July 23, 2002

Mr. Paul Hobbs, Reactor Manager
University of Missouri-Columbia
Research Reactor Center
Columbia, MO 65211

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-186/OL-02-02, UNIVERSITY OF MISSOURI-COLUMBIA, JULY 8-10, 2002

Dear Mr. Hobbs:

During the week of July 8, 2002, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Missouri reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Warren Eresian at 301-415-1833 or internet e-mail wje@nrc.gov.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures: 1. Initial Examination Report No. 50-186/OL-02-02
2. Examination and answer key

cc w/encls:
Please see next page

cc:

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Please see next page

DISTRIBUTION w/encls.:
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AAdams, PM
Facility File (EBarnhill)

DISTRIBUTION w/o encls.:
RORP/R&TR r/f
WEresian
PMadden

ADAMS ACCESSION #: ML021980564 **TEMPLATE #: NRR-074**

OFFICE	**RORP:CE**		**IEHB:LA**		**RORP:SC**	
NAME	**WEresian:rdr**		**EBarnhill**		**PMadden**	
DATE	**07/ 22 /2002**		**07/ 22 /2002**		**07/ 23 /2002**	

C = COVER **E = COVER & ENCLOSURE** **N = NO COPY**

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

REPORT NO.: 50-186/OL-02-02

FACILITY DOCKET NO.: 50-186

FACILITY LICENSE NO.: R-103

FACILITY: University of Missouri-Columbia

EXAMINATION DATES: July 8-9, 2002

EXAMINER: Warren Eresian, Chief Examiner

SUBMITTED BY: ***/RA/*** 07/ 22 /2002
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of July 8, 2002, the NRC administered operator licensing examinations to two Reactor Operator candidates. Both candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

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

3. Exit Meeting:

Mr. Mike Dixon, Manager of Operations
Warren Eresian, NRC Chief Examiner

The NRC thanked the facility staff for their cooperation during the examination. No generic concerns were noted. The facility provided comments on the written examination. As a result of their comments, three questions which were derived from procedures that have since been updated were deleted.

Category B

Question 005: No correct answer. Question deleted.

Question 014: No correct answer. Question deleted.

Category C

Question 008: No correct answer. Question deleted.

One question was identified as having two correct answers:

Category B

Question 010: A or B will be accepted as correct.

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

FACILITY: University of Missouri-Columbia

REACTOR TYPE: Pool/Tank

DATE ADMINISTERED: 07/09/02

REGION: 3

CANDIDATE:___________________________

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the exam page itself, or the answer sheet provided. Write answers one side ONLY. Attach any answer sheets to the examination. Points for each question 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	35	______	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
18	32	______	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19	33	______	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
57			_____% FINAL GRADE	

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 not received or 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.

6. Print your name in the upper right-hand corner of the answer sheets.

7. The point value for each question is indicated in parentheses after the question.

8. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

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

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

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION: 001 (1.00)

Reactor power is increasing by a factor of 10 every minute. The reactor period is:

a. 65 seconds.

b. 52 seconds.

c. 26 seconds.

d. 13 seconds.

QUESTION: 002 (1.00)

A reactor is slightly supercritical, with the thermal utilization factor = 0.700. A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.698

b. 0.700

c. 0.702

d. 0.704

QUESTION: 003 (1.00)

The neutron microscopic cross section for absorption, σ_a , generally:

a. increases as neutron energy increases.

b. decreases as neutron energy increases.

c. increases as the mass of the target nucleus increases.

d. decreases as the mass of the target nucleus increases.

QUESTION: 004 (1.00)

Which ONE of the reactions below is an example of a <u>photoneutron</u> source?

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

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

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

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

QUESTION: 005 (1.00)

During a reactor startup, the count rate is increasing linearly on a logarithmic scale, with no rod motion. This means that:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors.

b. the reactor is critical and the count rate increase is due to source neutrons.

c. the reactor is subcritical and the count rate increase is due to source neutrons.

d. the reactor is supercritical.

QUESTION: 006 (1.00)

A 1/M curve is being generated as fuel is loaded into the core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, C_o. Additional elements are then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

a. criticality will occur with the same number of elements loaded as if there were no change in the initial count rate.

b. criticality will occur earlier (i.e., with fewer elements loaded.)

c. criticality will occur later (i.e., with more elements loaded.)

d. criticality will be completely unpredictable.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 007 (1.00)

As a reactor continues to operate over a period of months, for a constant power level, the average neutron flux:

a. decreases, due to the increase in fission product poisons.

b. decreases, because fuel is being depleted.

c. increases, in order to compensate for fuel depletion.

d. remains the same.

QUESTION: 008 (1.00)

A reactor is operating at a constant power level of 250 kW. The fission rate of this reactor is approximately:

a. 0.78×10^{12} fissions/sec.

b. 1.56×10^{14} fissions/sec.

c. 0.78×10^{16} fissions/sec.

d. 3.90×10^{18} fissions/sec.

QUESTION: 009 (1.00)

Which ONE of the following statements correctly describes the influence of delayed neutrons during the neutron life cycle?

a. Delayed neutrons are more likely to cause fission because they thermalize more quickly than prompt neutrons.

b. Delayed neutrons take longer to thermalize because they are born at a higher average energy than prompt neutrons.

c. Delayed neutrons increase the average neutron generation time.

d. Delayed neutrons are produced some time after prompt neutrons and make up the majority of neutrons produced by fissions.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.

b. undermoderated will have a negative moderator temperature coefficient.

c. overmoderated will have a constant moderator temperature coefficient.

d. overmoderated will have a negative moderator temperature coefficient.

QUESTION: 011 (1.00)

Which ONE statement below describes a positive moderator temperature coefficient?

a. When moderator temperature increases, positive reactivity is added.

b. When moderator temperature decreases, positive reactivity is added.

c. When moderator temperature increases, negative reactivity is added.

d. When moderator temperature increases, reactor power decreases.

QUESTION: 012 (1.00)

A reactor with an initial population of 1×10^8 neutrons is operating with $K_{eff} = 1.001$. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume $\beta = 0.007$.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

a. reappears with a lower kinetic energy, with the nucleus emitting a gamma ray.

b. reappears with the same kinetic energy it had prior to the collision.

c. is absorbed by the nucleus, with the nucleus emitting a gamma ray.

d. reappears with a higher kinetic energy, with the nucleus absorbing a gamma ray.

QUESTION: 014 (1.00)

The Moderating Ratio measures the effectiveness of a moderator by combining the scattering cross section, the absorption cross section, and the average energy loss per collision. The Moderating Ratio is expressed as:

a. (absorption cross section)x(scattering cross section)/(average energy loss per collision).

b. (absorption cross section)x(average energy loss per collision)/(scattering cross section).

c. (scattering cross section)x(absorption cross section)x(average energy loss per collision).

d. (average energy loss per collision)x(scattering cross section)/(absorption cross section).

QUESTION: 015 (1.00)

An Integral Rod Worth (IRW) curve is ________________, while a Differential Rod Worth (DRW) curve is __________.

a. the total reactivity worth of the rod up to the point of withdrawal; the reactivity change per unit movement of the rod.

b. the slope of the DRW curve at the point of withdrawal; the area under the IRW curve up to the point of withdrawal.

c. the reactivity change per unit movement of the rod; the total reactivity worth of the rod up to the point of withdrawal.

d. at its maximum value when the rod is approximately half-way out of the core; at its maximum value when the rod is fully withdrawn from the core.

QUESTION: 016 (1.00)

Delayed neutron precursors decay by beta(-) decay. Which ONE reaction below is an example of beta(-) decay?

a. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

b. $_{35}Br^{87}$ -> $_{34}Kr^{87}$

c. $_{35}Br^{87}$ -> $_{35}Kr^{88}$

d. $_{35}Br^{87}$ -> $_{35}Kr^{86}$

QUESTION: 017 (1.00)

A reactor is subcritical by 5% delta k/k with a count rate of 100 cps on the startup channel. Rods are withdrawn until the count rate is 1000 cps. Which ONE of the following is the condition of the reactor following the rod withdrawal?

a. Critical with k_{eff} = 1.000.

b. Subcritical with k_{eff} = 0.995.

c. Subcritical with k_{eff} = 0.950.

d. Supercritical with k_{eff} = 1.005.

QUESTION: 018 (1.00)

A reactor is operating at a constant power level with equilibrium xenon. Reactor power is then doubled. The equilibrium xenon level at the higher power level will be:

a. higher than its value at the lower power level, but not twice as high.

b. twice as high.

c. more than twice as high.

d. the same as at the lower power level.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 019 (1.00)

The primary coolant temperature coefficient of reactivity is $-5x10^{-5}$ delta K/K/deg.F. When a control rod with an average rod worth of 0.01% delta K/K/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the primary coolant temperature has:

a. increased by 20 deg.F.

b. decreased by 20 deg.F.

c. increased by 2 deg.F.

d. decreased by 2 deg.F.

QUESTION: 020 (1.00)

Which ONE of the following statements correctly describes a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons added in the next generation.

c. For equal reactivity additions, it requires less time for the equilibrium neutron population to be reached.

d. When the indicated count rate doubles, the margin to criticality has been reduced by approximately one-half.

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

QUESTION: 001 (1.00)

Which ONE of the following statements define an "Instrument Channel Test?"

a. The introduction of a signal into a channel and observation of proper channel response.

b. An arrangement of sensors, components and modules as required to provide a single trip or other output signal relating to a reactor or system operating parameter.

c. The qualitative verification of acceptable performance by observation of channel behavior.

d. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

QUESTION: 002 (1.00)

The SHUTDOWN MARGIN of the MURR shall be at least:

a. 2% delta k/k.

b. 0.02% delta k/k with any one shim blade fully withdrawn.

c. 0.02% delta k/k.

d. 2% delta k/k with any one shim blade fully withdrawn.

QUESTION: 003 (1.00)

The reflector high and low differential pressure scram:

a. assures adequate cooling of the fuel and flux trap region.

b. provides a backup to the primary low pressure scram.

c. provides a backup to the primary coolant low flow scram.

d. provides a backup to the pool coolant low flow scram.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 004 (1.00)

If the reactor is not critical within the ECP limits, the reactor operator must:

a. recalculate the ECP prior to any further rod withdrawal.

b. shut down the reactor.

c. verify the ECP with a 1/M plot.

d. insert controls rods to 2 inches below ECP.

QUESTION: 005 (1.00) QUESTION DELETED

In accordance with the Technical Specifications, which ONE of the following conditions is NOT a condition for reactor containment integrity to be satisfied?

a. Truck entry door closed and sealed.

b. Personnel airlock door operable.

c. All containment building ventilation system automatically-closing doors and automatically-closing valves are operable or, if not, placed in the closed condition.

d. Utility seal trench filled with water to the depth required to maintain a minimum water seal of 4.25 feet.

QUESTION: 006 (1.00)

In accordance with the Technical Specifications, which ONE of the following conditions is NOT permissible when the reactor is operating?

a. Above 100 kW, the maximum distance between the highest and lowest shim blade = 1 inch.

b. A fueled experiment containing 300 millicuries of I-135.

c. Emergency generator is out of service for one hour for maintenance.

d. Core excess reactivity = 0.006 delta k/k.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 007 (1.00)

With the exception of routine silicon sample handling, when moving radioactive material around the pool, Health Physics personnel are required to be present when the dose rate exceeds:

a. 50 mR/hr.

b. 75 mR/hr.

c. 100 mR/hr.

d. 200 mR/hr.

QUESTION: 008 (1.00)

The shim blades:

a. shall be capable of full insertion in less than 0.7 seconds.

b. will automatically insert at a rate not to exceed 1 inch/min.

c. shall be capable of insertion to the 20% withdrawn position in less than 0.7 seconds.

d. shall remain within one inch of each other at power levels above 50 Kw.

QUESTION: 009 (1.00)

The reactor stack radiation monitor may be taken out of service for maintenance or calibration during reactor operation for a period of up to:

a. 1.0 hour.

b. 2.0 hours.

c. 8.0 hours.

d. 12.0 hours.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

Which ONE of the following Facility Emergencies require personnel to leave the containment building?

a. Facility evacuation.

b. Reactor Isolation.

c. Fire.

d. Medical.

QUESTION: 011 (1.00)

Which ONE of the following immediate actions should be taken by the operator if he detects a stuck rod drive mechanism during reactor power operation?

a. Attempt to drive the affected rod in until power decreases by 2%.

b. Drive all shim rods in, verifying the stuck rod fails to move.

c. Scram the reactor, noting the position of the stuck rod.

d. Stop all rod movement and notify the shift supervisor.

QUESTION: 012 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. However, there is a small section of pipe which reads 10 mrem/hr at one (1) meter. Assuming that the pipe is a point source, which ONE of the following defines the posting requirements for the area in accordance with 10CFR Part 20?

a. Restricted Area.

b. Radiation Area.

c. High Radiation Area.

d. Grave Danger, Very High Radiation Area.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	License Expiration	1.	1 year
b.	Medical Examination	2.	2 years
c.	Requalification Written Examination	3.	3 years
d.	Requalification Operating Test	4.	6 years

QUESTION: 014 (1.00) QUESTION DELETED

While operating at high power, it is necessary to reduce power in order to support some short evolution. For how long may the reactor be operated at the reduced power before it must be shut down?

a. 30 minutes.

b. 45 minutes.

c. 1 hour.

d. 2 hours.

QUESTION: 015 (1.00)

A survey instrument with a window probe is used to measure the beta-gamma dose rate from an irradiated experiment. The dose rate is 100 mrem/hour with the window open and 60 mrem/hour with the window closed. The gamma dose rate is:

a. 100 mrem/hour.

b. 60 mrem/hour.

c. 40 mrem/hour.

d. 160 mrem/hour.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

Two point sources have the same Curie strength. Source A's gammas have an energy of 1 Mev, while Source B's gammas have an energy of 2 Mev. You obtain a measurement from the same GM tube 10 feet from each source. Concerning the two measurements, which ONE of the following statements is true?

a. The measured dose rate from Source B is four times that of Source A.

b. The measured dose rate from Source B is twice that of Source A.

c. Both measurements are the same.

d. The measured dose rate from Source B. is half that of Source A.

QUESTION: 017 (1.00)

"All control blades, including the regulating blade, shall be operable during reactor operations." This is an example of a:

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

QUESTION: 018 (1.00)

Which ONE of the following is the 10 CFR 20 definition of TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 019 (1.00)

Which ONE of the following operations requires the direct supervision (i.e., presence) of a Senior Reactor Operator?

a. Stack monitor operational test.

b. Adjustment of nuclear instrumentation.

c. Start up pool coolant system.

d. Start up primary coolant system.

QUESTION: 020 (1.00)

In the event of a high stack monitor readings (in excess of alarm points), the reactor operator should immediately:

a. notify the shift supervisor.

b. scram the reactor.

c. shut down the reactor.

d. reduce power slowly until the alarm clears.

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

QUESTION: 001 (1.00)

In the event of a commercial power failure, the diesel engine starts and the emergency generator supplies power to_______. When normal power is restored, the emergency electrical load is shifted back after a time delay of_______.

a. Substation A; ten minutes.

b. Substation B; ten minutes.

c. Substation A; seven seconds.

d. Substation B; seven seconds.

QUESTION: 002 (1.00)

Containment building isolation is accomplished by closing two butterfly valves, 16A and 16B, in the main exhaust line. Which ONE of the following describes the operation of these valves?

a. 16A is air to open, air to close, while 16B is air to open, spring to close.

b. 16A is air to open, spring to close, while 16B is air to open, air to close.

c. 16A is a motor-operated valve, while 16B is air to open, air to close.

d. 16A is air to open, spring to close, while 16B is a motor-operated valve.

QUESTION: 003 (1.00)

When the “Pressurizer Lo Press” annunciator alarms, it means that:

a. Valve 537 has opened, reducing pressure to 70 psi.

b. Valve 526 has opened, reducing pressure to 60 psi.

c. PS 945 has sensed a pressure of 60 psi.

d. PS 941 has sensed a pressure of 70 psi.

QUESTION: 004 (1.00)

Match the detector type in Column B with the correct Area Radiation Monitoring channel in Column A. Detectors in Column B may be used once, more than once, or not at all.

	Column A		Column B
a.	Beamport Floor North Wall	1.	Ion Chamber
b.	Bridge ALARA	2.	Scintillation Detector
c.	Fission Product Monitor	3.	GM tube.
d.	Air Plenum 1		
e.	Secondary Coolant Monitor		

QUESTION: 005 (1.00)

Secondary Cooling System pumps should not be started at the same time because:

a. the power surge will trip the pump motor supply breakers.

b. initial high flow rates will result in thermal shock to the heat exchangers.

c. the pressure surge may produce a water hammer in the heat exchangers.

d. the basin level will be reduced, resulting in a low sump level trip.

QUESTION: 006 (1.00)

Which Area Radiation Monitors below can cause a Reactor Isolation?

a. Bridge, Bridge ALARA, Fission Product Monitor, Air Plenum 1.

b. Beamport Floor North Wall, Beamport Floor West Wall, Beamport Floor South Wall, Bridge.

c. Bridge, Bridge ALARA, Air Plenum 1, Air Plenum 2.

d. Fission Product Monitor, Air Plenum 1, Air Plenum 2, Bridge ALARA.

QUESTION: 007 (1.00)

Which ONE statement below describes the operation of the three-way solenoid valves in the Valve Operating System?

a. When the solenoid valve is energized, the vent side of the valve closes, directing air pressure to the isolation valve operator.

b. When the solenoid valve is deenergized, the vent side of the valve closes, directing air pressure to the isolation valve operator.

c. When the solenoid valve is energized, the vent side of the valve opens, directing air pressure to the isolation valve operator.

d. When the solenoid valve is deenergized, the vent side of the valve opens, directing air pressure to the isolation valve operator.

QUESTION: 008 (1.00) QUESTION DELETED

Which ONE condition listed below is NOT an interlock for the withdrawal of a shim-safety rod?

a. Thermal column door closed.

b. Source range greater than 2 counts per second.

c. Rods in contact with magnet.

d. “Rod Run-In” reset.

QUESTION: 009 (1.00)

The Fission Product Monitor samples primary coolant at a point:

a. between the outlet of the primary pumps and the inlet to the heat exchangers.

b. between the outlet of the heat exchangers and the inlet to the core.

c. between the outlet of the core and the inlet to the primary pumps.

d. at the inlet to the holdup tank.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

DPS 928A/B senses low flow. This will cause a reactor scram and:

a. valves 507A/B close.

b. valves 517A/B close.

c. valves 543A/B open.

d. valves 546A/B open.

QUESTION: 011 (1.00)

Temperature detectors 980A/B will provide a reactor scram in the event of high reactor coolant temperature. If they fail to initiate a scram, a backup scram signal is provided by:

a. TE901A.

b. TE901B.

c. TE901C.

d. TE980C/D.

QUESTION: 012 (1.00)

A Facility Evacuation can be manually initiated from the control console and:

a. the reactor bridge.

b. equipment room 278.

c. the front lobby.

d. equipment room 114.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

The operator wishes to place the reactor in the automatic mode of operation. Which ONE of the following conditions would prevent the operator from doing so?

a. Reactor period, as measured by IRM-2, is 40 seconds.

b. The 60% annunciator alarm for the regulating blade is energized.

c. Reactor period, as measured by IRM-3, is 40 seconds.

d. The Wide Range Monitor selector switch is in the 5 kW black scale position.

QUESTION: 014 (1.00)

Which ONE of the following devices is NOT connected to the Emergency Air Compressors?

a. Containment Building Exhaust Valve 16A.

b. Containment Building Exhaust Valve 16B.

c. Freight Door 101 gasket.

d. Pool Loop Isolation Valve 509.

QUESTION: 015 (1.00)

When the high alarm contact associated with CE932 is activated, an alarm sounds on an annunciator which reads:

a. “Reactor Loop Coolant Hi Activity.”

b. “Reactor or Pool Loop Hi Cond.”

c. “Secondary Coolant Hi Activity.”

d. “Off Gas Hi Activity.”

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

The Pool Coolant Cleanup System water returns to the pool at about two feet below the pool surface in order to:

a. aid in the mixing of the water, which results in the pool attaining a uniform temperature.

b. create a blanket of warm water to reduce mixing, and therefore to reduce the pool surface dose rate.

c. reduce pool surface temperature, since the DI water is cooler.

d. not interfere with the pool skimmer, which takes its suction from the pool surface.

QUESTION: 017 (1.00)

The operator wishes to transfer the operation of bypass valve S-1 from Automatic to Manual mode. If there is a large difference between the manual position demand and the position of the valve in the automatic mode:

a. rapid movement of the valve could result in damage to the valve.

b. a significant positive or negative reactivity insertion could occur.

c. the control circuit might not respond properly to the large deviation signal.

d. rapid movement of the valve could result in water hammer.

QUESTION: 018 (1.00)

In the Reactor Isolation System, the ventilation supply and return fans, SF2 and RF2, will be secured as a result of:

a. the closing of door 504.

b. deenergizing the 16" valve solenoids.

c. energizing the containment isolation horns.

d. an alarm from “Air Plenum 1" or “Air Plenum 2" radiation detectors.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 019 (1.00)

Which ONE of the following conditions is NOT a Nuclear Instrument Anomaly?

a. SRM high voltage supply is low.

b. IRM selector switch not in OPERATE position.

c. WRM selector switch not in OPERATE position.

d. PRM at 120% power.

QUESTION: 020 (1.00)

The neutron absorbing material of the shim rods is:

a. aluminum.

b. boron carbide.

c. stainless steel.

d. beryllium.

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

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 17.
Reactor Period = 26/Startup Rate

ANSWER: 002 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Neutron Life Cycle, page 4.
In order to decrease K (return to critical), thermal utilization must decrease.

ANSWER: 003 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Nuclear Cross Sections and Neutron Flux, page 9.

ANSWER: 004 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Neutron Sources, page 2.

ANSWER: 005 (1.00)
D.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 14.

ANSWER: 006 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

ANSWER: 007 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Reaction Rates, page 21.

ANSWER: 008 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Reaction Rates, page 20.
250 kW = 1.562×10^{18} Mev/sec.
(1.562×10^{18} Mev/sec)/(200 Mev/fission) = 0.78×10^{16} fissions/sec.

ANSWER: 009 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Prompt and Delayed Neutrons, page 29.

ANSWER: 010 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 25.

ANSWER: 011 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 26.

ANSWER: 012 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Prompt and Delayed Neutrons, page 29.
Increase = $1.001x10^8 - 1x10^8 = 1x10^5$. Prompt neutron population = $0.993x1x10^5$ = 99,300.

ANSWER: 013 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 1, Neutron Interactions, page 45.

ANSWER: 014 (1.00)
D.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Neutron Moderation, page 28.

ANSWER: 015 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Control Rods, page 51.

ANSWER: 016 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 1, Modes of Radioactive Decay, page 24.

ANSWER: 017 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.
$CR_1 (1-K_1) = CR_2 (1-K_2)$; $\rho = (K -1)/K$; -0.05 = (K - 1)/K; K = 0.952.
100(1 - 0.952) = 1000(1 - K_2); K_2 = 0.995.

ANSWER: 018 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Xenon, page 37.

ANSWER: 019 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity, page 21.
Control rod inserts positive reactivity = 0.0001delta k/k/inch x 10 inches = +0.001 delta k/k.
Primary coolant temperature inserts negative reactivity = $-5x10^{-5}$ delta k/k/deg.F x(+20 deg.F) = -0.001 delta k/k.

ANSWER: 020 (1.00)
D.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
A.
REFERENCE:
MURR Technical Specifications, Section 1.8.

ANSWER: 002 (1.00)
D.
REFERENCE:
MURR Technical Specifications, Section 3.1.e.

ANSWER: 003 (1.00)
D.
REFERENCE:
MURR Technical Specifications, Section 3.3.a bases.

ANSWER: 004 (1.00)
D.
REFERENCE:
OP-RO-210.

ANSWER: 005 (1.00) QUESTION DELETED
C.
REFERENCE:
MURR Technical Specifications, Section 1.15.

ANSWER: 006 (.00)
C.
REFERENCE:
MURR Technical Specifications, Section 3.10.a.

ANSWER: 007 (1.00)
C.
REFERENCE:
HP SOP VII-2.

ANSWER: 008 (1.00)
C.
REFERENCE:
MURR Technical Specifications, Section 3.2.c.

ANSWER: 009 (1.00)
B.
REFERENCE:
MURR Technical Specifications, Section 3.4.a.

ANSWER: 010 (1.00)
A or B.
REFERENCE:
FEP

ANSWER: 011 (1.00)
C.
REFERENCE:
REP-8

ANSWER: 012 (1.00)
C.
REFERENCE:
10 mrem/hr at 1 meter (100 cm.) = 111.1mrem/hr at 30 cm.

ANSWER: 013 (1.00)
A,4; B,2; C,2; D,1.
REFERENCE:
10CFR55

ANSWER: 014 (1.00) QUESTION DELETED
B.
REFERENCE:
SOP II.1.7.

ANSWER: 015 (1.00)
B.
REFERENCE:
The window stops the beta radiation and so the gamma dose rate is 60 mrem/hour.

ANSWER: 016 (1.00)
C.
REFERENCE:
GM tubes cannot distinguish between energies.

ANSWER: 017 (1.00)
C.
REFERENCE:
MURR Technical Specifications, Section 3.2.a.

ANSWER: 018 (1.00)
A.
REFERENCE:
10CFR20

ANSWER: 019 (1.00)
B.
REFERENCE:
OP-RO-340

ANSWER: 020 (1.00)
A.
REFERENCE:
REP-21

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, pages III.2.1, III.2.2.

ANSWER: 002 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, page I.11.2.

ANSWER: 003 (1.00)
C.
REFERENCE:
Training Manual for Reactor Operations, page I.3.1.

ANSWER: 004 (1.00)
A,3; B,1; C,2; D,3; E,2.
REFERENCE:
Training Manual for Reactor Operations, pages II.9.1, II.9.2.

ANSWER: 005 (1.00)
D.
REFERENCE:
SOP VI.1.

ANSWER: 006 (1.00)
C.
REFERENCE:
Training Manual for Reactor Operations, page II.9.2.

ANSWER: 007 (1.00)
A.
REFERENCE:
Training Manual for Reactor Operations, page I.5.1.

ANSWER: 008 (1.00) QUESTION DELETED
B.
REFERENCE:
Training Manual for Reactor Operations, page II.14.2.

ANSWER: 009 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, page II.7.1.

ANSWER: 010 (1.00)
D.
REFERENCE:
Training Manual for Reactor Operations, page I.2.8.

ANSWER: 011 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, page II.11.2.

ANSWER: 012 (1.00)
C.
REFERENCE:
Training Manual for Reactor Operations, page II.10.3.

ANSWER: 013 (1.00)
D.
REFERENCE:
Training Manual for Reactor Operations, page II.14.3.

ANSWER: 014 (1.00)
D.
REFERENCE:
Training Manual for Reactor Operations, page IV.2.1.

ANSWER: 015 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, page I.4.2.

ANSWER: 016 (1.00)
B.
REFERENCE:
Hazards Summary Report, page 7-15.

ANSWER: 017 (1.00)
B.
REFERENCE:
SOP VI.2

ANSWER: 018 (1.00)
A.
REFERENCE:
Training Manual for Reactor Operations, page II.10.3.

ANSWER: 019 (1.00)
D.
REFERENCE:
Training Manual for Reactor Operations, page II.5.2.

ANSWER: 020 (1.00)
B.
REFERENCE:
Training Manual for Reactor Operations, page I.1.1.

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ______

002 a b c d ______

003 a b c d ______

004 a b c d ______

005 a b c d ______

006 a b c d ______

007 a b c d ______

008 a b c d ______

009 a b c d ______

010 a b c d ______

011 a b c d ______

012 a b c d ______

013 a b c d ______

014 a b c d ______

015 a b c d ______

016 a b c d ______

017 a b c d ______

018 a b c d ______

019 a b c d ______

020 a b c d ______

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

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ______

002 a b c d ______

003 a b c d ______

004 a b c d ______

005 a b c d ______

006 a b c d ______

007 a b c d ______

008 a b c d ______

009 a b c d ______

010 a b c d ______

011 a b c d ______

012 a b c d ______

013 a______b______c______d ______

014 a b c d______

015 a b c d ______

016 a b c d ______

017 a b c d ______

018 a b c d ______

019 a b c d ______

020 a b c d ______

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ______

002 a b c d ______

003 a b c d ______

004 a______b______c______d______e______

005 a b c d ______

006 a b c d ______

007 a b c d ______

008 a b c d ______

009 a b c d ______

010 a b c d ______

011 a b c d ______

012 a b c d ______

013 a b c d ______

014 a b c d ______

015 a b c d ______

016 a b c d ______

017 a b c d ______

018 a b c d ______

019 a b c d ______

020 a b c d ______

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

EQUATION SHEET

$Q = m\ c_p\ \Delta T$	$CR_1\ (1-K_1) = CR_2\ (1-K_2)$
$P = P_0\ 10^{SUR(t)}$	$P = P_0\ e^{(t/\tau)}$
$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$	$\lambda_{eff} = 0.1$ seconds^{-1}
$DR_1D_1^2 = DR_2D_2^2$	$DR = Droe^{-\lambda t}$
$DR = 6CiE/D^2$	$\rho = (K-1)/K$
1 Curie = $3.7x10^{10}$ dps	1 gallon water = 8.34 pounds
$°F = 9/5°C + 32$	1 Mw = $3.41x10^{6}$ BTU/hr
$°C = 5/9\ (°F - 32)$	1 Mev = $1.6x10^{-13}$ watt-sec