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

REPORT NO.: 50-243/OL-96-01

FACILITY DOCKET NO.: 50-243

FACILITY LICENSE NO.: R-160

FACILITY: Oregon State University

EXAMINATION DATES: October 21, 1996

EXAMINER: Paul Doyle, Chief Examiner

SUBMITTED BY: Paul Doyle 10/30/96
Paul Doyle, Chief Examiner Date

SUMMARY:

During the week of October 21, 1996, the NRC administered a licensing examination to a Reactor Operator candidate at Oregon State University. The candidate passed all portions of the NRC administered examination.

REPORT DETAILS

1. Examiners:
   Paul Doyle, Chief Examiner

2. Results:

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

3. Exit Meeting:
   Paul Doyle, NRC, Chief Examiner
   Brian Dodd, Oregon State Univ., Radiation Center Director
   Jack Higginbotham, Oregon State Univ., Reactor Supervisor
   Arthur Hall, Oregon State Univ., Reactor Administrator

   During the exit meeting Mr. Doyle thanked the facility staff for their cordial assistance in the administration of the examinations, and reminded them of the importance to submit their comments on the written examination to expedite the grading process.

ENCLOSURE 1

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Facility Comments with NRC Resolution

QUESTION (A. 15)
Which ONE of the following conditions would result in a **DECREASE** in core excess reactivity?

a. Replace four fuel bundles with four new bundles (same original specifications).

b. Replace a control rod with a new control rod (same original specifications).

c. Burnout of xenon following restart from a scram (12 hours following scram).

d. Placement of an experiment containing xenon into the lazy susan.

ANSWER (A.15)

REFERENCE (A.15)
OSTR Training Manual Vol. III, p. 28

FACILITY COMMENT

Answer a is also acceptable because our current fuel element worth is greater than that of new fuel due to the erbium being burned at a greater rate than the uranium. Answer b is correct because boron burnup in the control rod. A new control rod could also contain a fuel follower and the argument of Answer a also applies. Answer d is also acceptable because such an experiment would cause a small decrease in the core excess reactivity, based upon actual experiments involving loading the rack with cadmium covered samples.

NRC RESOLUTION

Agree with facility comments. Question deleted from this examination.

QUESTION (A. 19)
At which ONE of the following times would the **MAXIMUM** amount of xenon in the core? (Assume initial condition was in effect for 8 hours before power change.)

a. 4 to 6 hours following a power increase from 50% to 100%

b. 4 to 6 hours following a power decrease from 100% to 50%

c. 8 to 12 hours following a startup to 100%.

d. 8 to 12 hours following a reactor shutdown from 100%

ANSWER (A.19)
a

REFERENCE (A.19)
OSTR Training Manual Vol. III, pp. 22 — 24.

FACILITY COMMENT

The correct answer is d, according to Figure 3.7 and the text of page 24 of the OSTR Training Manual, Volume 3. We suspect that since the correct references are cited that the answer key contains a typographical error.

NRC RESOLUTION

Agree with facility comments. Anwer key modified to accept d as correct response.

QUESTION (B.5)
Identify whether each experiment listed is classified as Class A, B or C from **OSTROP 18** *Procedures for the Approval and Use of Reactor Experiments.*

a. Placing an empty containment tube in lazy susan to test new sample containers.

b. Placing a new experiment into a beam tube.

c. An experiment requiring the movement of reactor shielding.

d. An experiment requiring the movement of reactor fuel.

ANSWER (B.5)
a, A; b, B; c, B; d, C
REFERENCE (B.5)
OSTROP 18.0 § 18.4, Classification of Reactor Experiments p. IV.18.3.
FACILITY COMMENT
The problem statement has a typographical error, the second word should be whether instead of wether. Also, answer d is acceptable because specific Class B experiments authorize fuel movement, for example B-3, when the CLICIT is inserted or removed.
NOTE: Per telephone conversation with J. Higgenbotham, this comment refers to matching part D of question.
NRC RESOLUTION
Agree with facility comment. Matching choice D has been modified to accept either B or C as correct responses.

QUESTION (B.7)
During an **EMERGENCY**, you received 2 REM performing actions that you volunteered to do to mitigate the accident. How is this radiation dose tracked?

a. It is tracked as part of the normal dose (5 REM/year) allowed for a radiation worker.

b. It is tracked as part of your Planned Special Exposure limit (5 REM per year, 15 REM per lifetime.

c. As an emergency dose it is not tracked on-site, but is reported to NRC.

d. As an emergency dose it is not tracked at all.

ANSWER (B.7)
b
REFERENCE (B.7)
10 CFR 20.1206
FACILITY COMMENT
We find that answer a is acceptable because of an OSTR institutional policy of not implementing Planned Special Exposures and that 2 REM is within the allowed annual occupational dose limit.
NRC RESOLUTION
Agree with facility comments. Answer key modified to accept either b or a as correct response.

QUESTION (B. 17)
Which ONE of the following is the SAFETY LIMIT for the maximum temperature for a FLIP TRIGA fuel element.

a. 800°C

b. 950°C

c. 1000°C

d. 1150°C

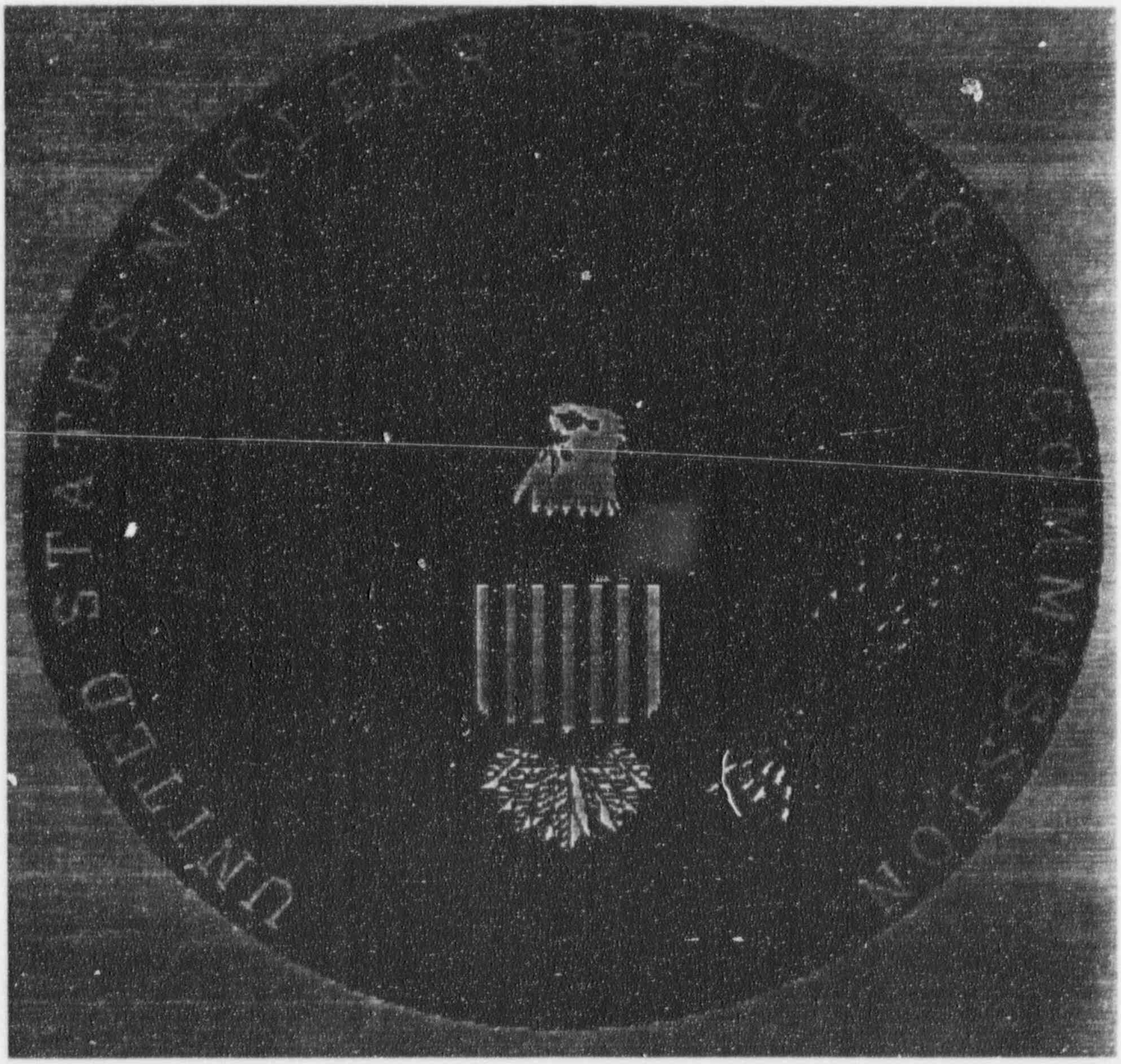
ANSWER (B.17)
c

REFERENCE (B.17)
OSTR Technical Specifications, § 2.1 *Safety Limit — Fuel Element Temperature*, p. 6

FACILITY COMMENT
The correct answer is d as per the cited reference in the answer key.

NRC RESOLUTION
Agree with facility comments. Answer key modified to accept d as correct response.

United States Nuclear Regulatory Commission
Operator Licensing Examination



Oregon State University
10/21/96

ENCLOSURE 3

QUESTION (A.1) [1.0]
The reactor was shutdown, with a shutdown margin of 2.5 dollars and count rate on the source range reads 15 counts/minute. After placing a sample into the reactor the count rate increased to 60 counts/minute. What is the worth of the sample?

a. ≈ -90¢

b. ≈+ 90¢

c. ≈ +1.50$

d. ≈ -1.50$

QUESTION (A.2) [1.0]
Which ONE of the following is the correct reason that indicated power will stabilize several hours following a reactor scram. (Assume source inserted into core, source range instrumentation operable reading 3 cpm, and no reactivity changes, i.e. no temperature changes, fuel movement, experiments inserted or removed, etc.)

a. Continuing decay of the shortest lived neutron precursor

b. Gamma saturation of the source range detector.

c. Subcritical multiplication of Source Neutrons

d. Neutron activation of the Source Range detector

QUESTION (A.3) [1.0]
A fast neutron will lose the most energy per collision when striking an atom of which ONE of the following elements?

A. H^1

b. H^2

c. C^{12}

d. U^{238}

QUESTION (A.4) [1.0]
Which ONE of the following elements has the **SMALLEST** cross-section for absorption of **THERMAL** neutrons?

a. $_{1}H^{1}$

B. $_{1}H^{2}$

C. $_{6}C^{12}$

D. $_{92}U^{238}$

QUESTION (A.5) [2.0]
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a STEADY-STATE OPERATING reactor?

	Production	Depletion
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

QUESTION (A.6) [1.0]
β for U^{235} is 0.0065, but β_{eff} at the Oregon State TRIGA reactor is 0.0070. Why is β_{eff} larger?

a. The reactor contains U^{238} which for fast fissioning has a larger β than U^{235}.

b. The reactor contains Pu^{239} which for thermal fissioning has a larger β than U^{235}.

c. Delayed neutrons are born at a higher average energy level than fission neutrons resulting in a greater amount of neutrons from fast fissions.

d. Delayed neutrons are born at a lower average energy level than fission neutrons resulting in fewer being lost to fast leakage.

QUESTION (A.7) [1.0]
Which ONE of the following is the correct definition of ***REACTIVITY***?

a. A measure of the core's deviation from criticality

b. A measure of the core's fuel depletion.

c. A measure of the core's state with all control rods fully withdrawn.

d. A measure of the core's state at prompt criticality.

QUESTION (A.8) [1.0]
Which ONE of the following is the difference between prompt and delayed neutrons? Prompt neutrons ...

a. account for less than 1% of the neutron population, while delayed neutrons account for the rest.

b. are released during fast-fission events, while delayed neutrons are released during the decay process.

c. are released during the fission process (fast & thermal), while delayed neutrons are release during the decay process.

d. are the dominating factor in determining reactor period, while delayed neutrons have little effect on reactor period.

QUESTION (A.9) [1.0]
K_{eff} for the reactor is 0.85. If you place an experiment worth +17.6% into the core, what will the new K_{eff} be?

a. 0.995

b. 0.9995

c. 1.005

d. 1.05

QUESTION (A.10) [1.0]
Given an average rod reactivity worth of 0.1%/inch, and $\alpha_{Tprompt}$ of -0.005%Δk/°C. If fuel temperature were to increase by 150°C, how far and in what direction would you have to move the rod to compensate?

a. 7.5 inches, inward

b. 0.75 inches, inward

c. 7.5 inches, outward

d. 0.75 inches, outward

QUESTION (A.11) [1.0]
The primary pump is operating at 490 gpm. The ΔT across the primary side of the heat exchanger is 14°F. What is the power level being generated in the reactor?

a. 12.1 kilowatts

b. 96.6 kilowatts

c. 121 kilowatts

d. 966 kilowatts

QUESTION (A.12) [1.0]
Five minutes following a shutdown you note a Nuclear instrumentation reading of about 3×10^5 counts. What reading would you expect after another three minutes?

a. 10^5 counts

b. 3×10^4 counts

c. 1.5×10^4 counts

d. 10^4 counts

QUESTION (A.13) [1.0]
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source ...

a. is impossible as there would be no neutrons available to start up the reactor.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

QUESTION (A.14) [1.0]
The source was removed from an operating reactor. Later, the source was reinstalled and the Reactor Operator noted reactor power increasing **LINEARLY**. What was the condition of the reactor when the source was inserted? (Assume source has no reactivity worth, and no other changes in reactor parameters.) The reactor was ...

a. very subcritical

b. slightly subcritical

c. exactly critical

d. slightly subcritical

QUESTION (A.15) [1.0] **QUESTION DELETED PER FACILITY COMMENT**
~~Which ONE of the following conditions would result in a **DECREASE** in core excess reactivity?~~

~~a. Replace four fuel bundles with four new bundles (same original specifications).~~

~~b. Replace a control rod with a new control rod (same original specifications).~~

~~c. Burnout of xenon following restart from a scram (12 hours following scram).~~

~~d. Placement of an experiment containing xenon into the lazy susan.~~

QUESTION (A.16) [12.0]
Given the height of a $1.50 Pulse. By what factor would you expect pulse height to increase by for a $2.00 pulse?

a. 1.333

b. 2

c. 1.778

d. 4

QUESTION (A.17) [1.0]
Which ONE of the following listed factors is MOST affected by a change in poison level in the core?

a. Fast Fission (ϵ)

b. Thermal Utilization (f)

c. Resonance Escape (p)

d. Reproduction Factor (η)

QUESTION (A.18)[1.0]
During a startup, you are withdrawing a control rod in equal increments (distance) as the reactor approaches criticality. Which ONE of the following statements best describes reactor behavior? (Assume reactor remains slightly subcritical.)

a. Each rod withdrawal will add the same amount of reactivity.

b. Reactor power will increase by the same amount for each rod withdrawal.

c. The time for power to stabilize will increase.

d. Decreasing time between withdrawals will result in a lower critical rod height.

QUESTION (A.19) [1.0]
At which ONE of the following times would the **MAXIMUM** amount of xenon in the core? (Assume initial condition was in effect for 8 hours before power change.)

a. 4 to 6 hours following a power increase from 50% to 100%

b. 4 to 6 hours following a power decrease from 100% to 50%

c. 8 to 12 hours following a startup to 100%.

d. 8 to 12 hours following a reactor shutdown from 100%

QUESTION (A.20) [1.0]
Which ONE of the following is the major source of the recoverable energy released during fission?

a. Kinetic energy of the fission neutrons

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt Gamma Rays

QUESTION (B.1) [1.0]
A point source generates a radiation field of 1 Rem/hr (γ) at 3 feet. Addition of ¼ inch of lead shielding reduces the radiation field to 500 mRem/hr at 3 feet. What will be the radiation field reading if you add another ½ inch of lead shielding?

a. 250 mRem/hr

b. 125 mRem/hr

c. 62.5 mRem/hr

d. 31.25 mRem/hr

QUESTION (B.2) [1.0]
Which ONE of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep does 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.

QUESTION (B.3) [2.0]
Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

	COLUMN A		COLUMN B
a.	10 mRem/hr	1.	Unrestricted Area
b.	150 mRem/hr	2.	Radiation Area
c.	10 Rem/hr	3.	High Radiation Area
d.	550 Rem/hr	4.	Very High Radiation Area

QUESTION (B.4) [2.0]
Identify each of the following as either a Channel Check, Channel Test or Channel Calibration, as defined by Technical Specifications.

a. Observe overlap between startup channel and intermediate range.

b. Replace resistance temperature detector (RTD) with a precision resistance bridge to check proper temperature circuit operation.

c. Monitor nuclear instrumentation after shutdown verifying that power decreases by a factor of 10 in three minutes.

d. Based on a heat balance (calorimetric) performed on the primary system, adjust Nuclear Instrumentation.

QUESTION (B.5) [2.0]
Identify whether each experiment listed is classified as Class A, B or C from **OSTROP 18** *Procedures for the Approval and Use of Reactor Experiments.*

a. Placing an empty containment tube in lazy susan to test new sample containers.

b. Placing a new experiment into a beam tube.

c. An experiment requiring the movement of reactor shielding.

d. An experiment requiring the movement of reactor fuel.

QUESTION (B.6) [1.0]
Which one of the following is the correct reason that the crane bridge is restricted to the NORTH side of the bay while the reactor is operating at or above 300 Kilowatts?

a. To reduce the potential of neutron embrittlement of the crane parts.

b. To reduce the buildup of fission gases due to restricted ventilation flow.

c. To reduce the buildup of N^{16} and Ar^{41} due to restricted ventilation flow.

d. To reduce the possibility of damage to the core during crane operations.

QUESTION (B.7) [1.0]
During an **EMERGENCY**, you received 2 REM performing actions that you volunteered to do to mitigate the accident. How is this radiation dose tracked?

a. It is tracked as part of the normal dose (5 REM/year) allowed for a radiation worker.

b. It is tracked as part of your Planned Special Exposure limit (5 REM per year, 15 REM per lifetime.

c. As an emergency dose it is not tracked on-site, but is reported to NRC.

d. As an emergency dose it is not tracked at all.

QUESTION (B.8) [1.0]
Who of the following listed personnel has responsibility for authorizing reentry following an evacuation of the facility?

a. Emergency Director

b. Campus Radiation Safety Officer

c. Emergency Coordinator

d. Senior Health Physicist

QUESTION (B.9) [1.0]
During maintenance in the reactor bay a hot spot is reading 5,000 mrem/hr at a distance of 2 feet. Assuming no shielding available, at what distance from the source must you set up a HIGH radiation area boundary?

a. 4½ feet

b. 15 feet

c. 21 feet

d. 101 feet

QUESTION (B.10) [1.0]
You are given a personnel dosimeter with a maximum reading of 200 mr/hr. You are assigned to work in an area with a general radiation dose of 15 mr/hr. How long can you work without having to leave to rezero your dosimeter? (Assume no hot spots, and all equipment is working fine.)

a. 8 hours

b. 12 hours

c. 16 hours

d. 20 hours

QUESTION (B.11) [1.0]
The Emergency Plan discusses all four of the listed Emergency Classifications. Which ONE of the four listed is described as NOT CREDIBLE based on the Safety Analysis Report?

a. Alert

b. Notification of Unusual Event

c. Personnel and Operational Events

d. Site Area Emergency

QUESTION (B.12) [1.0]
Which ONE of the following is the Technical Specification BASIS for the Limiting Condition for Operation for pool water temperature being maintained below 120°F?

a. To prevent damage to resin in the purification system.

b. To prevent cavitation in the primary coolant pump.

c. To maintain the integrity of the Aluminum Reactor Tank

d. To ensure correct operation of the conductivity cells in the purification system.

QUESTION (B.13) [1.0]
Who by title is the lowest level of OSTR management who may authorize restart of the reactor.

a. Reactor (Console) Operator

b. Reactor Supervisor

c. Reactor Administrator

d. Radiation Center Director

QUESTION (B.14) [1.0]
Which ONE of the following is the maximum number of times the reactor may be pulsed in a one hour period, without Reactor Supervisor permission.

a. Three

b. Six

c. Nine

d. Twelve

QUESTION (B.15) [1.0]
During an emergency, plant conditions have degraded badly enough that in order to ensure the health and safety of the public you must deviated from technicai specifications, per 10 CFR 50.54(x). What is the minimum level of OSTR management approval you must have to take this action?

a. Licensed Reactor Operator

b. Any licensed Senior Reactor Operator

c. Reactor Administrator

d. A quorum of the Reactor Operations Committee.

QUESTION (B.16) [1.0]
During operations the console operator encounters an unusual condition, prompting him/her to shutdown the reactor and suspend operations. Which one of the following is the concurrences required to restart the reactor?

a. The Console Operator, and the Reactor Supervisor.

b. The Reactor Supervisor and the Reactor Administrator.

c. The Console Operator, and the Reactor Supervisor.

d. The Console Operator, the Reactor Supervisor and the Reactor Administrator.

QUESTION (B.17) [1.0]
Which ONE of the following is the SAFETY LIMIT for the maximum temperature for a FLIP TRIGA fuel element.

a. 800°C

b. 950°C

c. 1000°C

d. 1150°C

QUESTION (C.1) [2.O]
Identify whether the equipment listed remains energized (System A), reenergizes after emergency generator starts [20 seconds] (System B) or remains deenergized (No Power) following a loss of normal AC power to the facility.

a. Argon Fan

b. Public Address System

c. Fire Alarm System

d. Stack Monitor Pump

e. Cypher Locks

f. Rabbit Fan

QUESTION (C.2) [1.0]
Which ONE of the following is the main function performed by the DISCRIMINATOR circuit in the startup channel?

a. To generate a current signal equal and of opposite polarity as the signal due to gammas generated within the Log-N Channel Detector.

b. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Log-N Channel Detector.

c. To convert the linear output of the Log-N Channel Detector to a logarithmic signal for metering purposes.

d. To convert the logarithmic output of the metering circuit to a δt (differential time) output for period metering purposes.

QUESTION (C.3) [1.0]
Water returning to the pool from the primary system is ejected through an angled nozzle, which causes a swirling motion in the pool. Which ONE of the following is the PRIMARY purpose for this design?

a. To increase the heat transfer rate due to increased convective flow.

b. To decrease the activation rate of O^{16} to N^{16} due to a decrease in time within the core.

c. To increase the transport time for N^{16} to reach the surface of the pool.

d. To break up O^{16} bubbles in the pool thereby decreasing the production of N^{16}.

QUESTION (C.4) [1.0]
Which ONE of the Nuclear Instrumentation channels/circuits listed below does NOT provide an input to the Regulating Rod Automatic Control circuit?

a. Linear Power

b. % Power

c. Log-N

d. Percent Demand

QUESTION (C.5) [1.0]
Which ONE of the following is NOT a design function of the purification system.?

a. Reduce radiation level due to dissolved ions.

b. Reduce corrosion due to dissolved ions.

c. Reduce radiation levels due to suspended solids.

d. Reduce radiation level due to gases in solution.

QUESTION (C.6) [1.0]
While operating in AUTOMATIC mode, the reactor operator depresses the UP button for a control rod. At the same time, the AUTOMATIC circuit energizes to drive the regulating rod up. Which ONE of the following will actually take place.

a. Due to the *ONE ROD WITHDRAWAL* interlock, only the CONTROL ROD will move.

b. Due to the *ONE ROD WITHDRAWAL* interlock, only the REGULATING ROD will move.

c. Due to the *ONE ROD WITHDRAWAL* neither rod will move.

d. THE *ONE ROD WITHDRAWAL* does not apply and both rods will move.

QUESTION (C.7) [1.0]
Which ONE of the following is the gas used in the pneumatic tube system?

a. Air

b. CO_2

c. N_2

d. He

QUESTION (C.8) [1.0]
Which ONE of the valve lineups listed below will result in sending a "rabbit" INTO the core? (Use drawing provided with handout.

	OPEN	SHUT
a.	A & B	C & D
b.	C & D	A & B
c.	A & C	B & D
d.	B & D	A & C

QUESTION (C.9) [1.0]
Which ONE of the following detectors is the most likely to detect a fuel element failure first?

a. Continuous Air Monitor

b. Stack Gas Monitor

c. Stack Particulate Monitor

d. Primary Coolant Reactivity Monitor

QUESTION (C.10) [1.0]
Which ONE of the following is the actual method used to generate the rod position indication on the control panel?

a. Voltage changes generated by the movement of a lead screw between two coils of a transformer.

b. A potentiometer linked to the rod drive motor

c. A series of several reed switches which as the rod moves up close to generate a current proportional to rod position.

d. A servo motor connected to the UP and DN buttons which when either button is depressed generates a signal proportional to rod speed.

QUESTION (C.11) [1.0]
You (the console operator) receive a report of thick black smoke coming from the demin pump. Where would you send someone to deenergize the breaker that supplies the pump?

a. Room 106 to Sub Distribution Panel A

b. Room 106 to Panel "G"

c. Reactor Bay Panel "A"

d. First Floor Hallway Panel "F"

QUESTION (C.12) [1.0]
Which ONE of the following is the neutron source utilized at OSTR?

a. ^{241}Am — ^{9}Be

b. ^{239}Pu — ^{9}Be

c. ^{210}Po — ^{9}Be

d. ^{124}Sb — ^{9}Be

QUESTION (C.13) [1.0]
What is the purpose of the Cadmium Lined In-Core Irradiation Tube (CLICIT)

a. To allow irradiation of samples by neutrons with an energy level greater than 0.5 ev.

b. To allow irradiation of samples by neutrons with an energy level of less than 0.5 ev.

c. To allow irradiation of samples by gammas within the core.

d. To allow irradiation of samples by alphas produced by the neutron interaction with the cadmium.

QUESTION (C.14) [1.0]
Which ONE of the following channels recorded by the **BLUE** pen on the console recorder, when the MODE switch is in the PULSE LO position?

a. Fuel Temperature

b. Linear Channel

c. Power Range Monitor nv circuit

d. Safety Channel

QUESTION (C.15) [1.0]
The ventilation system is designed to maintain reactor bay pressure slightly negative pressure with respect to the atmospheric pressure. If the outside atmospheric pressure increases, which ONE of the following actions will automatically occur to compensate the reactor bay pressure? A pressure regulator will generate a signal to ...

a. Increase the Reactor Bay Supply fan speed to increase bay pressure.

b. Decrease the Reactor Bay Exhaust fan speed to increase bay pressure.

c. Go more closed on a damper in the ventilation exhaust ducting increasing bay pressure.

d. Go more open on a damper in the ventilation supply ducting increasing bay pressure.

QUESTION (C.16) [1.0]
Which ONE of the following components in the purification system is PRIMARILY responsible for maintaining the primary coolant system conductivity low.

a. The surface skimmer

b. The pre-demineralizer filter

c. The demineralizer

d. The post-demineralizer filter

QUESTION (C.17) [1.0]
During a survey of the demineralizer ½ hour after shutdown, you note that the dose rate has increased by a factor of 10 over the previous day's reading. Is this normal or abnormal, and why?

a. Normal, due to N^{16} in the coolant.

b. Abnormal, due to the concentration of H^3 in the demineralizer.

c. Abnormal, due to fission products in the demineralizer.

d. Normal, due to Ar^{41} entrained in the coolant system.

QUESTION (C.18) [1.0]
Which ONE of the following scrams is available during pulsing operations?

a. Loss of Detector High Voltage

b. Safety Power Level

c. Percent Power Level

d. Wide Range Log Power Level

QUESTION (C.19) [1.0]
Which ONE of the following interlocks is NOT required for steady-state operations?

a. Wide Range Log Power Level Channel

b. Transient Rod Cylinder Air

c. Shim, Safety and Regulating Rod Drive Circuit

d. Transient Rod Cylinder Position.

ANSWER (A.1)
a
REFERENCE (A.1)
OSTR Training Manual Vol. III, p. 29
Initial SDM = 2.5$ = 2.5 × 0.007 = 0.0175 ΔK/K. K_{eff1} = 1/(1+SDM) = 1/1.0175 = 0.983
$CR_1/CR_2 = (1 - K_{eff2})/(1 - K_{eff1}) \rightarrow (1 - K_{eff2})$ = 15/30 (1 - 0.983) = ½(0.0170 = 0.00850
K_{eff2} = 1 - 0.00850 = 0.9915 SDM = (1 - 0.9915)/0.9915 = 0.00857
Experiment worth = 0.0086 -0.0189 = 0.0103 ΔK/K ÷ 0.007 = $1.475

ANSWER (A.2)
c
REFERENCE (A.2)
OSTR Training Manual Vol. III, Example on p. 41 (After prompt drop.)

ANSWER (A.3)
a
REFERENCE (A.3)
Glasstone, S & Sesonske, A., *Nuclear Reactor Engineering*, 3rd Edition, Kreiger Publishing, Malabar, Florida, 1991, Table 3.3, p. 164

ANSWER (A.4)
b
REFERENCE (A.4)
Glasstone, S & Sesonske, A., *Nuclear Reactor Engineering*, 3rd Edition, Kreiger Publishing, Malabar, Florida, 1991, Table 2.6, p. 100

ANSWER (A.5)
b
REFERENCE (A.5)
OSTR Training Manual Vol. III, pp. 22 & 23

ANSWER (A.6)
d
REFERENCE (A.6)
OSTR Training Manual Vol. III, p. 30

ANSWER (A.7)
a
REFERENCE (A.7)
OSTR Training Manual Vol. III, p. 10

ANSWER (A.8)
c
REFERENCE (A.8)
OSTR Training Manual Vol. III, p. 30

ANSWER (A.9)
b
REFERENCE (A.9)
OSTR Training Manual Vol. III, p. 30
SDM = $(1-k_{eff})/k_{eff}$ = (1-0.85)/0.85 = 0.15/0.85 = 0.1765, or a reactivity worth (ρ) of -0.1765. Adding + 0.176 reactivity will result in a SDM of 0.1765 - 0.1760 = 0.0005. K_{eff} = 1/(1+SDM) = 1/(1 + 0.0005) = 0.9995

ANSWER (A.10)
c
REFERENCE (A.10)
OSTR Training Manual Vol. III, pp. 16 and 66 — 68
Reactivity due to temperature increase: 150°C × -0.00005/°C = -0.0075. To compensate you must ADD +0.0075 worth of reactivity (move rods out) 0.075/0.0001 $inch^{-1}$ = 7.5 inches

ANSWER (A.11)
d
REFERENCE (A.11)

$$\dot{Q} = \dot{m} c_p \Delta T$$

$$\dot{Q} = 490\frac{gallons}{minute} \times 8\frac{lbm}{gallon} \times 60\frac{minutes}{hour} \times 1\frac{BTU}{°F\text{-}lbm} \times 14°F \times \frac{1Mw}{3.41 \times 10^6 BTU}$$

= 0.966 Mw or 966 kilowatts

ANSWER (A.12)
b
REFERENCE (A.12)
OSTR Training Manual Vol. III, Example on p. 41 (After prompt drop.)

ANSWER (A.13)
c
REFERENCE (A.13)
OSTR Training Manual Vol. III, p. 41

ANSWER (A.14)
c
REFERENCE (A.14)
OSTR Training Manual Vol. III, p. 51

ANSWER (A.15)
DELETED PER FACILITY COMMENT
REFERENCE (A.15)
OSTR Training Manual Vol. III, p. 28

ANSWER (A.16)
d
REFERENCE (A.16)
OSTR Training Manual Vol. III, pp. 84 — 87.

ANSWER (A.17)
b
REFERENCE (A.17)
OSTR Training Manual Vol. III, pp. 6 — 8.

ANSWER (A.18)
c
REFERENCE (A.18)
OSTR Training Manual Vol. III, p. 48

ANSWER (A.19)
d **Answer changed per facility comment**
REFERENCE (A.19)
OSTR Training Manual Vol. III, pp. 22 — 24.

ANSWER (A.20)
b
REFERENCE (A.20)
Glasstone, S & Sesonske, A., *Nuclear Reactor Engineering*, 3rd Edition, Kreiger Publishing, Malabar, Florida, 1991, § 6.25, p. 337

ANSWER (B.1)
b
REFERENCE (B.1)
¼ inch of lead reduces the radiation level by ½. Adding another ½ inch gives a total of three ½-thicknesses. Final radiation level will be $I = I_0 \times (½)^3$ = 1000 mRem/hr × ⅛ = 125 mRem/hr

ANSWER (B.2)
a
REFERENCE (B.2)
10 CFR 20.1003 *Definitions*

ANSWER (B.3)
a, 2; b, 3; c, 3; d, 4
REFERENCE (B.3)
10 CFR 20.1003, Definitions

ANSWER (B.4)
a, Check; b, Test; c, Check; d, Cal.
REFERENCE (B.4)
OSTR Technical Specifications, § 1.0 *Definitions*

ANSWER (B.5)
a, A; b, B; c, B; d, B or C **Second correct answer added per facility comment.**
REFERENCE (B.5)
OSTROP 18.0 § 18.4, Classification of Reactor Experiments p. IV.18.3.

ANSWER (B.6)
c
REFERENCE (B.6)
OSTROP 23, *Crane Operation Procedures*, § 23.3, Limitations on Crane Operation p. IV.23.4.

ANSWER (B.7)
b or a **Second correct answer added per facility comment.**
REFERENCE (B.7)
10 CFR 20.1206

ANSWER (B.8)
c
REFERENCE (B.8)
Emergency Response Plan, § 3.3.2 Authorities and Responsibilities of Facility Emergency Personnel, p. 3-7.

ANSWER (B.9)
b
REFERENCE (B.9)
100 mrem $(x\ ft)^2$ = 5000 mrem/hr $(2\ ft)^2$ X^2 = 5000/100 × 4 = 200 ft^2 X = 14.14 feet ≈ 15 feet

ANSWER (B.10)
b
REFERENCE (B.10)
200 mr/hr ÷ 15 mr = 40/3 = 13.333 hr

ANSWER (B.11)
d
REFERENCE (B.11)
Emergency Response Plan, § 4.0 Emergency Classification System

ANSWER (B.12)
c
REFERENCE (B.12)
Technical Specification 3.7, pp. 14 - 15.

ANSWER (B.13)
b
REFERENCE (B.13)
Emergency Operating Procedures § 1.2 Automatic Scrams, p. IV.1.2

ANSWER (B.14)
b
REFERENCE (B.14)
OSTROP 4, *Reactor Operation Procedures,* p. 9.

ANSWER (B.15)
b
REFERENCE (B.15)
OSTROP 1, *Emergency Operating Procedures,* § 1.E, p. 1

ANSWER (B.16)
d
REFERENCE (B.16)
OSTROP 1, 6, *Administrative and Personnel Procedures,* § VI.B.5, p. 24.

ANSWER (B.17)
d **Answer changed per facility comment.**
REFERENCE (B.17)
OSTR Technical Specifications, § 2.1 *Safety Limit — Fuel Element Temperature,* p. 6

ANSWER (C.1)
a, N; b, A; c, B; d, B; e, B; f, N
REFERENCE (C.1)
OSTROP 22.0 Emergency Power System, Figures 22.1, and 22.2

ANSWER (C.2)
b
REFERENCE (C.2)
OSTR Training Manual Vol. 2, § IIIA, page 13.

ANSWER (C.3)
c
REFERENCE (C.3)
OSTR Training Manual Vol. I, page 106

ANSWER (C.4)
b
REFERENCE (C.4)
OSTR Training Manual Vol II, Fig. 2.16

ANSWER (C.5)
d
REFERENCE (C.5)
OSTR Training Manual Vol. I, pg. 106

ANSWER (C.6)
d
REFERENCE (C.6)
OSTR Training Manual Vol II, p. 9.

ANSWER (C.7)
a
REFERENCE (C.7)
OSTR Training Manual, Vol I p. 70.

ANSWER (C.8)
c
REFERENCE (C.8)
OSTR Training Manual, Vol I, fig. 1.40 Standard Rabbit System Schematic, p. 71.

ANSWER (C.9)
a
REFERENCE (C.9)
Oregon State University TRIGA reactor Training Manual, *Radiological Protection*, p. 21

ANSWER (C.10)
b
REFERENCE (C.10)
OSTR Training Manual, Vol I, fig. 1.26 TRIGA Control Rod Drive Mechanism, p. 48.

ANSWER (C.11)
b
REFERENCE (C.11)
OSTROP 22.0 *Emergency Power System*, Fig. 22.1 One-Line Schematic Power Distribution

ANSWER (C.12)
a
REFERENCE (C.12)
OSTR Training Manual, Vol. I, p. 30 — 32

ANSWER (C.13)
a
REFERENCE (C.13)
OSTR Training Manual, Vol. I, p. 81.

ANSWER (C.14)
c
REFERENCE (C.14)
OSTR Training Manual Vol. II, fig. 2.17, p. 36

ANSWER (C.15)
c
REFERENCE (C.15)
OSTR Training Manual, Vol. I p. 148.

ANSWER (C.16)
c
REFERENCE (C.16)
OSTR Training Manual Vol. I, p. 116.

ANSWER (C.17)
c
REFERENCE (C.17)
OSTR Training Manual, Vol. I, p. 116

ANSWER (C.18)
a
REFERENCE (C.18)
OSTR Technical Specifications, TABLE I, p. 12

ANSWER (C.19)
d
REFERENCE (C.19)
OSTR Technical Specifications, TABLE II p. 12.

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

FACILITY: Oregon State University

REACTOR TYPE: TRIGA (Pulsing)

DATE ADMINISTERED: 1996/10/21

REGION: IV

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 paren-theses for each question. A 70% overall 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
20.00	33.3	_____	_____	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	_____	_____	C.	PLANT AND RADIATION MONITORING SYSTEMS
60.00		_____ . ___% FINAL GRADE			TOTALS

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

____
Candidate's Signature

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.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

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 kg = 2.21 lbm

1 Horsepower = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 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

ANSWER SHEET

A.1	a b c d	___
A.2	a b c d	___
A.3	a b c d	___
A.4	a b c d	___
A.5	a b c d	___
A.6	a b c d	___
A.7	a b c d	___
A.8	a b c d	___
A.9	a b c d	___
A.10	a b c d	___
A.11	a b c d	___
A.12	a b c d	___
A.13	a b c d	___
A.14	a b c d	___
A.15	a b c d	___
A.16	a b c d	___
A.17	a b c d	___
A.18	a b c d	___
A.19	a b c d	___
A.20	a b c d	___

ANSWER SHEET

B.1 a b c d ___

B.2 a b c d ___

B.3a 1 2 3 4 ___

b 1 2 3 4 ___

c 1 2 3 4 ___

d 1 2 3 4 ___

B.4a check test calibration ___

b check test calibration ___

c check test calibration ___

d check test calibration ___

B.5a A B C ___

b A B C ___

c A B C ___

d A B C ___

B.6 a b c d ___

B.7 a b c d ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

ANSWER SHEET

C.1a Sys-A Sys-B No-Power ___

b Sys-A Sys-B No-Power ___

c Sys-A Sys-B No-Power ___

d Sys-A Sys-B No-Power ___

e Sys-A Sys-B No-Power ___

f Sys-A Sys-B No-Power ___

C.2 a b c d ___

C.3 a b c d ___

C.4 a b c d ___

C.5 a b c d ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10 a b c d ___

C.11 a b c d ___

C.12 a b c d ___

C.13 a b c d ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___

C.18 a b c d ___

C.19 a b c d ___

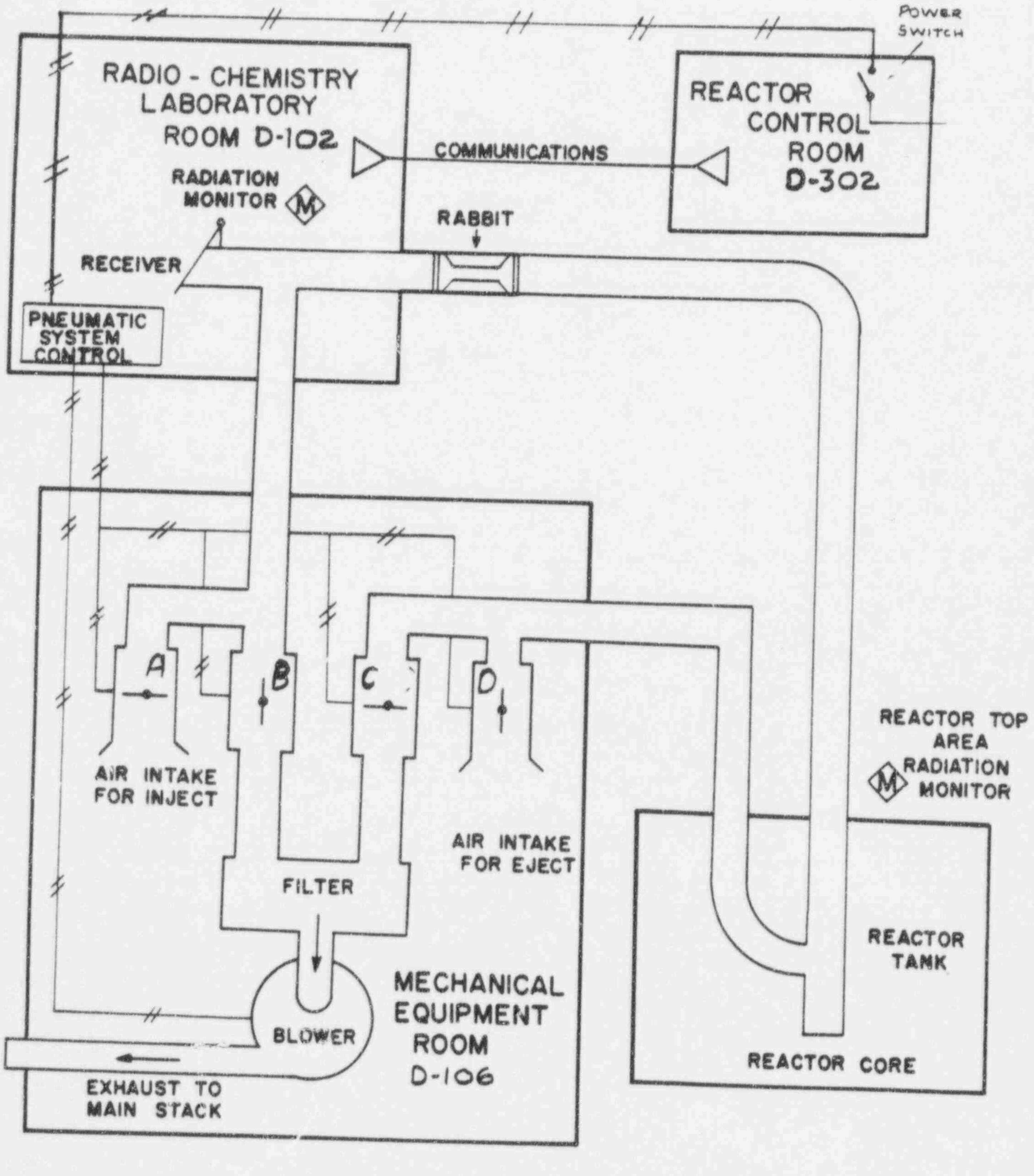


Fig. 1.40--Standard Rabbit System Schematic