ENCLOSURE 1

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

REPORT NO.: 50-186/OL-93-02

FACILITY DOCKET NO.: 50-186

FACILITY LICENSE NO.: R-103

FACILITY: University of Missouri — Columbia

EXAMINATION DATES: November 17, 1993

EXAMINER: Paul Doyle, Chief Examiner

SUBMITTED BY: _____ 12-23-93
Paul Doyle, Chief Examiner — Date

APPROVED BY: _____ 12/23/93
James I. Caldwell, Chief — Date
for Non-Power Reactor Section
Operator Licensing Branch
Division of Reactor Controls
and Human Factors,
Office of Nuclear Reactor Regulation

SUMMARY:

On November 17, 1993, the NRC and facility jointly administered a facility generated NRC approved Operator Licensing Requalification written examination to five Senior Reactor Operators. All five Senior Reactor Operators passed the examination.

REPORT DETAILS

1. Examiners:

   Paul Doyle, Chief Examiner
   Michael Wallis, Univ. of Missouri-Columbia

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail	Total (Pass/Fail)
NRC Grading:	0/0	5/0	5/0
Facility Grading:	0/0	5/0	5/0

3. Written Examination:

   On November 17, 1993 the NRC and facility jointly administered a facility generated NRC approved Operator Licensing Requalification Written Examination to five Senior Reactor Operators.

4. Operating Tests:

   No operating tests have been administered as of this time.

5. Exit Meeting:

   Paul Doyle, Chief NRC Examiner
   Michael Wallis, Univ. of Missouri-Columbia Examiner

   Mr. Doyle met briefly with Mr. Wallis. During the meeting Mr. Wallis furnished copies of the written examinations for all five SROs. Mr. Doyle informed Mr. Wallis of the requirements for forwarding grading results and asked when the facility planned on administering requalification examinations to the five Senior Reactor Operators. The facility is tentatively considering February 1994 for the administration of the operating test portion of the examinations.

ENCLOSURE 1

CATEGORY A

REACTOR THEORY, THERMO DYNAMICS, AND FACILITY OPERATING CHARACTERISTICS QUESTIONS

RTFO 1. Reactor period is the time it takes for reactor power to :
a. Change by a factor of e.
b. Double.
c. Change by a factor of 10.
d. Stabilize after a rod movement.

RTFO 2. In reactor theory, a poison can best be described as:
a. Radioactive gases which if un-contained, would present significant hazards to personnel.
b. Ionizing Radiation.
c. Anything which absorbes neutrons and does not produce fission.
d. Unwanted Plutonium as a result of U^{239}.

RTFO 3. The reactor is on a positive period during a reactor start up. Power rises from $2x10^{-6}$ to $8x10^{-6}$ amps (CH-3) in two (2) minutes. What is the reactor period?
a. 30 seconds.
b. 60 seconds.
c. 86.56 seconds.
d. 92.75 seconds.

RTFO 4. Using the following information compute a manual reactor heat balance:

Reactor flows	1940 gpm and 1930 gpm
Pool flows	625 gpm and 635 gpm
Demin flows	50 gpm pool and 50 gpm primary
Primary ΔT	16.1
Pool ΔT	5.6

a. 9.43 MW
b. 9.76 MW
c. 9.87 MW
d. 10.01 MW

RTFO 5. The pool system has a POSITIVE VOID COEFFICIENT because:
a. It is the ONLY way to insure adequate neutron flux for our samples.
b. If boiling were to occur in the Flux Trap region, it would then add negative reactivity, effectively placing the reactor in a safe condition.
c. The Flux Trap region is over moderated.
d. The Reactor core region is over moderated.

RTFO 6. The major source of neutrons used a for normal reactor start up at this reactor is:
a. The 100 curie (Antimony-Beryllium) neutron source normally placed in close proximity to the core.
b. Once the reactor has been initially run, due to spontaneous fission, a reactor source is normally no longer needed.
c. Source strength free neutrons exist at all times in the moderator as a result of N_{16} decay.
d. The (gamma-neutron) reaction in the Be^9 reflector ring as a result of the radioactive decay of previously activated structural materials.

RTFO 7. What causes the mechanical equipment room #114 radiation hazard during reactor operation?

a. The demineralizer resin becomes hot during reactor operation due to radioactive ions being removed.
b. There is always minute amounts of U_{235} which sluffs off the fuel during operation as a result of erosion due to high cooling flow rates.
c. Oxygen 17 becomes activated resulting in Nitrogen 17 decay by Proton/Gamma emission.
d. Oxygen 16 becomes activated resulting in Nitrogen 16 decay by Gamma emission.

RTFO 8. The reactor is considered CRITICAL when:

a. Power is either increasing or decreasing.
b. $K_{eff} = 1$.
c. Rods are withdrawn too quickly and a possible accident condition is developing.
d. $1/M = 1$.

RTFO 9. BINDING ENERGY is best defined as:

a. Minimum strength standard terminology used for the manufacture of fuel elements for Research Reactors.
b. Energy defined as equal to the mass of ANY atom.
c. The nuclear term equivalent of gravitational force.
d. Energy equal to the mass defect.

RTFO 10. The term departure from nucleate boiling means:

a. The point at which nucleate boiling ends and film boiling begins.
b. A dangerous high temperature condition as a result of a power and temperature excursion is over.
c. A steam layer which has prevented adequate heat transfer from the fuel plates to the cooling medium is dissipating.
d. The point at which fuel melting is eminent.

RTFO 11. According to Technical Specifications, Safety Limits are:
a. Limits on reactivity worth of all experiments in the reflector region of the reactor.
b. Settings for automatic protection devices on those variables having significant safety functions.
c. Limits on important process variables which are necessary to protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.
d. Limits on the maximum fuel loading allowed for our core.

RTFO 12. The reactor is operating in automatic control at 10 MW. Assuming all other conditions remain constant, over a period of time the average primary temperature increases from $120^{O}F$ to $125^{O}F$. Given Primary $\alpha T = -7.0 \times 10^{-5}$ $\delta k/^{O}F$ and Reg Blade = 8.85×10^{-5} δK/inch, what will the approximate change in Reg Blade height be.
a. 8" in.
b. 8" out.
c. 4" in.
d. 4" out.

RTFO 13. The major contributor of the production of Xe-135 in a reactor operating at full power is:
a. Direct production from fission of U-238.
b. The radioactive decay of Iodine.
c. The radioactive decay of Promethium.
d. Direct production from fission of U-235.

RTFO 14 The absolute value of the reactivity worth of all experiments in the center test hole shall not exceed:

a. 0.003 Δk
b. 0.020 Δk
c. 0.006 Δk
d. 0.005 Δk

RTFO 15. The production of Sodium-24 presents a significant radiation hazard to personnel in the reactor pool. Where does Na^{24} come from?

a. Na^{24} is produced as a bi-product of the water softening process in preparation of primary grade water.
b. Na^{24} is produced as a result of neutron interaction in our nuclear instruments.
c. Na^{24} is produced as a result of neutron interaction in our aluminum sample cans.
d. Na^{24} is produced as a result of neutron interaction in silicon.

RTFO 16. Which of the following is the definition for the FAST FISSION FACTOR?

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

RTFO 17. The Limiting Safety System Settings for Mode I operation are:

	Reactor Power	Primary Flow	Rx Inlet Temp	Primary Press
a.	125 %	1625 gpm	155°F	63 psia
b.	115 %	1625 gpm	155°F	75 psia
c.	125 %	1800 gpm	155°F	75 psia
d.	125 %	1625 gpm	155°F	75 psia

RTFO 18. A primary cooling system loss of pumps 501A/B will cause?

a. The reactor to scram and valves 546A/B to open.
b. The reactor to scram and valves 543A/B to open.
c. The reactor to scram and valves 507A/B to close.
d. The reactor to scram and valve 527C to close.

RTFO 19. A reactor has a count rate of 45 cps with a K_{eff} of 0.965. What will the K_{eff} be when the count rate reaches 90 cps?

a. .9800.
b. .9825.
c. .9850.
d. .9875.

RTFO 20. What is IRRADIATED FUEL?

a. Fuel with visible cerenkov radiation emanating.
b. Fuel with operating history as defined by the Reactor Physicist.
c. Fuel used to an integrated power of >1MW day .
d. Any fuel which has been exposed to a neutron source and has experienced subcritical multiplication.

RTFO 21. When can the master switch be in the "ON" position and the reactor be secured?

a. When all blades are fully inserted and no work is in progress involving transferring fuel in the core.
b. When a licensed Reactor Operator is in the control room with the pressure vessel head removed.
c. When a licensed Reactor Operator is in the control room, the dummy load test connectors are in place and the pressure vessel head is removed.
d. There is insufficient fuel in the reactor to establish criticality with all four control blades fully withdrawn.

RTFO 22. When is channel #1 (SRM) NOT required ?

a. During a reactor start up in which a 1/M critical prediction procedure is being performed.
b. Once reactor power is above the IRM Channel #1 count rate bypass set point.
c. When at a stable power level following a reactor start up.
d. Any time the detector is in the full out position.

RTFO 23. The Fuel Failure Monitor is required:

a. Any time the reactor is not shutdown, with the exception that it may be OOC if the primary water is sampled and analyzed manually every four hours.
b. Any time the reactor is not shutdown, without exception.
c. Only during fuel transfer, regardless of the reactor's operational status.
d. Only if the Stack Monitor is OOC. With the exception that the Stack Monitor can be OOC for 4 hours without the Fuel Failure Monitor being in operation.

RTFO 24. The term delayed neutron precursor can be described as:
a. The fraction of thermal neutrons which are born delayed.
b. A fission product nuclide which decays to an excited daughter which, in turn, emits a delayed neutron.
c. Neutrons emitted directly from fission.
d. Any neutron emitted 10^{-14} seconds after fission.

RTFO 25. K_{eff} is different from K_{inf} in that:
a. K_{eff} takes in to consideration leakage from the core
b. K_{eff} includes neutrons from fast fission K_{inf} does not.
c. K_{inf} does not include the reproduction factor.
d. K_{eff} takes into consideration poisons K_{inf} does not.

RTFO 26. Beta and beta effective both describe the total fraction of delayed neutrons, however, the difference between the two is?
a. Beta effective is smaller than beta since delayed neutrons are born at lower energy levels than prompt neutrons.
b. Beta effective is larger than beta since delayed neutrons are born at lower energy levels than prompt neutrons.
c. Beta effective is smaller than beta since delayed neutrons are born at higher energy levels than prompt neutrons.
d. Beta effective is larger than beta since delayed neutrons are born at higher energy levels than prompt neutrons.

RTFO 27. Which one of the following best describes the characteristics of a good moderator?

a. Low scattering cross section and low absorption cross section.
b. Low scattering cross section and high absorption cross section.
c. High scattering cross section and low absorption cross section.
d. High scattering cross section and high absorption cross section.

RTFO 28. Which one of the following is the maximum allowable excess reactivity in the reactor as specified by Techical Specifications?

a. 0.150 Δk/k.
b. 0.135 Δk/k.
c. 0.112 Δk/k.
d. 0.098 Δk/k.

RTFO 29. A complete core loading is in progress on a non-power reactor and during that loading, the following data was taken.

Number of Elements Installed	Detector A (cpm)	Detector B (cpm)
0	11	13
2	13	15
4	17	18
6	22	22
8	34	30

Using the 1/M plot provided, determine which of the following is the approximate number of fuel elements that will be required to be loaded for a critical mass?

a. 8
b. 10
c. 12
d. 14

RTFO 30 The number of neutrons passing through a one square centimeter of target material per second is the definition of which of the following?

a. Neutron Population (np)
b. Neutron Impact Potential (nip)
c. Neutron Flux (nv)
d. Neutron Density (nd)

(**** END OF SECTION A ****)

CATEGORY B

NORMAL AND EMERGENCY OPERATING PROCEDURES & RAD CON

OPRC 1) During a normal Rx startup to 10 mw we are required to stabilize power at two different power levels, what are these power levels?

a) 50 kw & 5 mw
b) 50 kw & 500 kw
c) 10 kw & 1 mw
d) 100 kw & 1 mw

OPRC 2) Responsibility for providing a reliable E.C.P. after fuel handling has taken place lies with the _____.

a) Operations engineer
b) Rx manager
c) Shift supervisor
d) Reactor physicist

OPRC 3) Which of the following is <u>not</u> a requirement for automatic operation?

a) Reg. blade 60% withdrawn annunciator energized
b) Channel 4 WRM recorder reading greater than the 75% red setpoint
c) Channel 2 & 3 IRM recorder indication greater than 10^{-8} amps
d) Channel 4 range switch 5 kw red scale or greater
e) Channel 2 & 3 period greater than 35 sec

OPRC 4) If there are radiation levels at the site boundary of_____ mr/hr whole body or _____ mr/hr thyroid dose then at least an alert condition exists.

a) 10,50
b) 20,100
c) 10,100
d) 20,50

OPRC 5) Containment integrity shall be maintained at all times except when:

a) The reactor is secured and irradiated fuel with a decay time of greater than 60 days is not being handled.
b) The reactor is secured and irradiated fuel with a decay time of less than 60 days is not being handled.
c) The reactor is shutdown and irradiated fuel with a decay time less than 60 days is not being handled.
d) The reactor is shutdown and irradiated fuel with a decay time of greater than 60 days is not being handled.

OPRC 6) When handling radioactive material around the pool, above what dose rate are health physics personal required to be present?

a) 50 mr/hr
b) 100 mr/hr
c) 75 mr/hr
d) 200 mr/hr

OPRC 7) What immediate action should be taken by the duty operator if a piece of equipment is causing a radiation hazard?

a) Call in an off duty operator
b) Notify MU public relations
c) Reduce power by Rod-Run -In
d) SCRAM

OPRC 8) An accessible area with a radiation level of 150 mr/hr should be posted as a(n) _____.

a) Restricted area
b) Radiation area
c) High radiation area
d) Exclusion area

OPRC 9) An unscheduled entry into room 114 shall not exceed:

a) 10 min
b) 15 min
c) 30 min
d) 45 min

OPRC 10) If the waste tank activity of nuclides other than tritium is > 2mci, whose authorization is needed to discharge to the sanitary sewer.

a) Senior Reactor Operator
b) Health Physics Manager
c) Operations Engineer
d) Reactor Manager

OPRC 11) To lower the pool below the refuel bridge we must have specific approval from _____.

a) Health Physics Manager
b) Operations Engineer
c) Shift Supervisor
d) Reactor Manager

OPRC 12) The MURR has an annual release limit for H^3 (tritium) of_____ curies.

a) 2
b) 4
c) 6
d) 8

OPRC 13) Who must authorize resumption of reactor operation after a safety limit, as defined by tech. spech, has been exceeded?

a) Reactor Safety Subcommittee
b) Reactor Advisory Committee
c) Reactor Manager
d) Nuclear Regulatory Commission

OPRC 14) The Rx off-gas stack monitor may be taken out of service for a period of up to _____ hours for maintenance or calibration during Rx operation.

1) .5
2) 1
3) 1.5
4) 2

OPRC 15) Boron carbide (B_4C) may be used as burnable poison in MURR fuel elements.

1) True
2) False

OPRC 16) Match the following Tech. Spec. reactivity limits.

1) ___ Core temp. coefficient (delta K / degree)
2) ___ Total reg. blade worth (delta K)
3) ___ Max shim insertion rate from all blades (delta K / sec)
4) ___ Core void coefficient (delta K / % void)
5) ___ Max. secured removable experiment (delta K)
6) ___ Max. movable experiment (delta K)

A) -2×10^{-3}
B) -6×10^{-5}
C) 3.0×10^{-4}
D) 0.006
E) 1×10^{-3}
F) 0.02

OPRC 17) On April 1st, a radiation worker is working in a 350 mr/hr gamma field. How long until this worker exceeds his quarterly whole body dose limit?

1) 3.57 hrs. 2) 53.57 hrs. 3) 21.42 hrs. 4) 3.25 hrs.

OPRC 18) To prevent damage to N.I. detectors or high voltage power supplies during maintenance or testing the drawer must be placed in the _____ position.

1) Standby
2) zero/zerc 1
3) Cal

OPRC 19) MURR classifies a REACTOR ISOLATION as:

a) a reactor emergency
b) a facility emergency
c) a site area emergency
d) a containment building emergency

OPRC 20) After a reactor shutdown due to a momentary loss of electrical power:

a) The reactor may be operated only after performing a full-power startup checksheet .

b) Place all valve controls in their normal shutdown position in manual mode.

c) Turn off all pumps and cooling tower fans in an expeditious manner.

d) The reactor may be operated after performing a reactor shortform precritical checksheet.

OPRC 21) If there is a loss of physical control of the facility then at least a(an) _____ emergency classification exists.

a) alert
b) site area
c) unusual event
d) facility

OPRC 22) During a cask handling event, a 100 Ci source of iridium falls out of a cask. An operator immediately picks up the source and tosses it back in the pool (total contact time 1.2 seconds). Assuming a contact hand dose of 1850 rem/hr/Ci:

a) What is the hand dose?
b) How long did it take to exceed the quarterly limit for extremities?

OPRC 23) Concentration of airborne radioactivity at the stack monitor exceeding 3800 mpc when averaged over a 24 hours would constitute at least a(an)?

a) site area emergency
b) alert
c) unusual event
d) this concentration is below our emergency classification levels, therefore, this event alone would be unclassified

OPRC 24) Activity produced from samples run in the P-tube system will normally be limited to:

a) 100 mCi
b) 50 mCi
c) 10 mCi
d) 25 mCi

OPRC 25) Which of the following is the reason for NOT starting two secondary pumps at the same time?

a) The power surge will result in tripping the power supply breakers
b) The pressure surge will cause water hammer in the pool heat exchanger
c) The basin level will be reduced resulting in a low sump level trip
d) Initial high flow rates may result in thermal shock to the heat exchanger

OPRC 26) While working in an area marked "Caution, Radiation Area," an operator discovers his dosimeter is off scale and leaves the area. If he had been working in the area for 45 minutes, which one of the following is the maximum dose he should have received?

a) 1 Rem
b) 100 mrem
c) 75 mrem
d) 45 mrem

OPRC 27) Which one of the following is responsible for determining if an RWP is required to conduct work at the facility?

a) shift supervisor
b) the job supervisor
c) radiation safety officer
d) reactor manager

OPRC 28) In accordance with the procedure which one of the following is the shortest reactor period which may be used to raise power to 50 kw?

a) 10 second
b) 30 second
c) 50 second
d) 100 second

OPRC 29) Which one of the following indications would result in the declaration of a Site Area Emergency?

a) a concentration of airborne radioactivity at the stack monitor exceeding 95,000 mpc averaged over 24 hours.
b) radiation levels at the site boundary of 20 mrem/hr whole body, or 100 mrem thyroid dose
c) loss of physical control of the facility
d) an explosion within the facility that could result in exposure to the staff of 1 rem whole body or 5 rem thyroid

OPRC 30) The radiation level one (1) foot from a component is 1.2 REM. How much lead shielding is necessary to reduce the radiation level to 10 mrem at one foot?
(assume a μ (Mu) of 1.53)

a) 4.2 inches
b) 3.6 inches
c) 3.0 inches
d) 2.8 inches

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

CATEGORY C

PLANT AND RADIATION MONITORING SYSTEMS

PRMS 1. The reactor shall not be operated if radiochemical analysis indicates iodine 131 concentration exceeds _____ uci/ml in the Primary Coolant.

a. $1x10^{-2}$ b. $5x10^{-2}$ c. $3.5x10^{-3}$ d. $5x10^{-3}$

PRMS 2. The Utility Seal Trench must be filled with water to a depth required to maintain a minimum water seal of _____ when containment integrity is required.

a. 3.5 feet b. 4 feet c. 4.25 feet d. 5 feet

PRMS 3. The reactor shall not be operated unless the reactor makeup water system is operable and connected to a source of at least _____ gallons of primary grade water.

a. 1500 b. 2000 c. 5000 d. 8000

PRMS 4 The fuel burnup limit restricts the peak fissions per cm^3 burnup to values correlated to result in less than a ____ swelling of the fuel plates.

a. 5% b. 10% c. 5 mil d. 1[illegible] mil

PRMS 5. True or False. Radiation hazards from the operation of the pneumatic tube system are minimized by rapid rate of travel of the irradiation container through the system.

PRMS 6. True or False. The vestibule for pedestrian entry at the second level of the reactor building is a portion of the containment system?

PRMS 7. Beamports _____ and _____ are considered "Tangential" while the remaining beamports are "Radial".

a) C & D
b) B & E
c) A & F
d) F & C

PRMS 8. Match the appropriate beamports with the correct diameter and relative height to centerline in adjacent column (answers may be used more than once).

_____ 1. Beamport A	a. 6" -14"
_____ 2. Beamport B	b. 6" -7"
_____ 3. Beamport C	c. 4" -2"
_____ 4. Beamport D	d. 4" -14"
_____ 5. Beamport E	e. 4" -7"
_____ 6. Beamport F	f. 6" -2"

PRMS 9. Match the following valves associated with the pressurizer with the answer that best describes its function.

1. 527A	a. PZR Charging Valve
2. 527B	b. PZR VentValve
3. 526	c. PZR Vent Manual Isolation Valve
4. 545	d. PZR Drain Valve
5. 544	e. PZR Drain Throttle Valve
6. 515AA	f. PZR Nitrogen Supply Valve

PRMS 10. List 4(four) conditions that must be met to satisfy the Rod Withdrawal Prohibit Circuit.

PRMS 11. The Stack Monitor may be placed out of service for maintenance and calibration for a period of ___.

a. 1 Hour
b. 2 Hours
c. 4 Hours
d. 8 Hours

PRMS 12. Which one of the following is a load supplied by the Emergency Generator?

a. Primary Coolant Isolation Valves 507 A/B
b. Reactor Exhaust System Fan EF-14
c Ventilation Fan SF-1
d. Primary Pump P501A

PRMS 13. Match the detector type with the correct Nuclear Instrument Channel.

1. NI Channel 1
a. Fission Chamber
2. NI Channel 2
b. Uncompensated Ion Chamber
3. NI Channel 3
c. Compensated Ion Chamber
4. NI Channel 4
5. NI Channel 5
6. NI Channel 6

PRMS 14. Choose the 2 (two) correct statements regarding operation of the 16" isolation valves.

a. 16A (east valve) air to open air to close
b. 16B (west valve) air to open air to close
c. 16A (east valve) air to open spring to close
d. 16B (west valve) air to open spring to close

PRMS 15. On very calm nights it is not unusual to see an increase on the Stack Monitor and other air monitors throughout the Facility, What is the cause?

PRMS 16. The Vent Tank Low Level Rod Run-in must occur by _____.

a. 6" above centerline
b. centerline
c. 6" below centerline
d. 12" below centerline

PRMS 17. Match the correct detector type for each of the following radiation sensors.

_____ 1. Fission Product Monitor
_____ 2. Secondary Coolant Monitor
_____ 3. Stack Gas Monitor
_____ 4. Stack Particulate Monitor
_____ 5. Stack Iodine Monitor
_____ 6. Bridge ARMS
_____ 7. Exhaust Plenum 1
_____ 8. Room 114 ARMS

a. Gieger Meuller Detector
b. Scintillation Detector
c. GeLi Detector
d. BF^3 Detector

PRMS 18. What input, other than the flow potentiometers, feeds a signal to the digital power meter?

a) Ch-4 power level
b) IRM period
c) Primary demin flow
d) Pri and Pool ΔT

PRMS 19. Just prior to pulling control rods with all process control systems on the line, Master Control Switch "1S1" is moved from on to off. Choose the correct statement.

a. All systems will shutdown
b. All systems will remain running without automatic operation
c. Cannot move "1S1" from on to off with systems running
d. All systems will remain running with all automatic functions operable

PRMS 20. In the Pneumatic Tube system, what type of sensor gives a rabbit in the reactor indication?

a) Photo cell
b) Magnetic Switch
c) Micro Switch
d) Reed Switch

PRMS 21. Choose the correct statement. With the Reactor Bridge ARMS in the upscale position:

a. All Isolation functions for that module are bypassed
b. Isolation function switches to a backup module
c. Isolation functions on all other modules are bypassed
d. All Isolation systems are bypassed

PRMS 22. Choose the correct statement. Criterion for Protection Systems for Nuclear Power Generating Stations (IEEE-279) requires:

a. All safety system wiring be placed in a single fire proof conduit capable of withstanding design based heat loads
b. All conduits carrying safety system wiring be separated to prevent a single accident from disabling the entire safety system
c. All conduits to carry no more than one wire unless they contribute to the same safety function
d. All safety system wires will be contained in one conduit

PRMS 23. Each fueled experiment shall be limited such that the total inventory of iodine isotopes 131 to 135 in the experiment is not greater than _____ Curies and the maximum strontium 90 inventory is no greater than _____ Millicuries.

PRMS 24. Fueled experiments containing inventories of iodine 131 through 135 greater than _____ Curies or strontium 90 greater than ___ Millicuries shall be vented to the exhaust stack system through Hepa and charcoal filters which are continuously monitored.

PRMS 25. How long after reactor shutdown is the Primary System required to be in operation?

a. not required
b. 5 minutes
c. 10 minutes
d. 15 Minutes

PRMS 26. At what regulating blade rod height will the "Auto Shim Circuit" be engaged and when will it be disengaged?

a. 60% engaged, 10% disengaged
b. 20% engaged, 60% disengaged
c. 10% engaged, 60% disengaged
d. 5% engaged, 15% disengaged

PRMS 27. During which of the following situations would the Source Range instrument be required to be in operation?

a. During a reactor startup
b. Always
c. During full power operation in Mode I
d. When the reactor is secured

PRMS 28. What type of detector is the fuel vault intrusion alarm detector?

a. A microswitch
b. A microswitch connected to the door handle
c. A motion detector
d. A pressure-sensitive detector in the floor

PRMS 29. The red leg of the safety system contains:

a. The reactor isolation system
b. NI Channels 2,4,6
c. NI Channels 3,5
d. DPS 929

PRMS 30. From what location(s) can a Reactor Isolation be manually initiated?

a. The front lobby
b. The control room console
c. The reactor bridge
d. The 5th level of containment building

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

ENCLOSURE 2

CATEGORY A

REACTOR THEORY, THERMO DYNAMICS, AND FACILITY OPERATING CHARACTERISTICS QUESTIONS

RTFO 1. Reactor period is the time it takes for reactor power to :

a. Change by a factor of e.

NUS Sect 3 Glossary

RTFO 2. In reactor theory, a poison can best be described as:

c. Anything which absorbes neutrons and does not produce fission.

NUS Sect 3 Glossary

RTFO 3. The reactor is on a positive period during a reactor start up. Power rises from 2×10^{-6} to 8×10^{-6} amps (CH-3) in two (2) minutes. What is the reactor period?

c. 86.56 seconds.

NUS Sect 3 Section 6.3

RTFO 4. Using the following information compute a manual reactor heat balance:

Reactor flows	1940 gpm and 1930 gpm
Pool flows	625 gpm and 635 gpm
Demin flows	50 gpm pool and 50 gpm primary
Primary ΔT	16.1
Pool ΔT	5.6

c. 9.87 MW
SOP Section VII.1

RTFO 5. The pool system has a POSITIVE VOID COEFFICIENT because:
c. The Flux Trap region is over moderated.
Hazard Summary Section 13.2.1

RTFO 6. The major source of neutrons used a for normal reactor start up at this reactor is:
d. The (gamma-neutron) reaction in the Be^9 reflector ring as a result of the radioactive decay of previously activated structural materials.
Hazard Summary Page 13-229

RTFO 7. What causes the mechanical equipment room #114 radiation hazard during reactor operation?

d. Oxygen 16 becomes activated resulting in Nitrogen 16 decay by Gamma emission.
Gladstone Section 6.189

RTFO 8. The reactor is considered CRITICAL when:

b. $K_{eff} = 1$.
NUS Sect 3 Section 1.3

RTFO 9. BINDING ENERGY is best defined as:

d. Energy equal to the mass defect.
Gladstone Section 1.17

RTFO 10. The term departure from nucleate boiling means:

a. The point at which nucleate boiling ends and film boiling begins.
Gladstone Section 6.132

RTFO 11. According to Technical Specifications, Safety Limits are:
c. Limits on important process variables which are necessary to protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.
Tech Spec Section 1.23

RTFO 12. The reactor is operating in automatic control at 10 MW. Assuming all other conditions remain constant, over a period of time the average primary temperature increases from $120^{o}F$ to $125^{o}F$. Given Primary $\alpha T = -7.0 \times 10^{-5}$ $\delta k/^{o}F$ and Reg Blade = 8.85×10^{-5} δK/inch, what will the approximate change in Reg Blade height be.
d. 4" out.
NUS Sect 3 Section 8.4.2

RTFO 13. The major contributor of the production of Xe-135 in a reactor operating at full power is:
b. The radioactive decay of Iodine.
NUS Sect 3 Section 10.2

RTFO 14 The absolute value of the reactivity worth of all experiments in the center test hole shall not exceed:

c. 0.006 Δk

Tech Spec Section 3.1.h

RTFO 15. The production of Sodium-24 presents a significant radiation hazard to personnel in the reactor pool. Where does Na^{24} come from?

c. Na^{24} is produced as a result of neutron interaction in our aluminum sample cans.

Reference Chart of the nuclides

RTFO 16. Which of the following is the definition for the FAST FISSION FACTOR?

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

Intro to NE Lamarsh Section 65 and 4 Section 2

RTFO 17. The Limiting Safety System Settings for Mode I operation are:

	Reactor Power	Primary Flow	Rx Inlet Temp	Primary Press
d.	125 %	1625 gpm	155^{o}F	75 psia

Tech Spec Section 2.2.a

RTFO 18. A primary cooling system loss of pumps 501A/B will cause?

a. The reactor to scram and valves 546A/B to open.
Reference MURR training manual page I-33

RTFO 19. A reactor has a count rate of 45 cps with a K_{eff} of 0.965. What will the K_{eff} be when the count rate reaches 90 cps?

b. .9825.
NUS Sect 3 Section 12

RTFO 20. What is IRRADIATED FUEL?

c. Fuel used to an integrated power of >1MW day .
Tech Spec Section 1.9

RTFO 21. When can the master switch be in the "ON" position and the reactor be secured?

d. There is insufficient fuel in the reactor to establish criticality with all four control blades fully withdrawn.
Tech Spec Section 1.20

RTFO 22. When is channel #1 (SRM) NOT required ?

c. When at a stable power level following a reactor start up.
Tech Spec Section 3.4

RTFO 23. The Fuel Failure Monitor is required:

a. Any time the reactor is not shutdown, with the exception that it may be OOC if the primary water is sampled and analyzed manually every four hours.
Tech Spec Section 3.9.b

RTFO 24. The term delayed neutron precursor can be described as:
b. A fission product nuclide which decays to an excited daughter which, in turn, emits a delayed neutron.
NUS Sect 3 glossary

RTFO 25. K_{eff} is different from K_{inf} in that:
a. K_{eff} takes in to consideration leakage from the core
NUS Sect 3 Section 2.1

RTFO 26. Beta and beta effective both describe the total fraction of delayed neutrons, however, the difference between the two is?
b. Beta effective is larger than beta since delayed neutrons are born at lower energy levels than prompt neutrons.
NUS Sect 3 Section 5

RTFO 27. Which one of the following best describes the characteristics of a good moderator?

c. High scattering cross section and low absorption cross section.

Intro to NE Lamarsh Section 6 and 7 Section 16

RTFO 28. Which one of the following is the maximum allowable excess reactivity in the reactor as specified by Techical Specifications?

d. 0.098 $\Delta k/k$.

Tech Spec Section 3.1f

RTFO 29. A complete core loading is in progress on a non-power reactor and during that loading, the following data was taken.

Number of Elements Installed	Detector A (cpm)	Detector B (cpm)
0	11	13
2	13	15
4	17	18
6	22	22
8	34	30

Using the 1/M plot provided, determine which of the following is the approximate number of fuel elements that will be required to be loaded for a critical mass?

c. 12

Intro to NE Lamarsh Section 4.2 and 3 Section 12

RTFO 30 The number of neutrons passing through a one square centimeter of target material per second is the definition of which of the following?

c. Neutron Flux (nv)
NUS Sect 2 Section 14

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

CATEGORY B

NORMAL AND EMERGENCY OPERATING PROCEDURES & RAD CON

OPRC 1) During a normal Rx startup to 10 mw we are required to stabilize power at two different power levels, what are these power levels?

a) 50 kw & 5 mw
SOP 2 1.1

OPRC 2) Responsibility for providing a reliable E.C.P. after fuel handling has taken place lies with the _____.

d) Reactor physicist
SOP 1 4.3

OPRC 3) Which of the following is <u>not</u> a requirement for automatic operation?

c) Channel 2 & 3 IRM recorder indication greater than 10^{-8} amps
S.O.P. 2.1.3

OPRC 4) If there are radiation levels at the site boundary of_____ mr/hr whole body or _____ mr/hr thyroid dose then at least an alert condition exists.

b) 20,100
Emergency plan page 26

OPRC 5) Containment integrity shall be maintained at all times except when:

b) The reactor is secured and irradiated fuel with a decay time of less than 60 days is not being handled.
T.S 3.5 p.1

OPRC 6) When handling radioactive material around the pool, above what dose rate are health physics personal required to be present?

b) 100 mr/hr
H.P.S.O.P. HP-4

OPRC 7) What immediate action should be taken by the duty operator if a piece of equipment is causing a radiation hazard?

c) Reduce power by Rod-Run -In
REP-10

OPRC 8) An accessible area with a radiation level of 150 mr/hr should be posted as a(n) _____.

c) High radiation area
10 CFR 20

OPRC 9) An unscheduled entry into room 114 shall not exceed:

b) 15 min
HP-2

OPRC 10) If the waste tank activity of nuclides other than tritium is > 2mci, whose authorization is needed to discharge to the sanitary sewer.

d) Reactor Manager
S.O.P. 7.8.3

OPRC 11) To lower the pool below the refuel bridge we must have specific approval from _____.

d) Reactor Manager
S.O.P. 5.4.2

OPRC 12) The MURR has an annual release limit for H^3 (tritium) of_____ curies.

b) 4
S.O.P. 7.8.3

OPRC 13) Who must authorize resumption of reactor operation after a safety limit, as defined by tech. spech, has been exceeded?

d) Nuclear Regulatory Commission

R.E.P. 0-2

OPRC 14) The Rx off-gas stack monitor may be taken out of service for a period of up to _____ hours for maintenance or calibration during Rx operation.

4) 2
Tech. Spec. 3.4 a

OPRC 15) Boron carbide (B_4C) may be used as burnable poison in MURR fuel elements.

1) True
Tech. Spec. 4.1 c

OPRC 16) Match the following Tech. Spec. reactivity limits.

1) __B__ Core temp. coefficient (delta K / degree)
2) __D__ Total reg. blade worth (delta K)
3) __C__ Max shim insertion rate from all blades (delta K / sec)
4) __A__ Core void coefficient (delta K / % void)
5) __D__ Max. secured removable experiment (delta K)
6) __E__ Max. movable experiment (delta K)

A) -2×10^{-3}
B) -6×10^{-5}
C) 3.0×10^{-4}
D) 0.006
E) 1×10^{-3}
F) 0.02

Tech. Spec. 3.1

OPRC 17) On April 1st, a radiation worker is working in a 350 mr/hr gamma field. How long until this worker exceeds his quarterly whole body dose limit?

1) 3.57 hrs.
10 CFR 20

OPRC 18) To prevent damage to N.I. detectors or high voltage power supplies during maintenance or testing the drawer must be placed in the _____ position.

2) zero/zero 1
SOP 3.1.2

OPRC 19) MURR classifies a REACTOR ISOLATION as:

b) a facility emergency
FEP-2

OPRC 20) After a reactor shutdown due to a momentary loss of electrical power:

d) The reactor may be operated after performing a reactor shortform precritical checksheet.
REP-9-4

OPRC 21) If there is a loss of physical control of the facility then at least a(an) _____ emergency classification exists.

a) alert
Ref: SEP-3

OPRC 22) During a cask handling event, a 100 Ci source of iridium falls out of a cask. An operator immediately picks up the source and tosses it back in the pool (total contact time 1.2 seconds). Assuming a contact hand dose of 1850 rem/hr/Ci:

a) What is the hand dose? 61.67 REM
b) How long did it take to exceed the quarterly limit for extremities? .36 seconds

OPRC 23) Concentration of airborne radioactivity at the stack monitor exceeding 3800 mpc when averaged over a 24 hours would constitute at least a(an)?

c) unusual event
Ref: SEP - 2

OPRC 24) Activity produced from samples run in the P-tube system will normally be limited to:

d) 25 mCi

Ref. SOP VIII.3.2

OPRC 25) Which of the following is the reason for NOT starting two secondary pumps at the same time?

c) The basin level will be reduced resulting in a low sump level trip

ref: SOP VI.1.H

OPRC 26) While working in an area marked "Caution, Radiation Area," an operator discovers his dosimeter is off scale and leaves the area. If he had been working in the area for 45 minutes, which one of the following is the maximum dose he should have received?

c) 75 mrem

ref: 10 CFR 20

OPRC 27) Which one of the following is responsible for determining if an RWP is required to conduct work at the facility?

a) shift supervisor

ref: SOP II.1.1.I

OPRC 28) In accordance with the procedure which one of the following is the shortest reactor period which may be used to raise power to 50 kw?

b) 30 second

ref: SOP II.1.1.I

OPRC 29) Which one of the following indications would result in the declaration of a Site Area Emergency?

a) a concentration of airborne radioactivity at the stack monitor exceeding 95,000 mpc averaged over 24 hours.

ref: Emergency Plan table 1

OPRC 30) The radiation level one (1) foot from a component is 1.2 REM. How much lead shielding is necessary to reduce the radiation level to 10 mrem at one foot?
(assume a μ (Mu) of 1.53)

b) 3.6 inches

NUS #2

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

CATEGORY C

PLANT AND RADIATION MONITORING SYSTEMS

PRMS 1. The reactor shall not be operated if radiochemical analysis indicates iodine 131 concentration exceeds _____ uci/ml in the Primary Coolant.
(Tech Spec 3.9)

d. $5x10^{-3}$

PRMS 2. The Utility Seal Trench must be filled with water to a depth required to maintain a minimum water seal of _____ when containment integrity is required.
(Tech Spec 1.15)

c. 4.25 feet

PRMS 3. The reactor shall not be operated unless the reactor makeup water system is operable and connected to a source of at least _____ gallons of primary grade water.
(Tech Spec 3.10)

b. 2000

PRMS 4 The fuel burnup limit restricts the peak fissions per cm^3 burnup to values correlated to result in less than a _____ swelling of the fuel plates
(Tech Spec 3.8)

b. 10%

PRMS 5. True Radiation hazards from the operation of the pneumatic tube system are minimized by rapid rate of travel of the irradiation container through the system.
(Hazards Summary 8.5)

PRMS 6. True The vestibule for pedestrian entry at the second level of the reactor building is a portion of the containment system?
(Hazards Summary 3.2.3)

PRMS 7. Beamports __C__ and __D__ are considered "Tangential" while the remaining beamports are "Radial".

a) C & D
(Hazards Summary 8.3 figures 9.7 & 9.8))

PRMS 8. Match the appropriate beamports with the correct diameter and relative height to centerline in adjacent column (answers may be used more than once).
(Hazards Summary Figure 9.7 & 9.8)

_____ 1.	Beamport A	C	a. 6"	-14"
_____ 2.	Beamport B	B	b. 6"	-7"
_____ 3.	Beamport C	A	c. 4"	-2"
_____ 4.	Beamport D	D	d. 4"	-14"
_____ 5.	Beamport E	B	e. 4"	-7"
_____ 6.	Beamport F	C	f. 6"	-2"

PRMS 9. Match the following valves associated with the pressurizer with the answer that best describes its function.
(Print 156)

1. 527A	D	a. PZR Charging Valve
2. 527B	A	b. PZR VentValve
3. 526	F	c. PZR Vent Manual Isolation Valve
4. 545	B	d. PZR Drain Valve
5. 544	C	e. PZR Drain Throttle Valve
6. 515AA	E	f. PZR Nitrogen Supply Valve

PRMS 10. List 4(four) conditions that must be met to satisfy the Rod Withdrawal Prohibit Circuit.

1) No NI anomaly
2) SRM > 1CPS
3) Rods in contact with magnet
4) Thermal Column door closed

(Print 42)

PRMS 11. The Stack Monitor may be placed out of service for maintenance and calibration for a period of ____.
(Tech Spec 3.4)

b. 2 Hours

PRMS 12. Which one of the following is a load supplied by the Emergency Generator?
(Tech Spec 4.5 & Training Manual p. III-3&12)

b. Reactor Exhaust System Fan EF-14

PRMS 13. Match the detector type with the correct Nuclear Instrument Channel. (Training Manual II.2-5)

1. NI Channel 1	A	a. Fission Chamber
2. NI Channel 2	C	b. Uncompensated Ion Chamber
3. NI Channel 3	C	c. Compensated Ion Chamber
4. NI Channel 4	C	
5. NI Channel 5	B	
6. NI Channel 6	B	

PRMS 14. Choose the 2 (two) correct statements regarding operation of the 16" isolation valves:
(Training Manual)

b. 16B (west valve) air to open air to close
c. 16A (east valve) air to open spring to close

PRMS 15. On very calm nights it is not unusual to see an increase on the Stack Monitor and other air monitors throughout the Facility, What is the cause?
RADON GAS

PRMS 16. According to Tech Specs, the Vent Tank Low Level Rod Run-in occurs at _____.
Tech Spec 3.4
d. 12" below centerline

PRMS 17. Match the correct detector type for each of the following radiation sensors.
(Training Manual & Modification Package 88-4)

B	1. Fission Product Monitor	a. Gieger Meuller Detector
B	2. Secondary Coolant Monitor	b. Scintillation Detector
A	3. Stack Gas Monitor	c. GeLi Detector
B	4. Stack Particulate Monitor	d. BF^3 Detector
B	5. Stack Iodine Monitor	
A	6. Bridge ARMS	
A	7. Exhaust Plenum 1	
A	8. Room 114 ARMS	

PRMS 18. What input, other than the flow potentiometers, feeds a signal to the digital power meter?
d) Pri and Pool ΔT
(SOP VII-I)

PRMS 19. Just prior to pulling control rods with all process control systems on the line, Master Control Switch "1S1" is moved from on to off. Choose the correct statement.
(Print 41&42)

d. All systems will remain running with all automatic functions operable

PRMS 20. In the Pneumatic Tube system, what type of sensor gives a rabbit in the reactor indication?
a) Photo cell

PRMS 21. Choose the correct statement. With the Reactor Bridge ARMS in the upscale position:
(Modification Package 88-4)

a. All Isolation functions for that module are bypassed

PRMS 22. Choose the correct statement. Criterion for Protection Systems for Nuclear Power Generating Stations (IEEE-279) requires:
(Hazards Summary A.1)

b. All conduits carrying safety system wiring be separated to prevent a single accident from disabling the entire safety system

PRMS 23. Each fueled experiment shall be limited such that the total inventory of iodine isotopes 131 to 135 in the experiment is not greater than __150__ Curies and the maximum strontium 90 inventory is no greater than __300__ Millicuries.
(Tech Spec 3.6)

PRMS 24. Fueled experiments containing inventories of iodine 131 through 135 greater than __1.5__ Curies or strontium 90 greater than _5__ Millicuries shall be vented to the exhaust stack system through Hepa and charcoal filters which are continuously monitored.
(Tech Spec 3.6)

PRMS 25. How long after reactor shutdown is the Primary System required to be in operation?
(SOP IV.2)

d. 15 Minutes

PRMS 26. At what regulating blade rod height will the "Auto Shim Circuit" be engaged and when will it be disengaged?
(SOP II.1.5, Print 42)

b. 20% engaged, 60% disengaged

PRMS 27. During which of the following situations would the Source Range instrument be required to be in operation?
(SOP I.4 3.H,J; II.1.1.L.T; Tech Spec 3.4)

a. During a reactor startup

PRMS 28. What type of detector is the fuel vault intrusion alarm detector?
(print 967)

c. A motion detector

PRMS 29. The red leg of the safety system contains:

d. DPS 929

PRMS 30. From what location(s) can a Reactor Isolation be manually initiated?
(print 524)

b. The control room console

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