U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-373/374/OL-85-~~01~~ 02

Dockets No. 50-374; 50-374 License No(s).

Licensee: Commonwealth Edison Company
Post Office Box 767
Chicago, IL 60690

Facility Name: LaSalle County Nuclear Station

Examination Administered At: LaSalle County Nuclear Station

Examination Conducted: November 18,19,20,21 and 22, 1985

Examiners: J. Lang 2/4/86
Date

J. Dimmock 2/4/86
Date

J. I. McMillen 2/4/86
Date

Approved By: J. I. McMillen, Chief 2/4/86
Operating Licensing Section
Date

Examination Summary
Examination administered during the week of November 18, 1985
(Report No. 50-373/374/OL-85-02)
To seven senior reactor operator and five reactor operator candidates.
Results: Six Senior operator and three reactor operator candidates passed the examination.

REPORT DETAILS

1. Examiners

   T. Lang, NRC Region III
   L. Dimmock, NRC Region III
   J. McMillen, NRC Region III
   M. Spencer, EGG

2. Examination Review Meeting

   Copies of the examinations and answer keys were given to facility personnel after the administration of the written examination. The facility provided written comments to the examiners on November 22, 1985. These comments are enclosed as attachment 1 to this report and resolution of the comments is included as attachment 2.

3. Exit Meeting

   Ron Crawford, Training Supervisor, was informed on November 22, 1985, of those persons who clearly passed the oral/operating examination.

ATTACHMENT 1

FACILITY COMMENTS

RO Exam, November 18, 1985
Reviewed by: L. Melander, SRO Training
R. Roy, SRO Cert. Training
W. Jakielski, SRO Operating

SUMMARY OVERVIEW

The following general observations are offered, intending to provide constructive feedback to the exam writer for consideration when grading applicant written exams.

- No LaSalle references were provided for answers to questions in Section 1. Some had no references at all.

- Many questions had unusually large point weight value when compared to the relative importance of the topics.

- Point distribution for answers to essay questions indicate a philosophy shift; i.e., more emphasis on memorization of details, in lieu of straight forward testing of concept understanding.

- Many questions involved confusing sentence and wording factors. Again this appears to depart from the straight forward approach of testing understanding and comprehension of operational principles.

- Numerous discrepancies exist for the point values between the exam and answer key.

In summary, it is felt these factors significantly detract from the quality of this examination and its intent to test the Operator's knowledge and ability to safely operate a reactor plant.

Specific comments, which support these observations, follow this summary.

SECTION 1

1.1 Disparity in the number of points between the exam and answer key. The test indicated 2.0 points and the answer key indicated 1.0 points. For the question asked, 1.0 points is a more realistic value for the subject being tested. In addition, the phrase, ". . .the feedwater energy in (lbm/hr)(BTU/lbm) is compared with the steam energy out (lbm/hr) (BTU/lbm). . ." should not be required for full credit - the question is more than adequately answered by the remaining paragraph.

1.3a Student answers that indicate a stable critical neutron population is achieved, but continue on stating that without further Operator action, the neutron population will decay off (due to poison building) should also be accepted for full credit.

1.3b Again, there is a disparity in the number of points on the test and the key. The test indicates part b is worth 2.0 points while the key indicates it is worth 1 5 points. The concept tested in part b is not substantially more impo ant than that tested in part a and as such, should also be worth on 1.0 point.

The wording of question 1.3 is very confusing. The lead in scenario is sketchy and does not clearly identify the condition which is a reactor startup with power levels below the SRM range. The question in part b by itself is not bad, but when it follows the question asked in part a causes considerable confusion as to what is the correct answer for either part due to the similarities in the situations. The students were confused by this question as well as most of the facility SRO licensed exam reviewers. Specifically, the question reactor response if rods were pulled to one notch above the critical position. As worded, this could be construed to mean that rods were stopped one notch before criticality is achieved, which drastically changes reactor response. Either question 1.3b should be deleted or answers should be accepted that address the possibility that the reactor is subcritical instead of supercritical. Also, if the question is not deleted, the following additional key change should be made. The weighting in the answer key needs to be changed. The important aspects in the answer should be that a supercritical condition is achieved causing reactor power to increase on a positive period until either an IRM scram is received, or, if the Operator ranged up, until negative reactivity (temp. or voids) turns power. (See attached corrected key).

1.4b ΔK/K is not a proper unit for keff. Keff as a fraction is unitless. By adding ΔK/K to the value of keff = 0.9 caused considerable confusion to some students. Compounding this, is the fact that an equation sheet was not provided to the students (which is required). In accordance with NUREG 1021, ES-202, page 6 of 6, "All equations required to answer parts of the examination should appear in the equation sheet or as part of the question."

Based on the confusion generated by the misplaced units and the lack of an equation sheet, the student may have calculated the reactivity value as follows:

$Keff_1 = 0.9$
$Keff_2 = 0.95$

$$K/K = \frac{keff_2 - keff_1}{keff_2} = \frac{0.95 - 0.9}{0.95} = 0.0526$$

As compared to the desired calculation:

$$P_1 = \frac{keff_1 - 1}{keff_1} = \frac{0.9 - 1}{0.9} = - \frac{.1}{.9} = -.111$$

$$P_2 = \frac{keff_2 - 1}{keff_2} = \frac{0.95\ 1}{0.95} = - \frac{.05}{0.95} = - 0.0526$$

P = 0.585

As such, the answer key should be changed to accept answer b or c as acceptable or question 1.4b should be deleted.

1.5b A nonLaSalle reference was used in the answer key. According to the LaSalle Reactor Physics review lesson plan submitted with the exam reverence material, Xenon peak on a down power transient would occur 4-6 hours after the power change. The answer key lists #2 as the correct answer (2-6 hours). However, answer #3 (5-7 hours) fits this time frame as well as #2 did and should be counted as a correct alternate answer.

REF: LaSalle Physics Review Lesson Plan, page 216

1.10 Question is somewhat tricky in that it asks for the primary contribution to heat energy added to the coolant with a subcritical reactor (decay heat). Three answers are listed that all deal with slowing down of fission products in the fuel and an Operator is trained that from the fission mechanism - the ionization by fission fragments is the biggest heat input. Also, radioactive decay of fission products occurs also by gamma and neutron emission not solely by Betas and that the total fission energy associated with decay gammas and decay Betas is very close.

In addition, after the first refuel outage, neutron sources can be pulled from the core as the buildup of transuranic elements, such as Curium produce, enough source neutrons to maintain a stable on-scale count rate. These neutrons are produced by spontaneous fission and these fissions are a major contributor to decay heat after a long shutdown. The major contributor to heat energy from these spontaneous fission events is the ionization by the resultant fission fragments.

Based on the misleading nature of the question and the evidence presented, the answer key should be changed to accept c as a correct answer for half credit.

REF: LaSalle Reactor Physics Review Lesson Plan, pages 12 and 58

1.11 The question is an SRO level question. The subject matter in itself is testable, but the manner in which the question is asked, requires the student to have considerable reading skills to interpret the two cases being given and contrast each of their effects in order to determine the correct answer. According to NUREG 1021, ES-202, page 4:

> "13. Practical realistic questions that relate to operator knowledge and required operating practice should be used."

As such question 1.11 should be deleted as it does not challenge the Reactor Operator's knowledge directly, but instead concentrates on his ability to interpret a complicated and somewhat vague written description in order to answer a basic concept regarding samarium changes with power. This is more appropriate for an SRO rather than an RO.

SECTION 2

2.2 Also accept emergency makeup water injection source to the reactor. Its use in this capacity is described in LGA-04, page 3 of 21, and also in LOA-SC-03.

2.7b Typographical error - should be high neutron flux <u>or</u> high pressure. Either answer should be acceptable for full credit.

2.11 Whether the Operator has memorized all loads supplied by non safety-related 125 VDC buses has little effect on his ability to operate the plant safely. Plant procedures provide reference lists so he can determine what equipment has been effected by the power failure.

In addition, reviewing the System Description, Chapter 43, objectives and review questions, the trainee is required to know loads on the vital DC buses, but not the non safety-related buses (111X, 112X, 121X, 211X, 212X, 221X). Also, NUREG 1021, ES-202, page 4 states: "Questions on detailed system characteristics or instrumentation, such as annunciator logic or setpoints, should be avoided unless required for safety system operation."

Based on this, question 2.11 should be deleted. If not deleted, only those answers dealing with the safety-related DC loads should be tested, namely b, c and f.

REF: NUREG 1021, ES-202; LaSalle System Description, Chapter 43

SECTION 3

3.1 Question does not ask for how each unit at LaSalle is effected. At the present time, only Unit 2 has a CRD charging header low pressure scram feature and as such an answer is only required for Unit 2. No credit should be lost if the student didn't say Unit 1 was effected as it is intuitively obvious as it doesn't have the feature and the question didn't ask for how both units would be effected.

3.2 Question needlessly confuses student by introductory statement stating RWM will generate an insert block upon receipt of the third insert error. This is extraneous and confuses the student as to what is being asked for in parts a and b. If a student assumed that the insert block had been applied by the lead-in statement, then no other rods than error rods can be moved and only in the direction necessary to clear the error. Based on this, a student could answer the question as false. For this reason, the question should be deleted.

REF: LaSalle System Description, Chapter 18, page 26-27

3.3a In order for the recirc pump to shift to fast speed, the following interlocks must also be satisfied: low RPV water level (<12.5"), inadequate subcooling as indicated by low ΔT between steam space and recirc pump suction ($<10.1^{\circ}F$), and EOC-RPT not actuated. Any of these three answers should also be accepted for full credit.

REF: LaSalle System Description, Chapter 5, page 84-85

3.3b The question did not ask for what is cavitation - it asked for the basis of the interlocks which is to prevent cavitation in the recirculation system components. As such, this is a sufficient answer for full credit.

3.4 Disparity again in point totals between the test and the answer key. For part a, the exam indicated it was worth 0.5 and part b was worth 2.0. The answer key didn't have a point total for part a. Part a should be worth 1.0 points - 0.5 points for each answer. Part b is probably overweighted and should be reduced to 1.5 points - 0.75 points for each answer.

3.5c Question asks for what 2 alarms are generated by the flux estimator not what conditions cause each alarm. As such the correct answer should also include "Flux Estimator Failure and Flux Estimator Needs Maintenance", which are the alarms. The answer in the key is the setpoints or conditions causing these alarms.

3.7 Question does not indicate that the component is part of RPIS/RSCS system and therefore, is ambiguous and easily confused. According to NUREG 1021, ES-202, E.6:

> "Questions on detailed system characteristics or instrumentation, such as annunciator logic or setpoints, should be avoided unless required for safety system operations.

As such, this question should be deleted.

3.8 The point distribution in the answer key is overly detail oriented. Althou the answer key contains a word-for-word description of the operation of the drywell equipment drain sump pumps and input to alarms, that type of detail should not be required in the student's answer. NUREG 1021, ES-202, Section E, points 6, 13 and 18, indicate that this type of question should be avoided. Based on this, question 3.8 should be deleted.

If not deleted, the following answer key changes should be made:

For part a - the following answers should be acceptable for full credit:

1. Excessive pump run time
2. Excessive pump restarts or short restart time
3. High drywell equipment drain sump temperature

REF: LaSalle System Description, Chapter 73, pages 26 and 28

Also, the point value for this trivial interlock is excessive - if not deleted, decrease the point value of part a to 1.0 points.

3.11 For corner room spot coolers - in lieu of Unit 1 and 2 NE and NW area coolers also accept either:

1. Division I ECCS pump corner room area (or spot) coolers
2. LPCS/RCIC Room area cooler and A RHR Pump Room area cooler

Also, as a point of interest, according to NUREG 1021, ES-202, Section E, point 18, if a certain number of responses are expected in an answer, then the specific number should be included as part of the question.

3.12 Power available should not be necessary for full credit as having electricity available to an electric motor operated valve in order for it to operate is intuitive. Also, either +1.69# drywell pressure or -129 RPV level will cause the valve to operate.

REF: LaSalle System Description, Chapter 38

3.14 Question is double jeopardy with question 3.2 and according to NUREG 1021, ES-202, Section E.15, should be avoided. Also, no point value on exam or key for question and doesn't count in point total.

Also, the question is tricky as it is a play on words, asking if the RWM will generate a rod block, when the fourth insert error is received. The question could be misunderstood and the Operator answer true as the rod block was generated on the third error and would also be in effect on the fourth error.

Consider deleting the question for this reason. If not, the question should be worth no more than 1.0 points.

3.15 Answers 1 and 4 should be separated and counted as independent answers. This makes 6 possible answers.

SECTION 4

4.1 Question was very confusing, part of this being due to the exam not delineating what part was part b. Question wording was unclear and the students weren't sure if they had to answer each of the 4 selections or pick out the best one.

Second, according to NUREG 1021, ES-202, Section E.23, states that diagrams should be included with questions such as this. The lack of such a drawing further complicated the question.

As such, the question should be deleted. If not deleted, grading should consider the confusion inherent in the question.

4.2 The Point value for this question is excessive, neither part should be worth more than 1.0 points.

4.3 According to the students, the examiner indicated that they should chose the single most correct answer, and yet the answer key lists two answers. Also, the wording for this question utilizing the word which causes the student to try and select the single most correct answer. On this basis, this question should be deleted.

However, if not deleted, question does not describe the type of failure that the CRD flow control system experienced. Therefore, three of the conditions described could occur as follows:

a. If CRD FCV failed closed, cooling water would be lost to the drives resulting in high temperatures.

b. If CRD FCV failed open, cooling water flow would be very high causing drive temperatures to cool off quite a bit, potential thermal shock to drives would be worse than normal on a scram.

c. Changing header pressure flow, if the CRD pumps trip off or the flow control valve fails wide open, flow to the charging header would decrease potentially causing a low pressure problem.

As such, answer a should be counted as a correct alternate answer to this question.

RED: LOA-RD-04, page 1

4.5 The question is included in the procedures section and does not ask for a detailed explanation of the reactor physics associated with why notch override restrictions are lifted when a bypass valve is opened. An acceptable answer should be on that says the open bypass valve stabilized void content which is more effective in providing negative feedback to changes in reactor power. Also, redistribute points as indicated on corrected key.

4.12 Procedural guidance for injecting boron into the reactor has changed significantly since the NRC exam reference material had been submitted. Guidance for injecting boron is contained in LGA-ATWS-01 and is required whenever the reactor cannot be shut down before Suppression Pool temperature reaches the Boron Injection Temperature limit (BIT curve).

Also acceptable should be answers that correlate the points on the curve which would apply, namely greater than 5% reactor power with Suppression Pool temperature at 110°F.

During the test, the examiners indicated that the students should put down the old answer, the new answer, or both. As such, any of these choices should be accepted for full credit.

REF: LGA-ATWS-01, page 5 of 13 and curve LGSA-G7

FACILITY COMMENTS
SRO Exam, November 18, 1985
Reviewed by: J. Harrington, RO/SRO Cert. Training
R. Armitage, SRO Operating
D. Crowl, SRO Operating
S. Harmon, SRO Training

The facility reviewers feel overall, that this was a well written examination. For the most part, questions were operationally oriented, written clearly, and were a good test of knowledge. We felt this showed improved effort on the part of the examiner, to produce a better quality examination. However, even more effort is needed to make sure questions are written clearly enough to illicit the "correct answer" as listed on exam key. Also, the exam keys should be more clearly reviewed so answers correspond to the question asked.

5.03a Increase

5.03b Increase

5.03c Decrease

Full credit should be given because this "literally explains" the effect on critical power due to the change of the given plant parameter. The question does not ask "why" critical power changes and therefore, the student should not be penalized for not doing so.

5.06a Rod worth will increase because of the density change in the moduator as temperature increases. Decreased density causes longer slowing down and thermal diffusion lengths. Hence, thermal neutrons have a higher probability of reaching a control rod from the fuel.

5.06b Rod worth will decrease as voids increase, because voiding suppresses thermal neutron flux. With decreased thermal flux (lower power) it will also result in decreased rod worths, as control rod blades absorb thermal neutrons.

5.11a Full credit should be given for part a, if the applicant states that the change is due to buildup of fission product poisons in the core.

REF: License Requal Physics Lesson Plan, Revision 1, page 194

5.12 Equation sheet given, does not have an applicable formula to work this count rate problem. If applicant assumes a formula and works math correctly, credit should be given.

5.13b Clarify that stating, "without condensate depression, the condensate pumps would cavitate because of inadequate NPSH", is the same as saying "due to the water at the eye of the pump being at saturation temperature."

6.01a Question could be answered by applicant referencing surveillance requirements for jet pump operability according to T.S. 4.4.1.2.1.

No clarification given for type of jet pump failure; therefore, if applicant assumes a type of failure and lists indications that support this assumed failure, full credit should be given.

6.04 Containment water volume is also used to suppress steam from reactor upon safety relief valve actuation and should be given credit.

6.05 Part one should be deleted, because the normal drain to 14A heater from 15A is open before, during and after the hi hi level trip. This valve does not reposition. Our procedures, LOA-FW-01, "Loss of Feedwater Heater," or LOP-HD-02, "Placing a Feedwater Heater Into Service," do not reference the normal drain on a hi hi level trip because this valve stays open.

6.09 The answer key has more to do with internal RSCS program interlocks. The question asks for system response at two conditions: 100% power and 1% power. Full credit should be given if the applicant gives an accurate operational response, as given on the corrected answer key. Also, at 1% power we are <75% density not greater than.

REF: RSCS Lesson Plan, pages 4 and 5

7.01c Technical Specifications also address training startups in T.S. 3.10.6. This states that reactor coolant temperature must be $\leq$200§°F. The question does not specifically state IAW LGP-1-1, therefore, $\leq$200°F is acceptable.

7.02b "Until one bypass valve is open OR main generator is on line." This statement should be given partial credit, as this is a pertinent part of notch override restrictions A50% rod density.

7.04a Clarify that the FW003 valve <u>is</u> the FRV Inlet Stop, which is manually throttled, and full credit should be given if this normal plant terminology is used.

7.04c Full credit should be given if applicant states "maximize blowdown or reject flow." Operationally this is how we eliminate "feedwater on-off cycles by maximizing blowdown to reject excess water during heatup, which prevents the FRV from opening and closing due to level oscillations. This in turn prevents colder condensate water from cycling "on-off to the feedwater spargers.

REF: LGP-1-1, page 10

7.07 LOA-NB-02, Stuck Open Safety Relief Valve, also states to:

1. Start Suppression Pool Cooling.
2. If pool temperature exceeds 100°F, refer to LGA-03.
3. If valve remains open after 4 attempts to close <u>OR</u> if: pool temperature exceeds 110°F <u>OR</u> if: two <u>2</u> minutes have elapsed since valve opened, then scram the reactor.

These are all acceptable answers, because the question asks for Operator actions on a stuck open SRV. The answer key addresses how to close the SRV. These are all part of LOA-NB-02, immediate Operator actions and therefore, should be acceptable for full credit.

7.08 LGA-ATWS-01 directs Operator to inject SBLC if the Boron Injection Temperature (BIT) Curve is exceeded. Full credit to applicant for this response should be given.

7.10 a & b Point values for this question are excessive; however, a good question. However, in 7.10b, the setpoints as listed on the answer key are not specifically asked for and should not be needed for full credit. Also, in 7.10a, 71% in 2 minutes and 23% in 3.5 minutes are acceptable answers versus exact amperage.

REF: System Description, Chapter 45, page 11

8.05b A second licensed Operator specifically means another licensed Reactor Operator, OR Senior Reactor Operator.

ATTACHMENT 2
RESOLUTION OF FACILITY COMMENTS

SUMMERY OVERVIEW

Some of the general observations are not technical and indicate only a difference in interpretation of the Examiner Standards between the reviewers and the examiner. The examination was prepared and reviewed in accordance with the guidar provided in NUREG-1021. Resolution of specific comments about questions and answers are treated below.

1.1 Question was considered to be worth two points. Answer key was adjusted to show value.

1.3a Consideration was given to answers that demonstrated an understanding of the concept of criticality. A just critical reactor would remain at a very low stable condition without significant buildup of poisons or an increase in temperature.

1.3b Question was corrected to indicate proper point value. The question is a standard question from the examination question bank and has been used many times without difficulty. The comments concerning the confusing nature of the wording, will be considered in rewriting the question.

1.4b Comment accepted. Credit was given for either 2 or 3.

1.5b Comment accepted. This question is from the examination question bank. NUREG-1021 does not prohibit the use of non-plant specific references in Section 1 and 5 of the examination. The answer key will be changed to eliminate any confusion.

1.10 The examiner does not consider the question to be "tricky." The question is from the examination question bank and has been used in the past. Based on the above explanation and a review of the reference, the alternate answer is acceptable.

1.11 The question deals with a principle of theory of the operation of a reactor and is proper material for use in an examination. Question stands.

2.2 Comment accepted.

2.11 Operator knowledge of systems that are affected by the loss of a bus is considered important to the operation of the plant. Question stands.

3.1 Both answers were listed in the answer key in order to give proper credit as long as the candidate specified which unit was being discussed.

3.2 Examiner reviewed the material and agrees that there might be some confusion concerning the question, although only one candidate gave an incorrect answer to part "b". Credit was given for this answer based on a review of the reference material

3.3a Comment accepted. Credit was given for the alternate answers.

3.3b Comment accepted. Question will be clarified in future examinations.

3.4 Reviewers opinion of point values is rejected.

3.5c Comment accepted.

3.7 Examiner believes knowledge of this system is an acceptable topic for examination, but question is deleted because of lack of clarity.

3.8 Examiner does not believe the question violates the guidance presented in the Examiner Standards. Details in the answer key were presented to facilitate grading. Credit was given for answers that demonstrated a knowledge of the alarms.

3.11 Alternate answers accepted. Comment concerning number of responses is noted, but had no effect on grading of question.

3.12 Comment accepted. Details are presented in answer key to facilitate grading and prevent being criticized for not including intuitive conditions.

3.14 Question deleted.

3.15 No change required. Credit given for 4 correct answers.

4.1 Although reviewer states that question was confusing, all candidates answered it correctly. Question will be clarified in future examinations.

4.2 Comment is not technical. No change to point value.

4.3 Examiner has no recollection of advising candidates to select the single most correct answer and has no notes to this effect on his copy of the examination. A review of the reference material indicates an error by the examiner in developing the question, therefore, it is deleted.

4.5 The question asks for the basis for lifting the restriction at this time. Detailed answer is given to facilitate grading. Credit was given for answers that indicated an understanding of the concept.

4.12 Comment accepted. Question graded according to material supplied.

5.02 Although there were no comments made in regards to this question, a change was made to the answer key. The answer key had two answers, either of which would be acceptable. When the point value for the question was assigned, it was inadvertently split with half credit for each answer. Each answer was given full credit if applicable.

5.03 Disagree with comment. The word "Explain" means to relate the "cause." Answer key remains unchanged.

5.06a&b Comment unnecessary. The comment only reworded the answer given in the key. Answer in the key was taken directly out of the reference material and will remain unchanged. Credit was given for reasonable answers.

5.11a Disagree with comment. There are other fission product poisons that buildup, but they do not have the same effect that samarium has.

5.12 Comment accepted

5.13b Comment accepted. Credit was given for answers that demonstrated an understanding of the concept.

6.01a The question asks for indications of failure at full power. The reviewer gave no reference for the <u>different</u> types of failures that would give different indications. Indications listed in the answer key would lead to the use of the surveillance requirements in order to determine whether the indications are valid. Answer key stands.

6.04 Reviewer did not provide a reference for the comment. No change to answer key. Only one candidate received less than full credit for answer.

6.05 Comment accepted. Points were not taken off for Item 1 in answer key.

6.09 Comment accepted. Credit given for alternate answer.

7.01c Comment accepted. It should be noted that the Technical Specifications list <200°F, while the LGP lists <212°F. An operator could comply with the LGP and be in violation of the Technical Specification.

7.02b Comment accepted, although no reference is given.

7.04a&c Comment accepted.

7.07 Comment accepted.

7.08 Comment accepted.

7.10a&b Alternate answers are acceptable. Comment concerning point value is an opinion and has no technical basis.

8.05b Comment unnecessary. Credit given for answers that indicate an understanding that the stand-in must be a licensed individual. Interpretation of the Technical Specification based on the comment might lead one to believe that the SRO, when he stands in for the RO could no longer be counted as one of the required SRO's on shift.

70 - 0815

MASTER COPY

U.S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY:	LaSalle
REACTOR TYPE	BWR
DATE ADMINISTERED:	November 18, 1985
EXAMINER:	J. I. McMillen
APPLICANT:	

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%.

Category Value	% of Total	Applicant's Score	% of Category Value		
~~25~~ 24	25	___	___	1.	Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow
25	25	___	___	2.	Plant Design Including Safety and Emergency Systems
~~25~~ 23	25	___	___	3.	Instruments and Controls
25	25	___	___	4.	Procedures - Normal, Abnormal, Emergency and Radiological Control
~~100~~ 97	100	___	___		TOTALS

Final Grade _______%

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

____
Applicant's Signature

Section 1 - Principles of Nuclear Power, Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow

1.1 The most common unit of flow is gallons per minute (gpm). In a BWR, feedwater and steam flow are measured in pounds per hour (lbm/hr). Why is lbm/hr used rather than gpm? (2.0)

1.2 What are four (4) design or operational factors that ensure Net Positive Suction Head (NPSH) for the recirculation pumps? (2.0)

1.3 A reactor startup is incorrectly attempted without a sufficient neutron source to give indications on the nuclear instrumentation:

a. Describe the response of the reactor if the operator stopped pulling rods at the just critical position. (1.0)

b. Describe the response of the reactor if the operator stopped pulling rods one notch above the critical position. 1.5 (~~2.0~~)

1.4 The reactor is shutdown with a Keff of 0.9Δk/k and the source range monitor indicates 100 cps. Rods are withdrawn and the source range now indicates 200 cps. Choose the correct answer for each of the following questions.

a. The new Keff will be: (1.0)

1. 0.93Δk/k
2. 0.95Δk/k
3. 0.97Δk/k
4. 0.99Δk/k

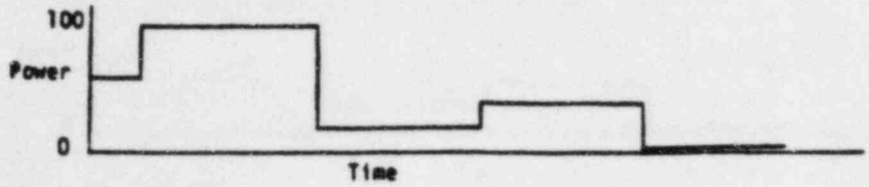
b. The amount of reactivity added was: (1.0)

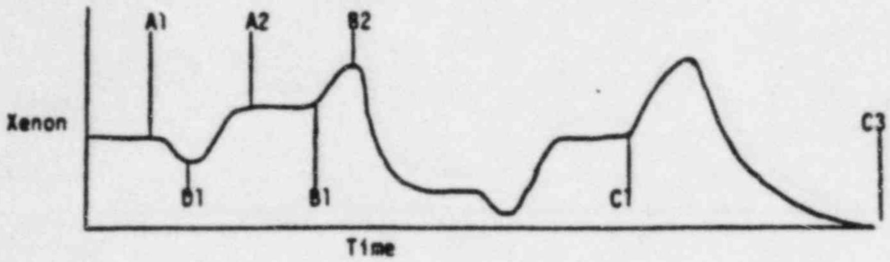
1. 0.0449Δk/k
2. 0.0526Δk/k
3. 0.0585Δk/k
4. 0.0635Δk/k

c. If the same amount of reactivity were added again, the reactor would be: (1.0)

1. Subcritical
2. Critical
3. Supercritical
4. Prompt critical

1.5 Using the following figures, choose the correct answer for each of the three (3) questions asked below:





a. What is the approximate time from A1 to A2? (1.0)

1. 10 hours
2. 30 hours
3. 50 hours
4. 70 hours

b. What is the approximate time from B1 to B2? (1.0)

1. 1-3 hours
2. 2-6 hours
3. 5-7 hours
4. 6-9 hours

c. Why does Xe concentration decrease from A1 to D1? (1.0)

1. Xenon decay is equal to iodine decay
2. Xenon burnout is equal to iodine decaying to Xenon
3. Xenon burnout is greater than iodine decaying to Xenon
4. Xenon decay is greater than iodine decay

1.6 Answer the following statements about the Doppler Coefficient, True or False.

a. Doppler Coefficient becomes more negative from 0 to 100% power due to the increased overlapping of resonance peaks at higher fuel temperatures. (1.0)

b. Doppler Coefficient becomes more negative over core life due to the buildup of Pu-240 and fission products with large resonances in the epithermal range. (1.0)

1.7 A reactor startup is in progress. You have been given the estimated critical rod position for the conditions at 1200. You start to pull rods at 0900 for the approach to critical. How would each of the following conditions or events affect the actual critical rod position compared to the estimated critical rod position? (Each condition or event should be considered independently of all others.) Answer as: more rod withdrawal, less rod withdrawal, or no significant effect.

a. One reactor recirculation pump is stopped (0.5)

b. Shutdown cooling is stopped (significant decay heat) (0.5)

c. Reactor head vent is inadvertently closed (0.5)

d. Moderator temperature gradually decreasing (0.5)

e. Reactor water cleanup system isolates (significant decay heat) (0.5)

1.8 Match the following terms with the proper definition terms.

a. Natural circulation (0.5)
b. Saturated liquid (0.5)
c. Enthalpy (0.5)
d. Departure from nucleate boiling (0.5)

Definitions

1. The point of which partial film boiling begins

2. The point on the boiling curve where heat transfer surface temperature will rise sharply with little or no increase in heat flux

3. The movement of a fluid base and the difference in density of the fluid caused by a differential temperature

4. The total energy of a substance per unit mass

5. A liquid that cannot absorb any more energy without starting to vaporize

6. The internal energy of a system that is no longer available to do work

1.9 Answer the following TRUE or FALSE

a. The differential temperature necessary to transfer heat is inversely proportional to heat flux. (0.5)

b. Pump runout is the term used to describe a centrifugal pump when it is operating with its discharge valve closed. (0.5)

c. The latent heat of vaporization is another term for the latent heat of condensation. (energy related) (0.5)

d. One of the pump laws for centrifugal pumps states that power required by the pump motor is directly proportional to the square of the pump speed. (0.5)

e. The faster a centrifugal pump rotates, the greater the NPSH required to prevent cavitation. (0.5)

1.10 Decay heat is primarily produced from: (0.5)

a. Neutron sources
b. Delayed neutrons slowing down in the fuel
c. Fission products slowing down in the fuel
d. Beta particles slowing down in the fuel

1.11 Consider two operating history cases for the same plant. In Case "A" the year is 1986 and the plant operates for 11 months at 50% power. In Case "B" the year is 1987 and the plant operates for 11 months at 100% power.

a. The samarium level in Case "A" is ______ times that in Case "B." (Select the answer) (1.0)

1. 1/2
2. 4/5
3. 1
4. 2

b. If the reactor is refueled <u>prior to</u> each of these operating history cases with 40 <u>new</u> assemblies. It would take ______ in Case "A" compared to the time in Case "B" to reach the equilibrium samarium value for the <u>new</u> elements. (1.0)

1. half as long
2. the same time
3. twice as long
4. four times as long

END OF SECTION 1

Section 2 - Plant Design Including Safety and Emergency Systems

2.1 Give four reasons for using bottom entry control rods in a Boiling Water Reactor. (GE likes the design is not one.) (2.0)

2.2 The Standby Liquid Control line serves several functions other than poison injection. List four of these functions. (2.0)

2.3 a. The scram discharge volume systems for Unit 1 and Unit 2 are different. What are these differences? (1.0)

b. What recent modifications have been made to the instrumentation on the scram discharge volumes? Explain why this was done. (2.0)

2.4 The signals to the RPS for Unit 1 and Unit 2 are different. Explain this difference. (1.0)

2.5 Each fuel bundle is surrounded by a fuel channel and these channels serve several functions. List four of these functions. (2.0)

2.6 Explain why it is necessary to have the turbine "slaved to" the reactor. (1.0)

2.7 With the plant operating at 100% power what would be the effect on the plant if

a. the load limit is reduced to 75% ([illegible])
b. the max combined flow is reduced to 75% (1.5)

2.8 The reactor is in cold shutdown. The Reactor Water Cleanup System (RWCU) and Recirculation System thermocouples are indicating 180°F and 190°F, respectively. Steam is issuing from the reactor head vent. Explain how this could happen. (Assume all instrumentation is properly calibrated.) (2.0)

2.9 A Primary Containment Group Isolation signal is received and all but one of the associated isolation valves begin to close. How does the PCIS status display indicate that a valve is stuck full open? (1.0)

2.10 For the following Reactor Core Isolation Cooling (RCIC) System motor-operated valves, indicate whether the power supply is AC or DC. (See attached drawing)

a. Inboard Isolation Valve (E51-F063) (0.5)
b. Outboard Isolation Valve (E51-008) (0.5)
c. Turbine Exhaust to Suppression Pool (E51-F068) (0.5)
d. Warmup Bypass Isolation Valve (E51-F076) (0.5)
e. Turbine Steam Supply Valve (E51-F045) (0.5)
f. Pump Discharge Valve (E51-F013) (0.5)

2.11 Match the following events with the loss of the appropriate breaker. (1.5)

Events

a. Loss of Control Power (close/trip) to Generator Excitation Field Breaker (0.25)

b. Loss of Narrow Range Pressure Indication on H13-P603 (0.25)

c. Loss of Main Steam Line "D" Flow Signal to Total Steam Flow Recorder (0.25)

d. Disables Narrow Range "B" Level Instrumentation (indication and signal to Reactor Level Control System) (0.25)

e. Loss of Generator/Transformer Trip System 1 (0.25)

f. Disables Backup Scram Valve F110A (0.25)

Bus

1. 111x
2. 211y
3. 212x

2.12 Regarding the end-of-cycle recirculation pump trip (EOC-RPT):

a. What two conditions will initiate this trip? (1.0)
b. What is the basis for the EOC-RPT? (1.0)
c. When is this trip bypassed? (0.5)

2.13 Unit 1 is operating at 80% power with the "A" TDRFP and the MDRFP controlling level in three element automatic operation. The "B" TDRFP is in manual and the operator depresses the automatic pushbutton on the M/A station for the "B" pump.

a. Explain the effect this will have on the Reactor Water Level Control. (0.5)

b. Why does this happen? (1.0)

END OF SECTION 2

Section 3 - Instruments and Controls

3.1 True or False

A low charging water pressure will initiate a reactor scram if the "test" switch is placed in the TEST position with the mode switch in "REFUEL MODE." (0.5)

3.2 True or False

The RWM will generate an "insert block" upon receipt of the third insert error, under the following conditions:

a. When a withdraw error is received, resulting in a rod block and a rod other than the error rod is inserted (0.5)

b. During power down maneuvering, when steam flow drops below 20% for at least 5 seconds and the operating sequence is not yet latched (0.5)

3.3 The recirculation pumps have an interlock which prevents increasing pump speed above the low speed unless certain conditions are met.

a. What are these conditions? (1.0)
b. Explain the basis for this interlock? (1.5)

3.4 Reactor Water Level No. 4 (31.5") has two functions.

a. What are these two functions? (0.5)
b. What is the basis for these functions? (2.0)

3.5 a. Why is the "flux estimator" used for the flux controller rather than the actual APRM signal? (1.0)

b. What two conditions will automatically initiate a switchover to the actual APRM signal from the flux estimator? (Give applicable setpoints) (1.0)

c. What two alarms are generated by the flux estimator? (1.0)

3.6 Match the ADS auto initiation signals (Column A) with the proper setpoint (Column B). (2.5)

Column A	
a. High drywell pressure	1. 119 psig
b. Low Reactor Water Level	2. -50 inches
c. Confirmatory low water level	3. 250 psig
d. LPCI/[redacted]S discharge pressure	4. 105 seconds

e. Time delay

5. 1.69 psig
6. 150 seconds
7. -12.9 inches   decrease -129
8. 2.00 psig
9. 12.5 inches

delete ~~3.7 What is the function of the Substitute Position Generator?~~ (0.5)

3.8 a. Describe two conditions, other than high level in the Drywell Equipment drain sump, that will cause the "DRYW EQUIP DRAIN SUMP TROUBLE" annunciator on panel 1PM13J to alarm. (2.0)

b. What does this alarm indicate to you. (0.5)

3.9 When the reactor building exhaust Plenum Radiation Monitor system setpoint is exceeded, what automatic actions occur? (1.5)

3.10 List six systems that can be controlled from the Remote Shutdown Panel. (3.0)

3.11 What are the loads supplied by Division I of the CSCS-ESW System? (1.5)

Emergency Service water

3.12 What conditions must be present to cause the LPCS injection valve to automatically open? Include setpoints. (2.0)

3.13 The ADS initiation logic has a time delay in it. What is the purpose of this time delay. (1.0)

deleted ~~3.14~~ True or False

A withdraw block is applied to all rods not having insert errors when the fourth insert error is received.

3.15 The Reactor Water Level Control System receives its level input from either the A or B transmitter. The selected transmitter provides a level signal for several other functions. What are these functions? (4 required) (1.0)

END OF SECTION 3

Section 4 - Procedures - Normal, Abnormal, Emergency and Radiological Control

4.1 a. Which of the following conditions would indicate a failure of the #1 seal, #2 seal or both seals? And indicate which seal or seals have failed. (1.5) - recirc pump

1. The #2 seal pressure higher than normal and staging flow through the second seal is unchanged.

2. The #1 and #2 seal pressure is higher than normal and staging flow through the second seal is unchanged.

3. The #1 and #2 seal pressures decrease and staging flow is lower.

4. The #2 seal pressure is lower and staging flow through the second seal increases.

4.2 a. What parameter changes would indicate that an off-gas hydrogen explosion had occurred? (List 4 parameters with their expected change where applicable.) (2.0)

b. What are four of your immediate actions if the explosion has occurred? (2.0)

4.3 Which of the following would indicate a failure of the control rod drive flow control system? (1.0)

a. Rod drive - High temperature
b. Rod drive - Low temperature
c. Charging water - Header pressure low
d. Charging water - Header pressure high

4.4 When operating in automatic level control and the Reactor Water Level Control system fails, why is it necessary to switch <u>all</u> M/A stations to manual prior to switching to the backup level control instrument? (That is, explain the consequences of not performing the change to manual on the M/A stations.) (Assume failure was due to loss of level sensing instrument.) (1.5)

4.5 During startup and heatup the procedurally enforced restriction on withdrawal of control rods is lifted after a bypass valve opens. Explain the basis for lifting this restriction under those conditions. (1.5)

4.6 Which of the following Process Radiation Monitoring Systems utilize Geigh-Mueller detectors? (0.5)

a. Main Steam Line Radiation Monitors
b. Service Water PRM
c. Control Room HVAC PRM
d. Reactor Building Closed Cooling Water PRM

4.7 You observe that a SRV has spuriously actuated and is stuck open.

a. Briefly explain two methods to close the valve as stated per LOA-NB-02. (0.5)

b. How would you determine that the valve has closed? (Four indications necessary for full credit.) (1.0)

c. A manual scram is required if a SRV is stuck open and any one of three conditions exist. What are these conditions? (1.5)

4.8 The Inboard Shutdown Cooling Containment Isolation Valve (E12-F009) is normally powered from Division II switchgear with the alternate source provided by Division I. When using the alternate power source are the following precautions TRUE or FALSE?

a. The Outboard Shutdown Cooling Isolation Valve (E12-F008) must be closed when using the alternate power supply for the inboard valves. (0.5)

b. There is no protective circuitry to prevent feeding the valve motor operator from both the normal and alternate power supplier. (0.5)

c. The F009 valve will not automatically isolate when the valve is powered form its alternate power source. (0.5)

4.9 During an ATWS, LGA-4 directs you to maintain the water level using condensate/feedwater, control rod drive and/or reactor core isolation cooling systems.

a. Why is the use of these systems preferred over the high pressure core spray, low pressure core spray and low pressure coolant injection systems? (1.25)

b. Explain the possible adverse consequences involved with using the HPCS, LPCS, or LPCI under ATWS conditions. (1.25)

4.10 Arrange the following LGA-03 (Primary Containment Control) operator actions in order of INCREASING Primary Containment Pressure. (1.5)

a. Emergency Depressurization of the RPV
b. Perform RPV Flooding per LGA-05
c. Restart a VP Chiller per LOA-VP-02
d. Initiate Suppression Chamber sprays
e. Shutdown RR Pumps, D/W fans and initiate D/W sprays

4.11 LOA-FP-04, "Loss of Both Diesel Fire Pumps With a Loss of Offsite Power," requires the starting of at least one service water pump as an immediate action. What are the four immediate action steps necessary to start a service water pump? (2.0)

4.12 Although LOA-NB-09, "Transient With Failure to Scram," contains a note that says the operator is not required to verify the exact number of control rods not properly inserted prior to performing immediate actions, the System Training Manual says the operator has authority to inject boron (SBLC) under certain reactor conditions. What are these conditions? (2.0)

4.13 One of the entry conditions for LGA-02, "Secondary Containment Control," is "Any of the following parameters above the maximum normal operating value."

What are these parameters? (Values not required) (2.5)

4.14 LGA-03, "Primary Containment Control," directs the operator to vent the containment regardless of release levels when drywell pressure exceeds ____.

a. What is this pressure? (0.5)

b. What component is the limiting factor in setting this pressure limit? (0.5)

END OF SECTION 4

END OF TEST

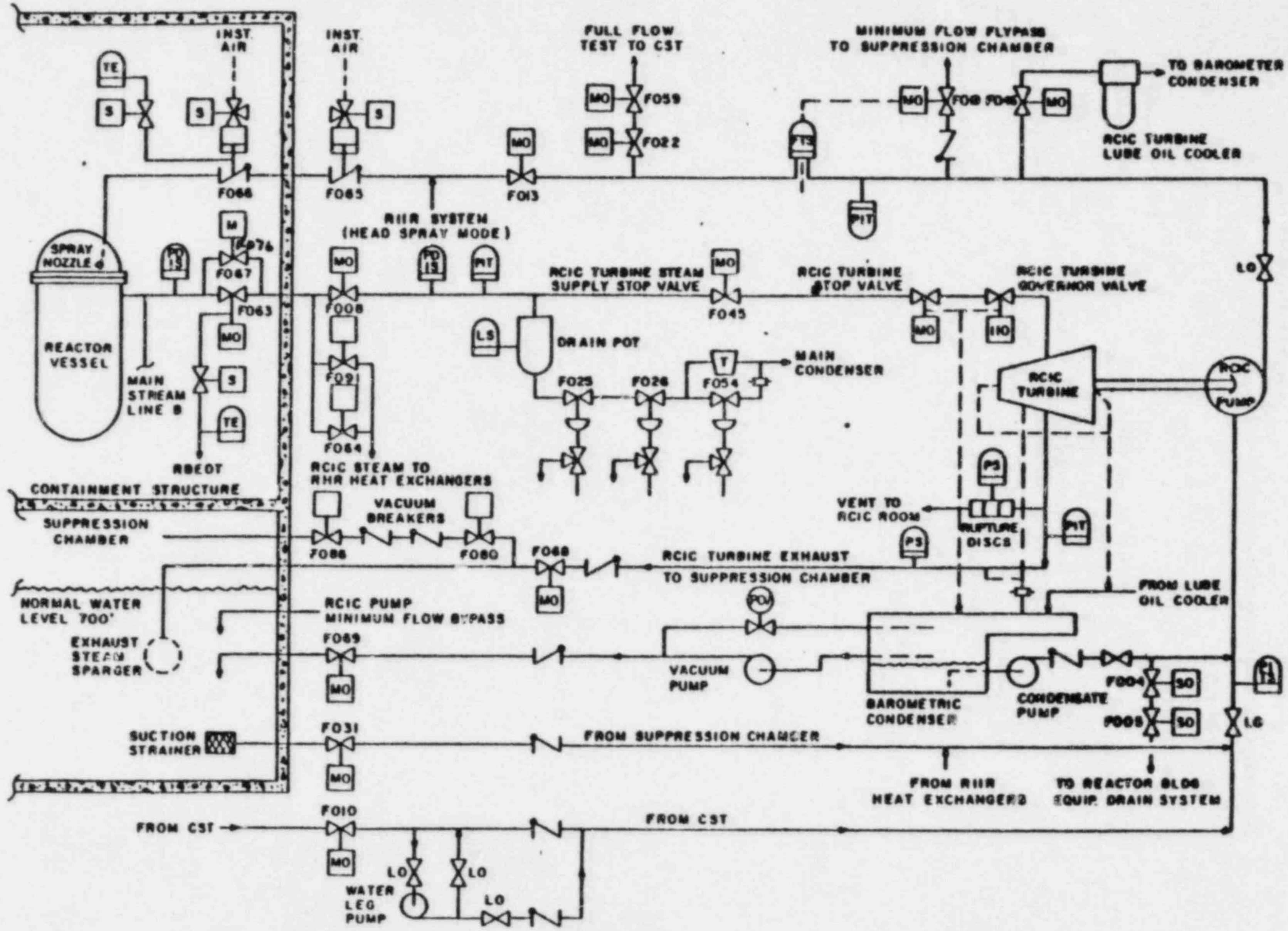


FIGURE 41-1 REACTOR C . ISOLATION COOLING SYSTEM SIMPLIFIED DRAWING

MASTER COPY

ANSWERS - Section 1 - Principles of Nuclear Power, Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow

1.1 Steam is a vapor and one gallon of steam contains only a fraction of the mass of one gallon of water (~~0.25~~); to establish an energy balance across the reactor (~~0.25~~); the feedwater energy in (lbm/hr) (BTU/lbm) is compared with the steam energy out (lbm/hr) (BTU/lbm) (~~0.25~~). (1.0) not need for full credit
Establishing flows in lbm/hr allows a true comparison of the two flows and a simple determination of whether mass is increasing or decreasing in the reactor vessel (~~0.25~~). 1.0

Ref.: Standard Heat Transfer Principles

1.2 1. Located far below the normal water line to provide a large static head

2. Feedflow less than 30%; trip to slow speed

3. At high power operation, feedwater subcooling provide adequate NPSH

4. Low reactor water level trips, cavitation interlock

5. Suction valve closed trip, cavitation interlock

6. ΔT steamline - pump suction < 10°F; trip to slow speed

7. No transfer to fast speed unless feedwater flow > 30% and flow control valve is at minimum

any four @ 0.5 ea.

Ref.: Standard Fluid Flow Principle

1.3 a. A chain reaction will be initiated by the neutrons in the core and power level will increase (0.5) but stabilize as some very low level (0.5).

b. A chain reaction will be initiated and super critical multiplication will result from the positive reacting addition associated with the rod notch withdrawal (0.5). Power will increase (0.25) on a period depending on the notch worth (0.25) until a safety function scram the reactor (0.25) or until sufficient negative reactivity (temp or void) (0.25) is added to stop the power increase.

Ref.: Standard Nuclear Principles

1.4 a. 2
b. 3 or 2
c. 3

each @ 1.0

Ref.: Standard Nuclear Principles

1.5 a. 3
b. 2 or 3
c. 3

Ref.: Standard Nuclear Principles ~~any~~ each @ (1.0)

1.6 a. False
b. True

each @ (1.0)

Ref.: Standard Nuclear Principles

1.7 a. No significant effect
b. More rod withdrawal
c. No significant effect
d. Less rod withdrawal
e. More rod withdrawal

each @ (0.5)

Ref.: Standard Nuclear Principles

1.8 a. 3
b. 5
c. 4
d. 1

each @ (0.5)

Ref.: Standard Heat Transfer Principles

1.9 a. False
b. False
c. True
d. False
e. True

each @ (0.5)

Ref.:

1.10 d or c (0.5)

Ref.:

1.11 a. 3
b. 3

each @ (1.0)

Ref.:

END OF SECTION 1

ANSWERS - Section 2 - Plant Design Including Safety and Emergency Systems

2.1 a. Less time required for refueling (0.5)

b. Internal moisture removal and steam separation can be more easily accomplished (0.5)

c. With a large % of voids in the upper part of the core power is reduced in this area. If rods entered from the top, flux would be overdepressed. (0.5)

d. Bottom entry rods can be used for axial power shaping. Helps control flux peaking in local area of core and yields optimum burnup. (0.5)

Ref.: LaSalle Training Manual, Volume II, Chapter 7, p. 8

2.2 a. Core ΔP measurement
b. HPCS line break detection
c. Jet pump ΔP tap
d. RWCU bottom head drain flow tap
e. CRD drive water and cooling water ΔP tap
f. Emergency makeup to R_x vessel

any four @ 0.5ea.

Ref.: LaSalle Training Manual, Volume I, Chapter 2, p. 56
LGA-04 p-3.

2.3 a. Unit 2 has 2 vent and 2 drain valves in series. (1.0)

b. Two additional scram level switches were added. These are ΔP instruments to provide diversity in measurement. (2.0)

Ref.: LaSalle Training Manual, Volume II, Chapter 8, p. 38

2.4 Unit 2 receives a signal from the CRD system which is effective in "Startup" and "Refuel." (1.0)

Ref.: LaSalle Training Manual, Volume II, Chapter 8, p. 70

2.5 1. Channels the coolant flow upward (90% through the channel 10% bypassed)

2. Bearing surface for control rod blades

3. Protection for fuel rods during handling

4. Primary resistance to lateral acceleration loading on the assembly

5. Insures correct control rod clearance

any four @ 0.5ea.

Ref.: LaSalle Training Manual, Volume I, Chapter 4, p. 14

2.6 A pressure control system was necessary so that reactor pressure is first changed and then turbine power (0.25) because an increase in reactor pressure would cause voids to compress and collapse (0.25) increasing moderator content (add reactivity) (0.25). This power increase would cause pressure to increase further and cause a possible divergent transient (0.25). (The opposite is also true, i.e., lower power decreases pressure more voids, etc.)

Ref.: LaSalle Training Manual, Volume IV, Chapter 26, p. 12

2.7 a. Turbine control valves close, bypass valves open to pass 25%. (1.0)

b. Control valves close. Bypass valves do not open. Reactor pressure increases; voids collapse, adding reactivity power goes up. Cycle repeats. Reactor scrams: ~~or~~ high neutron flux ~~or~~ or high pressure. (1.5)

Ref.: LaSalle Training Manual, Volume IV, Chapter 26, p. 12

2.8 It is possible to have thermal stratification in the core (1.0). Lacking sufficient circulation, the RWCU bottom drain and recirculation loop thermocouples will read significantly lower than the temperature at the surface of the water in the vessel (0.5). If insufficient heat is removed, this condition will result in raising the surface temperature above the boiling point (0.5).

Alternate If vessel level is not above steam separator drain lines (1.0) and you decrease shutdown cooling flow (0.5), there may not be adequate flow through the core to prevent surface temperature from rising to boiling point (0.5).

Ref.: LaSalle Training Manual, Volume I, Chapter 2, p. 84

2.9 A valve not moving would remain flashing indicating that it was stuck open. Valves that reach 90% open position are solid amber. (1.0)

Ref.: LaSalle Training Manual, Chapter 49

2.10 a. AC
b. AC
c. DC
d. AC
e. DC
f. DC

each @ (0.5)

Ref.: LOP-R1-01E

2.11 a. 111x 1
b. 211y 2
c. 211y 1
d. 212x 3
e. 111x 1
f. 211y 2

each (0.25)

Ref.: LOA-DC-02, pgs. 5/10

2.12 a. 1. Turbine trip (closure of Main Turbine Stop valves) (0.5)

2. Generator load reject (fast closure of the main Turbine Control RETS pressure low) (0.5)

(Full credit will not be given if only items in one are listed)

b. Improve MCPR consequences for the above transients (i.e., pressure transients) or recover loss of thermal margin which occurs at end of cycle (1.0)

c. < 30% reactor power (30% first stage pressure) (0.5)

2.13 a. No change (0.5)

b. Since "A" TDRFP and MDRFP are already in automatic and the RWLC system is interlocked so that no more than 2 components can be controlled automatically in 3 element control the third component does not become part of the auto control. (1.0)

Ref.: System Training Manual, Chapter 31

END OF SECTION 2

ANSWERS - Section 3 - Instruments and Controls

3.1 True, Unit 2; False, Unit 1 (0.5)

Ref.: LaSalle Training Manual, Volume II, Chapter 8, p. 40

3.2 a. True (0.5)
b. True (0.5)

Ref.: LaSalle Training Manual, Volume II, Chapter 18, p. 24

3.3 a. Feed flow > 30% and Flow Control Valve at minimum (1.0)

b. Cavitation in flow control valve due to inadequate subcooling (0.5). If fast speed were permitted there would be velocity increase (0.25) and a pressure decrease (0.25) at the valve. Bubbles would form in the valve and collapse at they exit causing valve damage (0.5).

Ref.: LaSalle Training Manual, Volume I, Chapter 5, pgs. 70-71

3.4 a. 1. Low level alarm (0.5)

2. Recirculation flow control valve runback permissive (0.25)

b. 1. Level below which steam carry under would significantly affect the subcooling available for the recirculation pump NPSH. (1.0)

2. With less than 2 feed pumps operating, the recirculation Flow Control Valve will auto close to a minimum position to reduce power within capability of one feed pump. (1.0)

Ref.: LaSalle Training Manual, Volume I, Chapter 3, p. 36

3.5 a. APRM signal is noisy and would cause the flow control valve to oscillate or (flux estimator signal is almost noise free providing steady signal to FCV). (1.0)

b. 1. Actual APRM signal reaches 110% (0.5)
2. Actual flux and estimated flux differ by more than 5% (0.5)

c. 1. APRM raw signal selected for continuous 20 minute period Flux estimator failure (0.5)

2. If logic switches between raw APRM and estimated signal more than 200 times in 5 minutes Flux estimator needs maintenance (0.5)

Ref.: LaSalle Training Manual, Chapter 6, p. 16 & 22

3.6 a. 5
b. 7
c. 9
d. 1
e. 4

each (0.5)

Ref.: System Training Manual, Chapter 37, p. 26 (Check reference)

delete

3.7 This is a device that uses ~~the position~~ data from the RPIS (identity ~~of the selected rod and rod driving signals~~) to generate the next expected position of the rod being driven.

Ref.: Systems Training Manual, pgs. 40 & 41

3.8 a) Pump starts; a timer actuates (0.25); timer interval corresponds to time for pump to pump 20 gpm leak (0.5); if pump runs past this time alarm sound (0.25). If pump stops prior to this time (0.25) a second timer starts (0.25). This timer looks at restart time (0.25). If pump starts before timer runs out (0.25).

b) Alarm indicates leak has progressed to 20 gpm (0.5).

Ref.: Systems Training Manual, Chapter 73, p. 26

3.9	a.	Start SBGT and associated samples	(0.5)
	b.	Isolate Reactor Building ventilation	(0.5)
	c.	Close primary containment vent and purge	(0.5)

Ref.: LaSalle Systems Training Manual, Chapter 72, pgs. 94 & 95

3.10 RCIC; RHR Loop B (does not include valves for Steam Condensing mode), RHR service water pumps C and D and B Hx outlet valve (68B), three safety relief valves H, K, P; recirculation pump A suction valve; RBCCW pump 1A; service water jockey pump 0A and strainer outlet valve (1WS113); plant evacuation siren.

any 6 each (0.5)

Ref.: LaSalle Systems Training Manual, Chapter 74, pgs. 40 & 41

3.11 RHR Heat Exchanger A; RHR pump A seal cooler; Diesel generator "0" cooler; Unit 1 and 2 LPCS pump motor coolers; Unit 1 and 2 NE an NW area cooler; fuel pool emergency makeup supply A.

any 3 each (0.5)

Ref.: LaSalle Systems Training Manual, Chapter 40, p. 52 & 53

3.12 Power available to 141y; Level 1 (-129"); 1.69 psig drywell pressure; less than 500 psig reactor pressure and < 500 psig between F005 and F006. (2.0)

Ref.: LaSalle Systems Training Manual, Chapter 38, pgs. 52 & 53

3.13 Time delay is to assure the HPCS has enough time to operate yet not so long that the LPCS/LPCI systems would be unable to cool the core. (1.0)

Ref.: LaSalle Systems Training Manual, Chapter 37, pgs. 52 & 53

3.14 ~~False~~ Deleted

Ref.: LaSalle Systems Training Manual, Chapter 18, p. 46

3.15 1. Upset/narrow range recorders
2. Recirculation runback permissive (alarm/trip)
3. Pump down shift (alarm/trip)
4. High/low level alarm

each @ .25)

Ref.: LaSalle Systems Training Manual, Chapter 3, p. 14

END OF SECTION 3

ANSWERS - Section 4 - Procedures - Normal, Abnormal, Emergency and Radiological Control

4.1 a. 4 (0.25)
b. 2 (0.75)

Ref.: LaSalle Training Manual, Volume I, Chapter 5, p. 30

4.2 a. Sudden abnormal change in prefilter ΔP, after filter ΔP and off-gas system pressure; high off-gas system flow; high pretreatment radiation monitor; high charcoal adsorber vault temperature; high area radiation in off-gas. any 4 each (0.5)

b. 1. Initiate load reduction (LOA-GG-01)
2. Warn all personnel to stay clear of off-gas areas
3. Notify shift supervisor and Load Dispatcher
4. Check "Adsorber Bed High Temperature" alarm (clear) any 4 each (0.5)
5. Check all off-gas area radiation monitors

Ref.: LOA, Volume 2, LOA-OG-02

4.3 [redacted] deleted

Ref.: LOA, Volume 2, LOA-RO-04

4.4 Switching to other level instrument prior to transferring all M/A stations to manual will cause excessive reactor level swings (0.5) and feedwater pipe vibrations (0.5). This is due to the large variation that exists between the failed instrument and the backup instrument (0.5).

Ref.: LOA, Volume 2, LOA-RL-01

4.5 At that condition the core would contain voids (0.25) and the voids suppress the flux (0.25) thus improving the peak to average flux ratio (0.25). This reduces the notch worth of all rods (0.25). The open bypass valve stabilizes pressure and the void content is also more stable (0.25) and much more effective in providing negative reactivity feedback (0.25).

Ref.: LaSalle Training Manual, Volume III, Chapter 19, pgs. 40 & 41

4.6 c. (0.5)

Ref.: LaSalle Training Manual, Chapter 72, p. 32

4.7 a. 1. Cycle control switch from auto to open and back to auto (.25)

2. Remove fuses for affected valve to deenergize control circuit (.25)

Alternate

3. Operate keylock for ADS valve

4. Hand switch at remote panel for HKP

b. Valve position indication (clear); leak detector; generator load; steamflow; no rumbling noises; down comer piping temperature normal; suppression pool normal; radiation levels normal. any 4 each 0.25

c. 1. Valve remains open for 2 minutes (0.5)

2. Valve remains open after a maximum of 4 attempts to close (0.5)

3. Suppression pool temperature reaches 110°F (0.5)

Ref.: LOA, Volume I, LOA-NB-02

4.8 a. F
b. T
c. T

each (0.5)

Ref.: LOP-RH-07, p. 4
Volume VIII, Chapter 49, pgs. 40 & 62

4.9 a. Condensate/feedwater, control rod drive and reactor core isolation cooling inject outside the shroud (0.5) which allows for mixing of the cold unborated water being injected (0.5) with the warm water in the down comer prior to entering the core (0.25).

b. Use of HPCS, LPCS or LPCI injects cold water directly into the core (1.0) and could cause a power surge (0.25).

4.10 c, d, e, a, b or c, d, a, b, e each (0.30)

Ref.: LGA-03, Step C.4

4.11 a. Dispatch operator to close discharge valve on selected pump. (0.5)

b. Restore power to bus by closing cross tie breakers [141x(241x) and 142x(242x) - ACB 1415(2415) and ACB 1425(2425)]. (0.5)

c. Start selected service water pump. (Select pump according to DG availability. Do not exceed amp 494 or load 2860KW.) (0.5)

d. Open service water pump discharge isolation valve. (0.5)

Ref.: LOA-FP-04, pgs. 1-2

4.12 Rx water level not maintained (0.5) or suppression pool water temperature reaches 110°F (0.5); and either

a. 5 or more adjacent rods not inserted to at least 06 or (0.5)

b. 30 or more rods not inserted to at least 06 (0.5)

Ref.: LOA-NB-09, p. 2
LaSalle Systems Training Manual, Volume II, Chapter 10, p. 48

4.13 Area temperature (0.5) area differential temperature (0.5) area radiation level (0.5). Area water level (0.5); Rx building or Fuel Pool Cooling ventilation exhaust radiation level (0.5).

Ref.: LGA-02, p. 1

4.14 a. 60 psig
b. SRV actuators each (0.5)

Ref.: LGA-03, p 15

END OF SECTION 4

Master

U.S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: LaSalle

REACTOR TYPE BWR

DATE ADMINISTERED: November 18, 1985

EXAMINER: T. E. Lang

APPLICANT: ____________

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%.

Category Value	% of Total	Applicant's Score	% of Category Value	
25.5	25.8	____	____	5. Theory of Nuclear Power Plant Operations, Fluids and Thermodynamics
25	25.2	____	____	6. Plant Design, Control and Instrumentation
25	25.2	____	____	7. Procedures - Normal, Abnormal, Emergency and Radiological Control
23.5	23.8	____	____	8. Administrative Procedures, Conditions and Limitations
99	100	____	____	TOTALS

Final Grade ________%

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

____
Applicant's Signature

Theory of Nuclear Power Plant Operations,
Fluids and Thermodynamics

5.01 For the following condition, state if the Fuel Temperature Coefficient becomes more or less negative.

a. Increase in fuel temperature (0.5)
b. Increase in moderator temperature (0.5)
c. Increase in void fraction (0.5)

5.02 Define the following items:

a. Latent heat of vaporization (1.0)
b. Critical Point (1.0)
c. Saturated Liquid (1.0)

5.03 Explain the effects of increasing the following core parameters on steady state critical power.

a. Core flow (1.0)
b. Inlet subcooling (1.0)
c. Reactor pressure (1.0)

5.04 If equilibrium xenon is obtained (the reactor has been operating at constant power for many hours), and the reactor power is doubled, will the new equilibrium xenon concentration be twice as great? Explain your answer. (2.0)

5.05 You increase core power by pulling control rods around the center fuel bundle. Assuming that recirculation flow is kept constant would the flow through the center bundle increase, decrease, or stay the same? Explain your answer. Assume Power Operation. (2.0)

5.06 Explain how and why Rod Worth changes for the following conditions.

a. Increase in moderator temperature (1.0)
b. Increase in void fraction (1.0)

5.07 Your reactor operator informs you that MAPRAT is 1.02

a. Is the MAPRAT, as stated, conservative? Explain your answer. (0.75)

b. In regards to MAPRAT, which of the following statements are True and which are False? (0.75)

1. MAPRAT maintained within limits ensures that transition boiling will not occur in 99% of the fuel bundles.

2. Maintaining MAPRAT limits ensures that the MFLPD limits are met.

3. Maintaining MAPRAT limits ensures that peak clad temperature will not reach 2200°F during a LOCA.

5.08 a. What are three coefficients of reactivity and what is a typical value of each? (1.5)

b. How are the above coefficients of reactivity affected by core age? (Less negative, more negative or remain the same) (1.5)

5.09 A fluid is at 400°F and 600 psig. Is it subcooled or super heated and by how many degrees? (1.0)

5.10 If reactor power level is increased from 50 MW to 370 MW in two minutes, what is the doubling time? (Show all work) (2.0)

5.11 Using the attached curve:

a. Why does core reactivity decrease from point A to point B? (0.5)

b. Why does core reactivity increase from point B to point C? (0.5)

c. Why does core reactivity decrease from point C to point D? (0.5)

5.12 With an initial Keff of 0.9, sufficient control rods are withdrawn to increase the count rate by a factor of 10. What is the final Keff of the core? (2.0)

5.13 a. Define "Condensate Depression." (0.5)

b. Is it necessary for plants to operate with "Condensate Depression?" Explain your answer. (0.5)

END OF SECTION

Plant Design, Control and Instrumentation

6.01 a. What are four indications of a failed jet pump? Assume full power conditions. (2.0)

b. Why is jet pump integrity important in regards to accident conditions? (0.5)

6.02 What are the five ranges of vessel level instrumentation? Be specific and include setpoints. *Set points are high and low reading on instrument.* (2.5)

6.03 In regards to Recirculation Pump Cavitation Interlocks:

a. What are the two cavitation interlocks which will trip the pumps from 100% to 25% speed? (2.0)

b. Are the interlocks above actuated immediately once their respective setpoints are reached? If not why not? (0.5)

6.04 The design of the suppression chamber incorporates a free air volume and a containment water volume. What is the purpose or function of each? (2.0)

6.05 What will happen to the inlet and outlet flow paths for the shell side of the 15A feedwater heater on an increasing level condition in the 15A heater? Assume level continues to increase to the trip points. (3.0)

6.06 Reactor Water level can be automatically controlled in the two modes. (Single Element and Three Element)

a. For each mode of operation what input signals are used to control level. (2.0)

b. What components are controlled or regulated in each mode of operation? Be specific, include how many components can be controlled in each mode. (2.0)

6.07 For each of the following, state whether a Rod Block, Half-scram, or No Reactor Protection System Action is generated for that condition. Note: If two or more actions are generated, i.e., rod block and half-scram, state the most severe, i.e., half-scram.

a. APRM B downscale, Mode Switch in Run (0.5)

b. 12 LPRM inputs *available inputs* to APRM C, Mode Switch in Startup (0.5)

c. Flow Units A and B upscale (>108% slow) Mode Switch in Run (0.5)

d. Reactor water level 55", Reactor Power 18% Mode Switch in Run (0.5)

6.08 There are two means of bypassing the operation of the RBM automatically. What are these two means? (2.0)

6.09 How does the RSCS respond when an RPIS failure occurs? Assume both high power (100% power) and low power (1% power) conditions. (2.0)

6.10 In regards to the Control Rod Drive System:

a. What prevents a control rod drive pump from going into "Runout" following a scram? (1.0)

b. How does the on-line FCV respond following a scram? (0.5)

6.11 The SBLC system has a minimum injection time of 50 minutes to prevent reactivity "Chugging." What is reactivity "Chugging," and why is it disadvantageous? (1.0)

END OF SECTION

Procedures - Normal, Abnormal, Emergency and Radiological Control

7.01 During a training startup with one RHR loop in the Shutdown Cooling Mode, three items are required to be verified once per hour. What are these three items? (1.5)

7.02 What restrictions apply to the use of "Notch Override" switch during a unit startup? (2.5)

7.03 What four items must be logged once the reactor has been brought critical? (1.0)

7.04 What actions must be performed to the Feedwater System and the RWCU System to prevent or minimize feedwater nozzle, sparger, and header, thermal stress at low flow conditions? Two actions required for full credit. (2.0)

7.05 During a normal unit shutdown you are cautioned not to open the turbine vacuum breaker at high RPMs. Why is this caution necessary? (1.0)

7.06 Define the following terms:

a. High Radiation Area (1.0)
b. Radiation Area (2.0)

7.07 What action must be taken on a stuck open safety relief valve? (1.5)

7.08 The operator is not required to verify the exact number of control rods not properly inserted before taking the immediate actions on an ATWS but there are some guidelines as to when to inject SBLC. What are these guidelines? (3.0)

Put new ans. or both old and new.

7.09 What automatic actions occur on a high reactor water level (level 8)? Four automatic actions required for full credit. (2.0)

7.10 If the generator trips during a Stator Cooling Runback:

a. What are two conditions which could have initiated the trip? (2.0)

b. What are two initiating signals for the Stator Cooling Runback? (2.0)

7.11 According to LaSalle "General Precautions," if directed to open the ADS SRVs or if ADS initiates automatically, DO NOT close the ADS valves unless one of two conditions exist. What are these two conditions? (2.0)

7.12 Other than "As directed" what are the entry conditions for Level/Pressure control LGA-01? Be specific, include all setpoints. (1.5)

END OF SECTION

Administrative Procedures, Conditions and Limitations

8.01 Define the following terms according to your Technical Specifications.

a. ~~Limited~~ Limiting Control Rod Pattern (1.0)
b. Channel Check (1.0)

8.02 What is required in order to implement a "Temporary System Change" on backshifts and weekends? Include in your answer any specific requirements such as qualifications? (2.0)

8.03 In order to remove a safety-related system from service the outage must have independent verification.

a. Can anyone verify the system is removed from service? Explain your answer. (1.0)

b. Under what conditions can the second verification be waived? (1.0)

8.04 Other than on-shift personnel what other personnel have unlimited access during normal operations? Six required for full credit. (3.0)

8.05 a. 10 CFR 50.54 states, "An operator or Senior Operator licensed pursuant to Part 55 shall be at the controls at all times during operation of the facility." What must an operator do to meet this requirement? (2.0)

b. If a unit operator finds it necessary to leave the "at the controls" area who must stand-in for him? (0.5)

8.06 What three (3) actions must be completed within one hour if one control rod is determined inoperable due to being immovable, as a result of excessive friction or mechanical interference, or known to be untrippable? (3.0)

8.07 For each of the following conditions, state whether you would consider the system operable or inoperable for Condition 1 plant operation. For each one you consider inoperable, briefly state why you determined the system to be inoperable (i.e., why it cannot perform its intended function).

a. The LPCS "Keep Filled" pressure alarm has actuated and subsequent high point venting of the LPCS discharge piping does not result in water issuing from the vents. (1.5)

b. Two Suppression Chamber Vacuum Breakers cannot be shut. (1.5)

8.08 What is meant by Primary Containment Integrity? (3.0)

8.09 According to Technical Specifications, what is the basis of the following scram.

a. Main Steam Line Isolation Valve Closure (1.0)
b. Main Steam Line Radiation High (1.0)
c. Turbine Stop Valve Closure (1.0)

END OF TEST

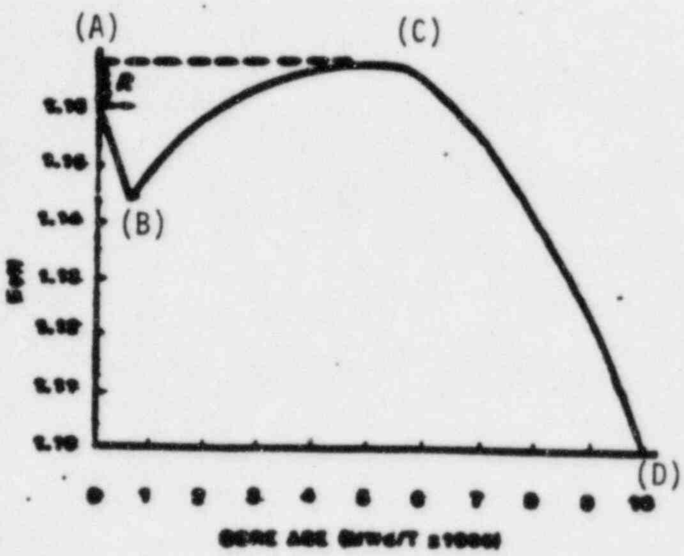


Figure 11. Keff vs. Core Age

Table 1. Saturated Steam: Temperature Table

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
32.0*	0.08859	0.016022	3304.7	3304.7	-0.0179	1075.5	1075.5	0.0000	2.1873	2.1873	32.0*
34.0	0.09600	0.016021	3061.9	3061.9	1.996	1074.4	1076.4	0.0041	2.1762	2.1802	34.0
36.0	0.10395	0.016020	2839.0	2839.0	4.008	1073.2	1077.2	0.0081	2.1651	2.1732	36.0
38.0	0.11249	0.016019	2634.1	2634.2	6.018	1072.1	1078.1	0.0122	2.1541	2.1663	38.0
40.0	0.12163	0.016019	2445.8	2445.8	8.027	1071.0	1079.0	0.0162	2.1432	2.1594	40.0
42.0	0.13143	0.016019	2272.4	2272.4	10.035	1069.8	1079.9	0.0202	2.1325	2.1527	42.0
44.0	0.14192	0.016019	2112.8	2112.8	12.041	1068.7	1080.7	0.0242	2.1217	2.1459	44.0
46.0	0.15314	0.016020	1965.7	1965.7	14.047	1067.6	1081.6	0.0282	2.1111	2.1393	46.0
48.0	0.16514	0.016021	1830.0	1830.0	16.051	1066.4	1082.5	0.0321	2.1006	2.1327	48.0
50.0	0.17796	0.016023	1704.8	1704.8	18.054	1065.3	1083.4	0.0361	2.0901	2.1262	50.0
52.0	0.19165	0.016024	1589.2	1589.2	20.057	1064.2	1084.2	0.0400	2.0798	2.1197	52.0
54.0	0.20625	0.016026	1482.4	1482.4	22.058	1063.1	1085.1	0.0439	2.0695	2.1134	54.0
56.0	0.22183	0.016028	1383.6	1383.6	24.059	1061.9	1086.0	0.0478	2.0593	2.1070	56.0
58.0	0.23843	0.016031	1292.2	1292.2	26.060	1060.8	1086.9	0.0516	2.0491	2.1008	58.0
60.0	0.25611	0.016033	1207.6	1207.6	28.060	1059.7	1087.7	0.0555	2.0391	2.0946	60.0
62.0	0.27494	0.016036	1129.2	1129.2	30.059	1058.5	1088.6	0.0593	2.0291	2.0885	62.0
64.0	0.29497	0.016039	1056.5	1056.5	32.058	1057.4	1089.5	0.0632	2.0192	2.0824	64.0
66.0	0.31626	0.016043	989.0	989.1	34.056	1056.3	1090.4	0.0670	2.0094	2.0764	66.0
68.0	0.33889	0.016046	926.5	926.5	36.054	1055.2	1091.2	0.0708	1.9996	2.0704	68.0
70.0	0.36292	0.016050	868.3	868.4	38.052	1054.0	1092.1	0.0745	1.9900	2.0645	70.0
72.0	0.38844	0.016054	814.3	814.3	40.049	1052.9	1093.0	0.0783	1.9804	2.0587	72.0
74.0	0.41550	0.016058	764.1	764.1	42.046	1051.8	1093.8	0.0821	1.9708	2.0529	74.0
76.0	0.44420	0.016063	717.4	717.4	44.043	1050.7	1094.7	0.0858	1.9614	2.0472	76.0
78.0	0.47461	0.016067	673.8	673.9	46.040	1049.5	1095.6	0.0895	1.9520	2.0415	78.0
80.0	0.50683	0.016072	633.3	633.3	48.037	1048.4	1096.4	0.0932	1.9426	2.0359	80.0
82.0	0.54093	0.016077	595.5	595.5	50.033	1047.3	1097.3	0.0969	1.9334	2.0303	82.0
84.0	0.57702	0.016082	560.3	560.3	52.029	1046.1	1098.2	0.1006	1.9242	2.0248	84.0
86.0	0.61518	0.016087	527.5	527.5	54.026	1045.0	1099.0	0.1043	1.9151	2.0193	86.0
88.0	0.65551	0.016093	496.8	496.8	56.022	1043.9	1099.9	0.1079	1.9060	2.0139	88.0
90.0	0.69813	0.016099	468.1	468.1	58.018	1042.7	1100.8	0.1115	1.8970	2.0086	90.0
92.0	0.74313	0.016105	441.3	441.3	60.014	1041.6	1101.6	0.1152	1.8881	2.0033	92.0
94.0	0.79062	0.016111	416.3	416.3	62.010	1040.5	1102.5	0.1188	1.8792	1.9980	94.0
96.0	0.84072	0.016117	392.8	392.9	64.006	1039.3	1103.3	0.1224	1.8704	1.9928	96.0
98.0	0.89356	0.016123	370.9	370.9	66.003	1038.2	1104.2	0.1260	1.8617	1.9876	98.0
100.0	0.94924	0.016130	350.4	350.4	67.999	1037.1	1105.1	0.1295	1.8530	1.9825	100.0
102.0	1.00789	0.016137	331.1	331.1	69.995	1035.9	1105.9	0.1331	1.8444	1.9775	102.0
104.0	1.06965	0.016144	313.1	313.1	71.992	1034.8	1106.8	0.1366	1.8358	1.9725	104.0
106.0	1.1347	0.016151	296.16	296.18	73.99	1033.6	1107.6	0.1402	1.8273	1.9675	106.0
108.0	1.2030	0.016158	280.28	280.30	75.98	1032.5	1108.5	0.1437	1.8188	1.9626	108.0
110.0	1.2750	0.016165	265.37	265.39	77.98	1031.4	1109.3	0.1472	1.8105	1.9577	110.0
112.0	1.3505	0.016173	251.37	251.38	79.98	1030.2	1110.2	0.1507	1.8021	1.9528	112.0
114.0	1.4299	0.016180	238.21	238.22	81.97	1029.1	1111.0	0.1542	1.7938	1.9480	114.0
116.0	1.5133	0.016188	225.84	225.85	83.97	1027.9	1111.9	0.1577	1.7856	1.9433	116.0
118.0	1.6009	0.016196	214.20	214.21	85.97	1026.8	1112.7	0.1611	1.7774	1.9386	118.0
120.0	1.6927	0.016204	203.25	203.26	87.97	1025.6	1113.6	0.1646	1.7693	1.9339	120.0
122.0	1.7891	0.016213	192.94	192.95	89.96	1024.5	1114.4	0.1680	1.7613	1.9293	122.0
124.0	1.8901	0.016221	183.23	183.24	91.96	1023.3	1115.3	0.1715	1.7533	1.9247	124.0
126.0	1.9959	0.016229	174.08	174.09	93.96	1022.2	1116.1	0.1749	1.7453	1.9202	126.0
128.0	2.1068	0.016238	165.45	165.47	95.96	1021.0	1117.0	0.1783	1.7374	1.9157	128.0
130.0	2.2230	0.016247	157.32	157.33	97.96	1019.8	1117.8	0.1817	1.7295	1.9112	130.0
132.0	2.3445	0.016256	149.64	149.66	99.95	1018.7	1118.6	0.1851	1.7217	1.9068	132.0
134.0	2.4717	0.016265	142.40	142.41	101.95	1017.5	1119.5	0.1884	1.7140	1.9024	134.0
136.0	2.6047	0.016274	135.55	135.57	103.95	1016.4	1120.3	0.1918	1.7063	1.8980	136.0
138.0	2.7438	0.016284	129.09	129.11	105.95	1015.2	1121.1	0.1951	1.6986	1.8937	138.0
140.0	2.8892	0.016293	122.98	123.00	107.95	1014.0	1122.0	0.1985	1.6910	1.8895	140.0
142.0	3.0411	0.016303	117.21	117.22	109.95	1012.9	1122.8	0.2018	1.6834	1.8852	142.0
144.0	3.1997	0.016312	111.74	111.76	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	144.0
146.0	3.3653	0.016322	106.58	106.59	113.95	1010.5	1124.5	0.2084	1.6684	1.8769	146.0
148.0	3.5381	0.016332	101.68	101.70	115.95	1009.3	1125.3	0.2117	1.6610	1.8727	148.0
150.0	3.7184	0.016343	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150.0
152.0	3.9065	0.016353	92.66	92.68	119.95	1007.0	1126.9	0.2183	1.6463	1.8646	152.0
154.0	4.1025	0.016363	88.50	88.52	121.95	1005.8	1127.7	0.2216	1.6390	1.8606	154.0
156.0	4.3068	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5197	0.016384	80.82	80.83	125.96	1003.4	1129.4	0.2281	1.6245	1.8526	158.0
160.0	4.7414	0.016395	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160.0
162.0	4.9722	0.016406	73.90	73.92	129.96	1001.0	1131.0	0.2345	1.6103	1.8448	162.0
164.0	5.2124	0.016417	70.70	70.72	131.96	999.8	1131.8	0.2377	1.6032	1.8409	164.0
166.0	5.4623	0.016428	67.67	67.68	133.97	998.6	1132.6	0.2409	1.5961	1.8371	166.0
168.0	5.7223	0.016440	64.78	64.80	135.97	997.4	1133.4	0.2441	1.5892	1.8333	168.0
170.0	5.9926	0.016451	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170.0
172.0	6.2736	0.016463	59.43	59.45	139.98	995.0	1135.0	0.2505	1.5753	1.8258	172.0
174.0	6.5656	0.016474	56.95	56.97	141.98	993.8	1135.8	0.2537	1.5684	1.8221	174.0
176.0	6.8690	0.016486	54.59	54.61	143.99	992.6	1136.6	0.2568	1.5616	1.8184	176.0
178.0	7.1840	0.016498	52.35	52.36	145.99	991.4	1137.4	0.2600	1.5548	1.8147	178.0

*The states shown are meta stable

Table 1. Saturated Steam: Temperature Table—*Continued*

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
180.0	7.5110	0.016510	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180.0
182.0	7.850	0.016522	48.172	48.189	150.01	989.0	1139.0	0.2662	1.5413	1.8075	182.0
184.0	8.203	0.016534	46.232	46.249	152.01	987.8	1139.8	0.2694	1.5346	1.8040	184.0
186.0	8.568	0.016547	44.383	44.400	154.02	986.5	1140.5	0.2725	1.5279	1.8004	186.0
188.0	8.947	0.016559	42.621	42.638	156.03	985.3	1141.3	0.2756	1.5213	1.7969	188.0
190.0	9.340	0.016572	40.941	40.957	158.04	984.1	1142.1	0.2787	1.5148	1.7934	190.0
192.0	9.747	0.016585	39.337	39.354	160.05	982.8	1142.9	0.2818	1.5082	1.7900	192.0
194.0	10.168	0.016598	37.808	37.824	162.05	981.6	1143.7	0.2848	1.5017	1.7865	194.0
196.0	10.605	0.016611	36.348	36.364	164.06	980.4	1144.4	0.2879	1.4952	1.7831	196.0
198.0	11.056	0.016624	34.954	34.970	166.08	979.1	1145.2	0.2910	1.4888	1.7798	198.0
200.0	11.526	0.016637	33.622	33.639	168.09	977.9	1146.0	0.2940	1.4824	1.7764	200.0
204.0	12.517	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	204.0
208.0	13.568	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	208.0
212.0	14.696	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	212.0
216.0	15.901	0.016747	24.876	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
224.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	224.0
228.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	228.0
232.0	21.567	0.016854	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	232.0
236.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	236.0
240.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240.0
244.0	26.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	244.0
248.0	28.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3649	1.3379	1.7028	248.0
252.0	30.883	0.017022	13.358	13.375	220.62	944.1	1164.7	0.3706	1.3266	1.6972	252.0
256.0	33.091	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	256.0
260.0	35.427	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	260.0
264.0	37.894	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	264.0
268.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	268.0
272.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	272.0
276.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	276.0
280.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280.0
284.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	284.0
288.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	288.0
292.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	292.0
296.0	63.084	0.01741	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	296.0
300.0	67.005	0.01745	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	300.0
304.0	71.119	0.01749	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	304.0
308.0	75.433	0.01753	5.7655	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6256	308.0
312.0	79.953	0.01757	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	312.0
316.0	84.688	0.01761	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	316.0
320.0	89.643	0.01766	4.8961	4.9136	290.4	894.8	1185.2	0.4640	1.1477	1.6116	320.0
324.0	94.826	0.01770	4.6418	4.6595	294.6	891.6	1186.2	0.4692	1.1378	1.6071	324.0
328.0	100.245	0.01774	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	328.0
332.0	105.907	0.01779	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	332.0
336.0	111.820	0.01783	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1086	1.5936	336.0
340.0	117.992	0.01787	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	340.0
344.0	124.430	0.01792	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0894	1.5849	344.0
348.0	131.142	0.01797	3.4078	3.4258	319.7	872.2	1191.1	0.5006	1.0799	1.5806	348.0
352.0	138.138	0.01801	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	352.0
356.0	145.424	0.01806	3.0863	3.1044	328.1	865.5	1193.6	0.5110	1.0611	1.5721	356.0
360.0	153.010	0.01811	2.9392	2.9573	332.3	862.1	1194.4	0.5161	1.0517	1.5678	360.0
364.0	160.903	0.01816	2.8002	2.8184	336.5	858.6	1195.2	0.5212	1.0424	1.5637	364.0
368.0	169.113	0.01821	2.6691	2.6873	340.8	855.1	1195.9	0.5263	1.0332	1.5595	368.0
372.0	177.648	0.01826	2.5451	2.5633	345.0	851.6	1196.7	0.5314	1.0240	1.5554	372.0
376.0	185.517	0.01831	2.4279	2.4462	349.3	848.1	1197.4	0.5365	1.0148	1.5513	376.0
380.0	195.729	0.01836	2.3170	2.3353	353.6	844.5	1198.0	0.5416	1.0057	1.5473	380.0
384.0	205.294	0.01842	2.2120	2.2304	357.9	840.8	1198.7	0.5466	0.9966	1.5432	384.0
388.0	215.220	0.01847	2.1126	2.1311	362.2	837.2	1199.3	0.5516	0.9876	1.5392	388.0
392.0	225.516	0.01853	2.0184	2.0369	366.5	833.4	1199.9	0.5567	0.9786	1.5352	392.0
396.0	236.193	0.01858	1.9291	1.9477	370.8	829.7	1200.4	0.5617	0.9696	1.5313	396.0
400.0	247.259	0.01864	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	400.0
404.0	258.725	0.01870	1.7640	1.7827	379.4	822.0	1201.5	0.5717	0.9518	1.5234	404.0
408.0	270.600	0.01875	1.6877	1.7064	383.8	818.2	1201.9	0.5766	0.9429	1.5195	408.0
412.0	282.894	0.01881	1.6152	1.6340	388.1	814.2	1202.4	0.5816	0.9341	1.5157	412.0
416.0	295.617	0.01887	1.5463	1.5651	392.5	810.2	1202.8	0.5866	0.9253	1.5118	416.0
420.0	308.780	0.01894	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	420.0
424.0	322.391	0.01900	1.4184	1.4374	401.3	802.2	1203.5	0.5964	0.9077	1.5042	424.0
428.0	336.463	0.01906	1.3591	1.3782	405.7	798.0	1203.7	0.6014	0.8990	1.5004	428.0
432.0	351.00	0.01913	1.30266	1.32179	410.1	793.9	1204.0	0.6063	0.8903	1.4966	432.0
436.0	366.03	0.01919	1.24887	1.26806	414.6	789.7	1204.2	0.6112	0.8816	1.4928	436.0
440.0	381.54	0.01926	1.19761	1.21687	419.0	785.4	1204.4	0.6161	0.8729	1.4890	440.0
444.0	397.56	0.01933	1.14874	1.16806	423.5	781.1	1204.6	0.6210	0.8643	1.4853	444.0
448.0	414.09	0.01940	1.10212	1.12152	428.0	776.7	1204.7	0.6259	0.8557	1.4815	448.0
452.0	431.14	0.01947	1.05764	1.07711	432.5	772.3	1204.8	0.6308	0.8471	1.4778	452.0
456.0	448.73	0.01954	1.01518	1.03472	437.0	767.8	1204.8	0.6356	0.8385	1.4741	456.0

Table 1. Saturated Steam: Temperature Table—*Continued*

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
460.0	466.87	0.01961	0.97463	0.99424	441.5	763.2	1204.8	0.6405	0.8299	1.4704	460.0
464.0	485.56	0.01969	0.93588	0.95557	446.1	758.6	1204.7	0.6454	0.8213	1.4667	464.0
468.0	504.83	0.01976	0.89885	0.91862	450.7	754.0	1204.6	0.6502	0.8127	1.4629	468.0
472.0	524.67	0.01984	0.86345	0.88329	455.2	749.3	1204.5	0.6551	0.8042	1.4592	472.0
476.0	545.11	0.01992	0.82958	0.84950	459.9	744.5	1204.3	0.6599	0.7956	1.4555	476.0
480.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.6648	0.7871	1.4518	480.0
484.0	587.81	0.02009	0.76613	0.78622	469.1	734.7	1203.8	0.6696	0.7785	1.4481	484.0
488.0	610.10	0.02017	0.73641	0.75658	473.8	729.7	1203.5	0.6745	0.7700	1.4444	488.0
492.0	633.03	0.02026	0.70794	0.72820	478.5	724.6	1203.1	0.6793	0.7614	1.4407	492.0
496.0	656.61	0.02034	0.68065	0.70100	483.2	719.5	1202.7	0.6842	0.7528	1.4370	496.0
500.0	680.86	0.02043	0.65448	0.67492	487.9	714.3	1202.2	0.6890	0.7443	1.4333	500.0
504.0	705.78	0.02053	0.62938	0.64991	492.7	709.0	1201.7	0.6939	0.7357	1.4296	504.0
508.0	731.40	0.02062	0.60530	0.62592	497.5	703.7	1201.1	0.6987	0.7271	1.4258	508.0
512.0	757.72	0.02072	0.58218	0.60289	502.3	698.2	1200.5	0.7036	0.7185	1.4221	512.0
516.0	784.76	0.02081	0.55997	0.58079	507.1	692.7	1199.8	0.7085	0.7099	1.4183	516.0
520.0	812.53	0.02091	0.53864	0.55956	512.0	687.0	1199.0	0.7133	0.7013	1.4146	520.0
524.0	841.04	0.02102	0.51814	0.53916	516.9	681.3	1198.2	0.7182	0.6926	1.4108	524.0
528.0	870.31	0.02112	0.49843	0.51955	521.8	675.5	1197.3	0.7231	0.6839	1.4070	528.0
532.0	900.34	0.02123	0.47947	0.50070	526.8	669.6	1196.4	0.7280	0.6752	1.4032	532.0
536.0	931.17	0.02134	0.46123	0.48257	531.7	663.6	1195.4	0.7329	0.6665	1.3993	536.0
540.0	962.79	0.02146	0.44367	0.46513	536.8	657.5	1194.3	0.7378	0.6577	1.3954	540.0
544.0	995.22	0.02157	0.42677	0.44834	541.8	651.3	1193.1	0.7427	0.6489	1.3915	544.0
548.0	1028.49	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.7476	0.6400	1.3876	548.0
552.0	1062.59	0.02182	0.39479	0.41660	552.0	638.5	1190.6	0.7525	0.6311	1.3837	552.0
556.0	1097.55	0.02194	0.37966	0.40160	557.2	632.0	1189.2	0.7575	0.6222	1.3797	556.0
560.0	1133.38	0.02207	0.36507	0.38714	562.4	625.3	1187.7	0.7625	0.6132	1.3757	560.0
564.0	1170.10	0.02221	0.35099	0.37320	567.6	618.5	1186.1	0.7674	0.6041	1.3716	564.0
568.0	1207.72	0.02235	0.33741	0.35975	572.9	611.5	1184.5	0.7725	0.5950	1.3675	568.0
572.0	1246.26	0.02249	0.32429	0.34678	578.3	604.5	1182.7	0.7775	0.5859	1.3634	572.0
576.0	1285.74	0.02264	0.31162	0.33426	583.7	597.2	1180.9	0.7825	0.5766	1.3592	576.0
580.0	1326.17	0.02279	0.29937	0.32216	589.1	589.9	1179.0	0.7876	0.5673	1.3550	580.0
584.0	1367.7	0.02295	0.28753	0.31048	594.6	582.4	1176.9	0.7927	0.5580	1.3507	584.0
588.0	1410.0	0.02311	0.27608	0.29919	600.1	574.7	1174.8	0.7978	0.5485	1.3464	588.0
592.0	1453.3	0.02328	0.26499	0.28827	605.7	566.8	1172.6	0.8030	0.5390	1.3420	592.0
596.0	1497.8	0.02345	0.25425	0.27770	611.4	558.8	1170.2	0.8082	0.5293	1.3375	596.0
600.0	1543.2	0.02364	0.24384	0.26747	617.1	550.6	1167.7	0.8134	0.5196	1.3330	600.0
604.0	1589.7	0.02382	0.23374	0.25757	622.9	542.2	1165.1	0.8187	0.5097	1.3284	604.0
608.0	1637.3	0.02402	0.22394	0.24796	628.8	533.6	1162.4	0.8240	0.4997	1.3238	608.0
612.0	1686.1	0.02422	0.21442	0.23865	634.8	524.7	1159.5	0.8294	0.4896	1.3190	612.0
616.0	1735.9	0.02444	0.20516	0.22960	640.8	515.6	1156.4	0.8348	0.4794	1.3141	616.0
620.0	1786.9	0.02466	0.19615	0.22081	646.9	506.3	1153.2	0.8403	0.4689	1.3092	620.0
624.0	1839.0	0.02489	0.18737	0.21226	653.1	496.6	1149.8	0.8458	0.4583	1.3041	624.0
628.0	1892.4	0.02514	0.17880	0.20394	659.5	486.7	1146.1	0.8514	0.4474	1.2988	628.0
632.0	1947.0	0.02539	0.17044	0.19583	665.9	476.4	1142.2	0.8571	0.4364	1.2934	632.0
636.0	2002.8	0.02566	0.16226	0.18792	672.4	465.7	1138.1	0.8628	0.4251	1.2879	636.0
640.0	2059.9	0.02595	0.15427	0.18021	679.1	454.6	1133.7	0.8686	0.4134	1.2821	640.0
644.0	2118.3	0.02625	0.14644	0.17269	685.9	443.1	1129.0	0.8746	0.4015	1.2761	644.0
648.0	2178.1	0.02657	0.13876	0.16534	692.9	431.1	1124.0	0.8806	0.3893	1.2699	648.0
652.0	2239.2	0.02691	0.13124	0.15816	700.0	418.7	1118.7	0.8868	0.3767	1.2634	652.0
656.0	2301.7	0.02728	0.12387	0.15115	707.4	405.7	1113.1	0.8931	0.3637	1.2567	656.0
660.0	2365.7	0.02768	0.11663	0.14431	714.9	392.1	1107.0	0.8995	0.3502	1.2498	660.0
664.0	2431.1	0.02811	0.10947	0.13757	722.9	377.7	1100.6	0.9064	0.3361	1.2425	664.0
668.0	2498.1	0.02858	0.10229	0.13087	731.5	362.1	1093.5	0.9137	0.3210	1.2347	668.0
672.0	2566.6	0.02911	0.09514	0.12424	740.2	345.7	1085.9	0.9212	0.3054	1.2266	672.0
676.0	2636.8	0.02970	0.08799	0.11769	749.2	328.5	1077.6	0.9287	0.2892	1.2179	676.0
680.0	2708.6	0.03037	0.08080	0.11117	758.5	310.1	1068.5	0.9365	0.2720	1.2086	680.0
684.0	2782.1	0.03114	0.07349	0.10463	768.2	290.2	1058.4	0.9447	0.2537	1.1984	684.0
688.0	2857.4	0.03204	0.06595	0.09799	778.8	268.2	1047.0	0.9535	0.2337	1.1872	688.0
692.0	2934.5	0.03313	0.05797	0.09110	790.5	243.1	1033.6	0.9634	0.2110	1.1744	692.0
696.0	3013.4	0.03455	0.04916	0.08371	804.4	212.8	1017.2	0.9749	0.1841	1.1591	696.0
700.0	3094.3	0.03662	0.03857	0.07519	822.4	172.7	995.2	0.9901	0.1490	1.1390	700.0
702.0	3135.5	0.03824	0.03173	0.06997	835.0	144.7	979.7	1.0006	0.1246	1.1252	702.0
704.0	3177.2	0.04108	0.02192	0.06300	854.2	102.0	956.2	1.0169	0.0876	1.1046	704.0
705.0	3198.3	0.04427	0.01304	0.05730	873.0	61.4	934.4	1.0329	0.0527	1.0856	705.0
705.47*	3208.2	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	705.47*

*Critical temperature

Table 2: Saturated Steam: Pressure Table

Abs Press Lb/Sq In. p	Temp Fahr t	Specific Volume: Sat. Liquid v_f	Specific Volume: Evap v_{fg}	Specific Volume: Sat. Vapor v_g	Enthalpy: Sat. Liquid h_f	Enthalpy: Evap h_{fg}	Enthalpy: Sat. Vapor h_g	Entropy: Sat. Liquid s_f	Entropy: Evap s_{fg}	Entropy: Sat. Vapor s_g	Abs Press Lb/Sq In. p
0.08865	32.018	0.016022	3302.4	3302.4	0.0003	1075.5	1075.5	0.0000	2.1872	2.1872	0.08865
0.25	59.323	0.016032	1235.5	1235.5	27.382	1060.1	1087.4	0.0542	2.0425	2.0967	0.25
0.50	79.586	0.016071	641.5	641.5	47.623	1048.6	1096.3	0.0925	1.9446	2.0370	0.50
1.0	101.74	0.016136	333.59	333.60	69.73	1036.1	1105.8	0.1326	1.8455	1.9781	1.0
5.0	162.24	0.016407	73.515	73.532	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	5.0
10.0	193.21	0.016592	38.404	38.420	161.26	982.1	1143.3	0.2836	1.5043	1.7879	10.0
14.696	212.00	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	14.696
15.0	213.03	0.016726	26.274	26.290	181.21	969.7	1150.9	0.3137	1.4415	1.7552	15.0
20.0	227.96	0.016834	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	20.0
30.0	250.34	0.017009	13.7266	13.7436	218.9	945.2	1164.1	0.3682	1.3313	1.6995	30.0
40.0	267.25	0.017151	10.4794	10.4965	236.1	933.6	1169.8	0.3921	1.2844	1.6765	40.0
50.0	281.02	0.017274	8.4967	8.5140	250.2	923.9	1174.1	0.4112	1.2474	1.6586	50.0
60.0	292.71	0.017383	7.1562	7.1736	262.2	915.4	1177.6	0.4273	1.2167	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	110.0
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	120.0
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	130.0
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	140.0
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	150.0
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	160.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	170.0
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	180.0
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	190.0
200.0	381.80	0.01839	2.2685	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	200.0
210.0	385.91	0.01844	2.16373	2.18217	359.9	839.1	1199.0	0.5490	0.9923	1.5413	210.0
220.0	389.88	0.01850	2.06779	2.08629	364.2	835.4	1199.6	0.5540	0.9834	1.5374	220.0
230.0	393.70	0.01855	1.97991	1.99846	368.3	831.8	1200.1	0.5588	0.9748	1.5336	230.0
240.0	397.39	0.01860	1.89909	1.91769	372.3	828.4	1200.6	0.5634	0.9665	1.5299	240.0
250.0	400.97	0.01865	1.82452	1.84317	376.1	825.0	1201.1	0.5679	0.9585	1.5264	250.0
260.0	404.44	0.01870	1.75548	1.77418	379.9	821.6	1201.5	0.5722	0.9508	1.5230	260.0
270.0	407.80	0.01875	1.69137	1.71013	383.6	818.3	1201.9	0.5764	0.9433	1.5197	270.0
280.0	411.07	0.01880	1.63169	1.65049	387.1	815.1	1202.3	0.5805	0.9361	1.5166	280.0
290.0	414.25	0.01885	1.57597	1.59482	390.6	812.0	1202.6	0.5844	0.9291	1.5135	290.0
300.0	417.35	0.01889	1.52384	1.54274	394.0	808.9	1202.9	0.5882	0.9223	1.5105	300.0
350.0	431.73	0.01912	1.30642	1.32554	409.8	794.2	1204.0	0.6059	0.8909	1.4968	350.0
400.0	444.60	0.01934	1.14162	1.16095	424.2	780.4	1204.6	0.6217	0.8630	1.4847	400.0
450.0	456.28	0.01954	1.01224	1.03179	437.3	767.5	1204.8	0.6360	0.8378	1.4738	450.0
500.0	467.01	0.01975	0.90787	0.92762	449.5	755.1	1204.7	0.6490	0.8148	1.4639	500.0
550.0	476.94	0.01994	0.82183	0.84177	460.9	743.3	1204.3	0.6611	0.7936	1.4547	550.0
600.0	486.20	0.02013	0.74962	0.76975	471.7	732.0	1203.7	0.6723	0.7738	1.4461	600.0
650.0	494.89	0.02032	0.68811	0.70843	481.9	720.9	1202.8	0.6828	0.7552	1.4381	650.0
700.0	503.08	0.02050	0.63505	0.65556	491.6	710.2	1201.8	0.6928	0.7377	1.4304	700.0
750.0	510.84	0.02069	0.58880	0.60949	500.9	699.8	1200.7	0.7022	0.7210	1.4232	750.0
800.0	518.21	0.02087	0.54809	0.56896	509.8	689.6	1199.4	0.7111	0.7051	1.4163	800.0
850.0	525.24	0.02105	0.51197	0.53302	518.4	679.5	1198.0	0.7197	0.6899	1.4096	850.0
900.0	531.95	0.02123	0.47968	0.50091	526.7	669.7	1196.4	0.7279	0.6753	1.4032	900.0
950.0	538.39	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	950.0
1000.0	544.58	0.02159	0.42436	0.44596	542.6	650.4	1192.9	0.7434	0.6476	1.3910	1000.0
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	1050.0
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	1100.0
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	1150.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	1200.0
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	1250.0
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	1300.0
1350.0	582.32	0.02288	0.29250	0.31537	592.3	585.4	1177.8	0.7906	0.5620	1.3525	1350.0
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	1400.0
1450.0	591.70	0.02327	0.26584	0.28911	605.3	567.4	1172.8	0.8026	0.5397	1.3423	1450.0
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	1500.0
1550.0	600.59	0.02366	0.24235	0.26601	618.0	549.4	1167.4	0.8142	0.5182	1.3324	1550.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	1600.0
1650.0	609.05	0.02407	0.22143	0.24551	630.4	531.3	1161.6	0.8254	0.4971	1.3225	1650.0
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	1700.0
1750.0	617.12	0.02450	0.20263	0.22713	642.5	513.1	1155.6	0.8363	0.4765	1.3128	1750.0
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	1800.0
1850.0	624.83	0.02495	0.18558	0.21052	654.5	494.6	1149.0	0.8470	0.4561	1.3030	1850.0
1900.0	628.56	0.02517	0.17761	0.20278	660.4	485.2	1145.6	0.8522	0.4459	1.2981	1900.0
1950.0	632.22	0.02541	0.16999	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.89	0.02727	0.12406	0.15133	707.2	406.0	1113.2	0.8929	0.3640	1.2569	2300.0
2400.0	662.11	0.02790	0.11287	0.14076	719.0	384.8	1103.7	0.9031	0.3430	1.2460	2400.0
2500.0	668.11	0.02859	0.10209	0.13068	731.7	361.6	1093.3	0.9139	0.3206	1.2345	2500.0
2600.0	673.91	0.02938	0.09172	0.12110	744.5	337.6	1082.0	0.9247	0.2977	1.2225	2600.0
2700.0	679.53	0.03029	0.08165	0.11194	757.3	312.3	1069.7	0.9356	0.2741	1.2097	2700.0
2800.0	684.96	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9468	0.2491	1.1958	2800.0
2900.0	690.22	0.03262	0.06158	0.09420	785.1	254.7	1039.8	0.9588	0.2215	1.1803	2900.0
3000.0	695.33	0.03428	0.05073	0.08500	801.8	218.4	1020.3	0.9728	0.1891	1.1619	3000.0
3100.0	700.28	0.03681	0.03771	0.07452	824.0	169.3	993.3	0.9914	0.1460	1.1373	3100.0
3200.0	705.08	0.04472	0.01191	0.05663	875.5	56.1	931.6	1.0351	0.0482	1.0832	3200.0
3208.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3208.2*

*Critical pressure

EQUATIONS

$P = P_0 e^{t/\tau}$

$1Ci = 3.7 \times 10^{10} Bq$

$dps = \lambda NV = \lambda w Ao/A$

W=gms, $Ao = .6023 \times 10^{24}$, A=atomic weight

$R/hr = 6CE/d^2$

$I(x) = Io\ e^{-\mu x}$

$L_{(1/n)} = \ln(n)/\mu$

$I(t) = Io\ e^{-\lambda t}$

$T_{1/2} = \ln(2)/\lambda$

$CP = (CP_{base})(Ks)(K_\lambda)$

$o(V_f + xV_{fg}) = \chi V_g$

$H_f = f\ L\ V^2/(D2g_c)$

$Re = VD\rho/\mu$

$Q = MCp\ \Delta t$

$\Delta p = f \frac{L}{D} \frac{\rho V^2}{2g_c}$

$f = 64/Re$

30 inch Hg = 14.7 psia

$M = 1/(1-k)$

$N(t) = No\ e^{-\lambda t}$

$I(r) = Io/r^2$

$A(t) = V\ \Sigma\ \phi e^{-\lambda t}$

$n = \nu/(1+d)$

$P = \Sigma\ \phi\ v\ /(3.7 \times 10^{10})$

$\tau = (\beta-\rho)/\lambda\rho$

$\tau = \ell/(\rho-\beta)$

$\tau = \bar{\ell}/\rho + (\beta-\rho)/\lambda\rho$

$v = v_f + x v_{fg}$

$H = x h_g + (1-x)\ h_f$

$S = x S_g + (1-x)\ S_f$

1 in = 2.54 cm

1 gal = 3.785 liters

1 kg = 2.205 lb

$N = \rho A_0/A$

$\hat{T} = T_b T_r/(T_r+T_b)$

Master.

ANSWERS - Theory of Nuclear Power Plant Operations, Fluids and Thermodynamics

5.01 a. Less (0.5)
b. More (0.5)
c. More (0.5)

Ref.: Reactor Physics Review, pgs. 150 & 160

5.02 a. Latent Heat of Vaporization - The thermal energy which must be added to a substance to change its state from saturated liquid to saturated vapor. (This heat must also be removed from a substance to change its state from saturated vapor back to saturated liquid.) (1.0)

b. Critical Point (K) - The critical point represents the highest temperature (critical temperature) and pressure (critical pressure) at which a gas and liquid can exist in equilibrium as distinguishable phases. (1.0)

c. Saturated Liquid - The state of a substance wherein (given a constant pressure):

Any further addition of thermal energy in the form of heat will result in vaporization (boiling) of the substance at a constant temperature (saturation temperature) until all of the substance is evaporated. ~~(0.5)~~

OR *Either ans. acceptable.* *(1.0)*

Any further removal of thermal energy in the form of heat will result in lowering the temperature of the substance. ~~(0.5)~~

Note: Either a further addition or removal will be accepted for full credit.

Ref.: Reactor Physics Review, Thermodynamics, p. 44

5.03 a. Increasing the bundle mass flow rate also causes critical power to increase. The higher mass flow rate provides a more efficient heat transfer mechanism. Therefore, a greater coolant enthalpy increase is required to reach saturation conditions. Thus, for the same bundle power conditions, the margin to OTB has increased. (1.0)

b. An event that increases bundle inlet subcooling (such as removing a feedwater heater from service) causes an increase in critical power. For a given flow rate, a greater coolant enthalpy rise is required to reach saturation conditions. Therefore, the bundle power required to produce critical quality/OTB is also increased. (1.0)

c. Increasing bundle pressure, in the normal reactor operating pressure range, causes critical power to decrease. Consulting the steam tables, at high pressure (>800 psia), the latent heat of vaporization (h_{fg}) decreases as pressure is increased. Therefore, the bundle power required to reach OTB also decreases as pressure increases. (1.0)

Note: (0.25) pts for direction either increase or decrease.
(0.75) pts for explanation.

Ref.: Core Thermal Hydraulics, pgs. 56 & 58

5.04 No. The production rate is directly proportional to power level, but removal rate is proportional to xenon concentration and it contains a power dependent term, thermal neutron flux. Since flux is directly proportional to power level, the burnout term becomes more significant. This results in an equilibrium xenon value which is higher than the original value, but not twice as high. This is demonstrated in Figure 70 which is shown here. (2.0)

Ref.: Reactor Physics Review, p. 216

5.05 As fuel temperature is increased (due to Control Rod Pull) more voiding is created. Therefore, more back pressure which would mean less flow (1.0). However, because of core orificing back pressure is less significant and flow through the bundle is almost the same (1.0). (2.0)

Ref.: Core Thermal Hydraulics, pgs. 20 & 22

5.06 a. Moderator Temperature Effects on Rod Worth. First, it must be realized that regardless of its dimensions, a control rod is still localized poison. The neutrons which interact with a control rod, travelled a measurable distance to reach the control rod. It stands to reason that the further a neutron travels while slowing and while thermal, the better the chances of interacting with a control rod. As moderator temperature increases during reactor heatup, the density decreases. This decreased density will yield longer slowing down lengths, and longer thermal diffusion length. Hence, thermal neutrons from further within a fuel bundle will visit a control blade. Rod worth will increase as the reactor heats up to operating temperatures around 545°F. (1.0)

b. Void Effects on Rod Worth. Recall from the discussion on voids and neutron flux, that a small increase in void fraction made a large change in moderator density. It would seem that this effect would follow the guidelines of a temperature change. However, as with the previous discussions, void effects are much more pronounced. The key is that the increased slowing down and thermal diffusion lengths will result in a considerable increase in the average energy of the neutron flux. Thus, more fast and epithermal neutrons will result. The fast nonleakage probability decreases, and the resonances of U-238 and Pu-240 will have a greater to strip the epithermal neutrons from the generation. The net effect is lower or decreased thermal flux. While decreased thermal flux will cause a decrease in power, it will also result in a decreased worth of the control rods. Remember, if you have no thermal neutrons, you cannot turn power in a reactor by the use of control rods. In case of voids and control rods, power is turned because of the decrease in thermal neutrons available to cause thermal fission. (1.0)

Ref.: Reactor Physics Review, p. 190

5.07 a. The process computer compares the APLHGR in a node to the MAPLHGR limit for the node in a ratio called MAPRAT.

$$MAPRAT = \frac{APLHGR}{MAPLHGR\ limit}$$

As long as the largest MAPRAT is <u>less than one</u>, we are assured that we have not exceeded this thermal limit.

Therefore, the MAPRAT as stated is not conservative. (0.75)

b. 1. F (0.25)

2. F (0.25)

3. T (0.25)

Ref.: Core Thermal Hydraulics, pgs. 46 & 50

5.08 a.

Voids	$1 \times 10^{-3}\ \Delta k/k$	(0.5)
Temperature	$1 \times 10^{-4}\ \Delta k/k$	(0.5)
Doppler	$1 \times 10^{-5}\ \Delta k/k$	(0.5)

b. Less negative (0.5)
Less negative (0.5)
More negative (0.5)

Ref.: Reactor Theory, p. 168

5.09 400°F sat. pressure = 247.26 psia
600 psig = 614.7 psia: sat. temperature = 488.7°F

Fluid is subcooled (0.5) by 88.7°F (0.5)

Partial credit given if 14.7 is forgotten. (1.0)

Ref.: Thermodynamics/Steam Tables

5.10 P = Poe T/T

$370 = 50e^{120 \text{ sec}/T}$

T = 59.95 sec. (1.0)

Doubling time = $\frac{T}{1.445}$ = 41.49 sec (1.0)

Ref.: Reactor Physics

5.11 a. Decreases mainly due to samarium build-in (0.5)

b. Increases mainly due to gadolinia burnout.
(May also give credit for Pu-239 build-in) (0.5)

c. Decrease due to fuel depletion. (0.5)

Ref.: Reactor Physics

5.12 $CR_1 (1 - Keff_1) = CR_2 (1 - Keff_2)$

$CR_2/CR_1 = 10$

$CR_1 (1 - Keff_1)/CR_2 (1 - Keff_2)$

$(1 - 0.9)/10 = (1 - Keff_2)$

$(0.1)/10 = 1 - Keff_2$

$.01 = 1 - Keff_2$

$Keff_2 = 1 - 0.01$

$Keff_2 = 0.99$ (2.0)

Ref.: Reactor Physics Review, p. 72

5.13 a. The subcooling of condensate, i.e., the condensed liquid existing in the hotwell usually is about 8°F below saturation temperature. (0.5)

b. Without "Condensate Depression" the condensate pumps would cavitate due to the water at the eye of the pump being at saturation temperature. (0.5)

Ref.: Reactor Physics Review

END OF SECTION

ANSWERS - Plant Design, Control and Instrumentation

6.01 a. An increase in indicated core flow (0.5)
An increase in affected recirculation loop flow (0.5)
A decrease in generator output (0.5)
A decrease in core plate ΔP (0.5)

b. Will accept either of the answers below for full credit. (0.5)

1. During a line break, an intact jet pump will act as a flow restrictor, and limit blowdown, while a broken jet pump will increase the blowdown area.

2. An intact jet pump acts as a standpipe which prevents water from draining below two thirds core height.

Ref.: Reactor Vessel and Internals, Chapter 2

6.02

narrow range	0 + 60	(0.5)
wide range	-150 to +60	(0.5)
upset range	0 to +180	(0.5)
shutdown range	0 to +400	(0.5)
fuel zone	-111 to -311	(0.5)

Ref.: RPU Instrumentation

6.03 a. 1. If the temperature difference between steamline and pump suction is less than 10.1°F. (1.0)

2. If feedwater flow is less than 30% (1.0)

b. These interlocks activate fifteen seconds after the condition is indicated in order to prevent spurious trips from temporary changes in temperature or feedwater flow. (0.5)

Ref.: Recirc., Chapter 5, p. 70

6.04 The containment water volume function is to provide a standby reservoir of water capable of quenching the steam resulting from a loss of coolant accident. (1.0)

The suppression chamber gas volume, is of sufficient size to accommodate, under accident conditions, all the non-condensable gases within the drywell without exceeding the design pressure capabilities of the primary structure. (1.0)

Ref.: Primary Containment, Chapter 48, p. 20

6.05 1. Normal drain to 14A heater full open. (0.5)

2. Emergency drain valve opens. (0.5)

3. 15A Extraction Steam Inlet Stop Valve closes. (0.5)

4. LP Heater 15A Drain Input from HP heater 16A Normal Drain Valve closes. (0.5)

5. LP Heater 15A Input from HP 16B Normal Drain Valve closes. (0.5)

6. LP Heater 15A/B/C Extraction Non-Return Check Valve closes. (0.5)

Ref.: Feedwater Heaters and Drains, Chapter 30, pgs. 58/60

60.6 a. Single Element - level (0.5)
Three Element - level, feed flow steam flow (1.5)

b. Single Element - one component (Turbine A-Valve-Turbine B) (1.0)
Three Element - two components, two TDRFP or one TDRFP and FRV (1.0)

Ref.: RWLC, Chapter 31, pgs. 6 & 8

6.07 a. Rod block (0.5)
b. Half-scram (0.5)
c. Rod Block (0.5)
d. No Reactor Protection System Action (0.5)

Ref.: APRMs, Chapter 14, p. 104

6.08 1. If the Reference APRM downscale trip occurs (Setpoint $\leq$ 30% power) the associated RBM is automatically bypassed. (1.0)

2. If an edge or peripheral control rod is selected, both RBM channels are bypassed automatically. (1.0)

Ref.: RBM, Chapter 15, p. 62

6.09 1. < 75% rod density RPIS failure blocks all rod movement. (1.0)

2. > 75% rod density RPIS - N/A (1.0)

Ref.: RSCS, Chapter 19, pgs. 18 & 19

6.10 a. After a scram the CRD pumps will try to charge all 185 accumulators at once. To prevent "Runout" and pump damage a series of restricting orifices in the charging line will limit flow to approximately 200 gpm. (Setpoint not required for full credit) (1.0)

b. After a scram the FCV diverts most of the water to recharge the accumulators. The FCV does not shut fully, which minimizes water hammer on downstream piping, when the scram is reset. (0.5)

Ref.: CRD Hydraulics, Chapter 8, pgs. 22 & 24

6.11 Reactivity "Chugging" is when a mass of water with a high sodium penetaborate concentration is periodically cycled in and out of the core. (0.5)

This results in extreme power oscillations, which could damage fuel. (0.5)

Ref.: SBLC, Chapter 10, pgs. 30 & 31

END OF SECTION

ANSWERS - Procedures - Normal, Abnormal, Emergency and Radiological Control

7.01 a. Reactor Vessel shall be verified to be unpressurized. (0.5)

b. Thermal power less than 1% of rated thermal power. (0.5)

c. Reactor Coolant Temperature less than 212°F. (0.5)

Ref.: LGP 1-1, p. 8

7.02 a. When 25% of the control rods have been pulled to position 48 (0.5). Discontinue use of the "Notch Override" switch for control and withdrawals between positions 0 and 12 (0.5) (1.0)

b. When 50% of the control rods have been pulled to position 48 (0.5). Discontinue the use of the "Notch override" switch between rod position 00 and 24 (0.5) while startup and reactor heatup are in progress (0.5). (1.5)

Ref.: LGP 1-1, p. 12

7.03 a. Time (0.25)
b. Rod Position (0.25)
c. Coolant Temperature (0.25)
d. Reactor Period (0.25)

Ref.: LGP 1-1, p. 13

7.04 To minimize feedwater nozzle, sparger, and header thermal stress at low flow conditions:

a. FRV Inlet Stop will be manually throttled

b. Reactor Water Cleanup return flow will be maintained as high as possible.

c. Feedwater on-off cycles should be eliminated

Any two for full credit (2.0)

Ref.: LGP 1-2, p. 7

7.05 Opening the vacuum breaker at high RPMs imposes excessive loads on the turbine last stage buckets. (1.0)

Ref.: Normal Unit Shutdown Procedure

7.06 a. High Radiation Area - Any area accessible to personnel in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem. (1.0)

b. Radiation Area - Any area accessible to personnel in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem (1.0) or in any 5 consecutive days a dose in excess of 100 millirem (1.0). (2.0)

Ref.: Radiation Protection Definitions

7.07 Attempt to close the valve as follows

1. Cycle the SRV from auto to open and back to auto. (0.5)

2. Remove the valve fuses. (0.5)

3. Replace the fuse and observe the valve indication to see if the valve closed.

4. Scram the reactor if the SRV did not close after two minutes. (0.5)

Note: Part 3 is implied in Part 2 and if not mentioned by the candidate no credit will be lost.

Ref.: LOA-NB-02, p. 2

7.08 If five or more adjacent rods are not inserted to at least notch position 06 (1.0) or thirty or more rods are not inserted to at least notch position 06 (1.0) AND Reactor Vessel Water level cannot be maintained above +12.5" (0.5) or Suppression Pool temperature reaches 110°F (0.5). (3.0)

Ref.: LOA-NB-09, p. 2

7.09 a. Trip Main Turbine (0.5)
b. Close the RCIC Turbine Steam Supply Valve (0.5)
c. Trip the Reactor Feed Pumps (0.5)
d. Close the HPCS injection valve (0.5)

Ref.: LOA-NB-10, p. 2

7.10 a. Stator amps less than 21,831 in two minutes (1.0) or stator amps less than 7057 in 3 1/2 minutes (1.0). (2.0)

b. 46 psig Stator Inlet Pressure (1.0) or 81°C Stator Outlet Temperature (1.0). (2.0)

Ref.: LOA-GC-01

7.11 a. Directed by an LGA caution to stay above 57 psig (1.0)

b. Misoperation in the auto mode is confirmed by at least two independent indications (1.0)

Ref.: LGA-GP

7.12 Boron has not been injected into the RPV to shutdown the reactor (0.3)

AND

a. RPV water level (0.2) below +12.5" (0.2)
b. RPV pressure (0.2) above 1043 psig (0.2)
c. Drywell pressure (0.2) above 1.69 psig (0.2) (1.5)

Ref.: LGA 0.1

END OF SECTION

ANSWERS - Administrative Procedures, Conditions and Limitations

8.01 a. Limiting Control Rod Pattern - shall be a pattern which results in the core being on a thermal hydraulic limit, i.e., operating on a limiting valve for APLHGR, LHGR or MCPR. (1.0)

b. Channel check shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter. (1.0)

Ref.: T.S. Definitions

8.02 On backshifts and weekends if an immediate "Temporary System Change" is required, it may be implemented provided the safety evaluation is completed (0.5) and reviewed by two SROs (0.5) and the change is authorized by the Shift Engineer (0.5). One of the SROs must have an engineering degree such as the SCRE (0.5). (2.0)

Ref.: LAP 240-6, p. 3

8.03 a. The person making the inspection for verification should be at least as qualified as the person placing the outage. (1.0)

b. When the second verification involves high radiation conditions, the second verification can be waived. (1.0)

Ref.: LAP 900-4

8.04 Any six for full credit.

1. Station Manager
2. Superintendents
3. Assistant Superintendents
4. Operating Engineers
5. Technical Staff Supervisor
6. Region III Resident Inspectors
7. Station QA
8. Station Security (3.0)

Ref.: LAP 1100-12

8.05 a. "At the controls" means that the unit operator will be in line-of-sight of the unit front panels, that he is in a position to monitor plant parameters, and that he is in a position to take immediate action, if required. (2.0)

b. A second licensed operator, normally the center desk operator. (0.5)

Ref.: LAP 1600-2

8.06 a. Verify the inop rod is separated from all other inop rods by at least two control cells in all directions. (1.0)

b. Electrically or mechanically disarm the associated directional control valves. (1.0)

c. Verify adequate shutdown margin. (1.0)

Ref.: T.S., pgs. 3/4 1-1 & 1-3

8.07 a. Inoperable LPCS (0.5). Potential for water hammer in discharge piping and possible discharge piping damage (1.0). (1.5)

b. Inoperable Vacuum Relief System (0.5). Would allow bypassing the suppression pool in case of an accident (1.0). (1.5)

Ref.: T.S., pgs. 3/4 5-4, 1-20 & 6-35
and B 3/4 5-1, 1-4 & 6-4

8.08 a. All primary containment penetrations required to be closed are either:

1. Capable of being closed by an operable primary containment automatic isolation system or; (0.25)

2. Closed by at least one manual valve, blind flange, or deactivated automatic valve secured in its closed position. (0.25)

b. All primary containment equipment hatches are closed and sealed. (0.5)

c. Each primary containment air lock is operable. (0.5)

d. The primary containment leakage rates are within limits. (0.5)

e. The suppression chamber is operable. (0.5)

f. The sealing mechanism associated with each primary containment penetration; e.g., welds, bellows or O-rings, is operable. (0.5)

Ref.: LaSalle Technical Specifications

8.09 a. Main Steam Line Isolation Valve - Closure

The main steam line isolation valve closure trip was provided to limit the amount of fission product release for certain postulated events. The MSIVs are closed automatically from measured parameters such as high steam flow, high steam line radiation, low reactor water level, high steam tunnel temperature and low steam line pressure. The MSIVs closure scram anticipates the pressure and flux transients which could follow MSIV closure and thereby protects reactor vessel pressure and fuel thermal/hydraulic Safety Limits. (1.0)

b. Main Steam Line Radiation - High

The main steam line radiation detectors are provided to detect a gross failure of the fuel cladding. When the high radiation is detected a trip is initiated to reduce the continued failure of fuel cladding. At the same time the main steam line isolation valves are closed to limit the release of fission products. The trip setting is high enough above background radiation levels to prevent spurious trips yet low enough to promptly detect gross failures in the fuel cladding. No credit was taken for operation of this trip in the accident analyses; however, its functional capability at the specified trip setting is required by this specification to enhance the overall reliability of the Reactor Protection System. (1.0)

c. Turbine Stop Valve - Closure

The turbine stop valve closure trip anticipates the pressure, neutron flux, and heat flux increases that would result from closure of the stop valves. With a trip setting of 5% of valve closure from full open, the resultant increase in heat flux is such that adequate thermal margins are maintained. (1.0)

Ref.: T.S., B2-11 & B2-12

END OF SECTION