylene to aid in themalizing neutrons.
d. moderator has half the density of polyethylene to aid in themalizing neutrons.

Answer: C.06 a.
REF: ISU SAR – Table 4.2.1

Question C.007 [1.0 point] {7.0}
Which one of the following is the method used at Idaho State University to generate control rod position indication? The signal is generated by …

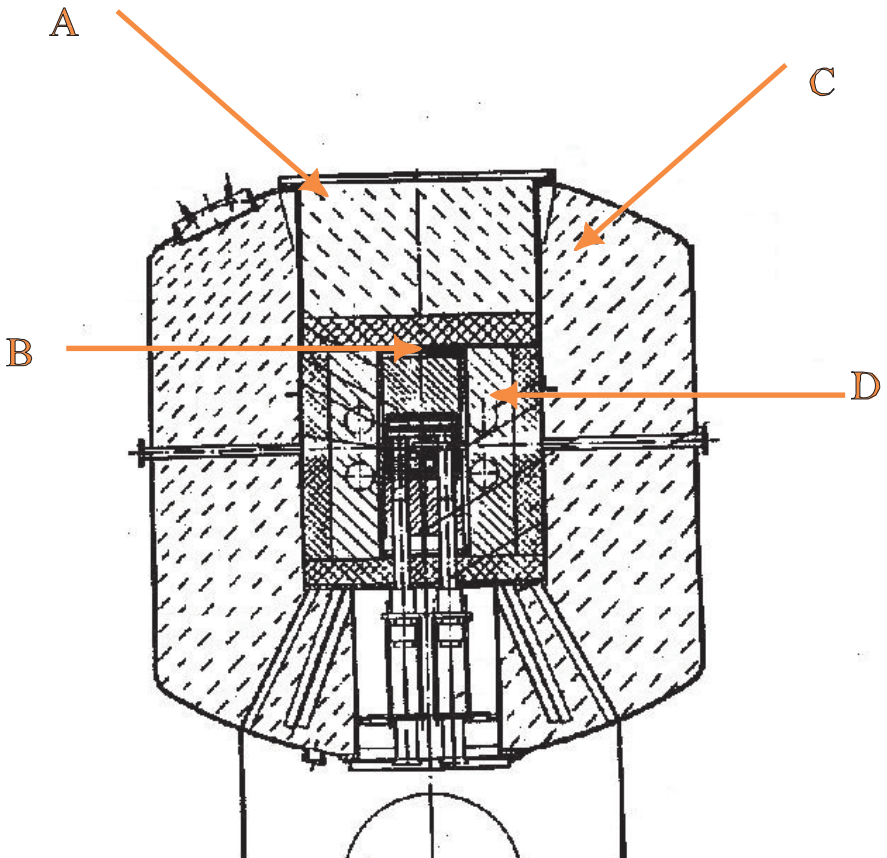
a. a direct output from the rod drive DC motor.
b. the output of a synchro-generator linked to the rod drive DC motor.
c. the change in voltage due to movement of a lead screw linked to the rod itself.
d. the changing current due to the closing of multiple magnetic reed switches located the entire length of the rod.

Answer: C.07 b.
Reference: ISU SAR § 4.3.1 Figure 4.3-1, p. 54

Question C.008 [2.0 point, 0.5 each] {9.0}
In the following diagram, match the appropriate materials with the locations they belong in:

a. ___ 1. Graphite
b. ____ 2. Lead
c. ___ 3. Water
d. ___ 4. Polyethylene

Answer: C.08 a. = 1; b. = 4; c. = 3; d. = 2
Reference: Safety Analysis Report



Question C.009 [1.0 point] {10.0}
Which ONE of the following is the type of detector for Nuclear Instrumentation Channel #1.

a. Argon filled Geiger-Mueller.
b. U^{235} lined Fission Chamber.
c. BF_3 filled Proportional Counter.
d. BF_3 filled Ion Chamber.

Answer: C.09 c.
Reference: ISU SAR § 4.3.2

Question C.010 [1.0 point] {11.0}
What is one of the purposes for the neutron count interlock?

a. To prevent the reactor from being manipulated to a critical position before channel 1 is verified to be operable.

b. To provide a reference point where all instruments undergo a check before the reactor is brought to a critical position.

c. To allow for all experiments to be installed before the reactor is critical.

d. To ensure that the reactor is not started up without a neutron source.

Answer: C.10 d.
Reference: Safety Analysis Report

Question C.011 [1.0 point] {12.0}
Which one of the following describes the mechanism that allows the Channel No. 1 neutron monitoring system to be operable over the entire range of power?

a. Campbell circuit.
b. Automatic voltage reduction.
c. Natural buoyancy of plastic tube.
d. Rotation of neutron absorbing material.

Answer: C.11 C.
Reference: Safety Analysis Report – 4.3.2

Question C.012 [1.0 point] {13.0}
An aluminum baffle plate separates the fuel disks in the upper section of the core from the fuel disks in the lower section of the core. Of the total of ____fuel disks, ___are in the upper section and _____are in the lower section.

a. 7; 4; 3
b. 7; 3; 4
c. 9; 6; 3
d. 9; 5; 4

Answer: C.12 C.
Reference: Safety Analysis Report,

END OF SECTION C

END OF WRITTEN EXAMINATION