U. S. NUCLEAR REGULATORY COMMISSION

REGION V

Examination Report No. 50-361 /OL-84-02

Facility: San Onofre Nuclear Generating Station, Units 2 and 3

Docket No.: 50-361/362

Examinations Administered at San Onofre NGS, San Clement, California from October 1-5, 1984

Chief Examiner: John P O'Brien 11-9-84
J. P. O'Brien, Operator Licensing Examiner Date Signed

Approved: John O. Elin 11-9-84
J. O. Elin, Chief, Operations Section Date Signed

Summary:

Examinations on October 1-5, 1984.

Written and operating examinations were administered to ten RO candidates. Additionally, written exams were administered to ten RO retake candidates. Also, one RO candidate was given a retake simulator exam. Twenty candidates passed their exams. One candidate failed an operating exam.

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Report 50-361/OL-84-02

REPORT DETAILS

1. Persons Examined:

   SRO candidates:

   R. E. Arnold
   S. A. Giannel
   J. R. Martin
   J. L. Mullins
   S. Popowski
   K. Sandberg
   E. R. Sengstacken
   R. B. Slaughter
   K. L. Albers
   K. O. Cornelson
   C. E. Dube
   J. A. Faupel
   S. P. Hathaway
   O. Hicks
   S. L. Kamrath
   M. P. McDonnell
   M. J. Pell
   J. W. Phelps
   R. L. Sprague
   J. Tokumoto
   O. P. Wong

2. Examiners:

   *J. P. O'Brien, RV
   J. Upton, PNL
   A. Prichard, PNL

   *Lead Examiner

3. Persons attending the exit meeting:

   H. Mathis
   R. Maisel
   M. Kirby
   M. Hyman
   M. Ehredt
   L. Simmons
   D. Shaffer
   M. Speer
   H. Morgan
   J. Tate
   C. Kergis
   D. Dack

4. Written Examination and Facility Review

Written exams were administered as follows:

20 RO exams - October 2, 1984

At the conclusion of each exam, the facility staff reviewed the exams. The facility staff comments are noted in the enclosed attachment (1). These comments were discussed with the facility staff and appropriate revisions to the master examination key were made by the lead examiner prior to grading the candidate responses.

5. Operating Examinations:

Oral exams and facility walkthroughs were conducted October 3-5, 1984. The following general weakness was noted:

In general, the candidates took longer than expected to analyse an ATWS condition, and decide to manually trip the reactor.

6. Exit Meeting:

On October 5, 1984 the lead examiner met with licensee representatives. Those individual candidates who clearly passed the operating exam were identified.

Report 50-361/OL-84-02

ATTACHMENT 1

EXAMINATION REVIEW MEETING

At the conclusion of the written examination (date: October 2, 1984) the examiner met with the facility staff to review the written examinations and answer keys. There were no comments on either examination as to the validity or phrasing of the questions. In response to the facility comments on the answer key, the following changes were made:

COMMENT 1:

1.03.b (KEY) "Point distribution is questionable since rod motion is not asked for in question."

RESOLUTION:

Asked for effects on reactivity revised pt. value for two effects given to 0.7 vs. 0.5, and reduced control rod motion to 0.1 vs. 0.5.

COMMENT 2:

1.08 "QSPDS (Unit 3 only) is a possible addition to list." Reference: same as key.

RESOLUTION:

Will accept QSPDS if candidate states assumption that it is applicable to Unit 3 only.

COMMENT 3:

2.01.a (Question) "Asked for" purpose", key requires 2 responses.

RESOLUTION:

Asked "What are the purpose"...; this was a typo error. Question performance show most candidates gave 2 or more purposes. No change to the key.

COMMENT 4:

2.01.c (key) "Question is open ended."

RESOLUTION:

Candidate will be required to describe new vent path to RCGVS for full credit or possible vent path to quench tank or RB atmosphere for 1/4 credit.

COMMENT 5:

2.02.a (Key) "MSIS is incorrect (S/G pressure is >729 psi), also in 2.02.c EFAS-1 is correct terminology."

RESOLUTION:

MSIS removed from key and pts. redistributed. AFAS corrected to read EFAS-1.

COMMENT 6:

2.02.d "CIAS is incorrect, cont. press. less than 2.9 psi."

RESOLUTION:

Removed CIAS from key.

COMMENT 7:

2.05.a (key) "Auto. sequence will not automatically pick up the other diesel's bus. Has to be paralleled by operator."

RESOLUTION:

Removed from key/pts. redistributed.

COMMENT 8:

2.05.b(key) "EFAS signal will not start its respective diesel generator."

RESOLUTION:

Response removed and pts. redistributed.

COMMENT 9:

2.08.b&c (key) "50 psid logic in both problems - possible double jeopardy."

RESOLUTION:

No change to the key - full credit require knowledge of the three logic statements a, b and c are three separate problems.

COMMENT 10:

3.02 (Key) "#2 is correct, but also #4 is correct."

RESOLUTION:

We asked "the most correct answer." full credit will be given for #2, half credit for #4 and quarter credit if both are given.

COMMENT 11: 3.03.a (Key) "Tech. Spec's. also list some other safety related instruments. "(Reference T.S. 3.3.3.1)

RESOLUTION:

After reviewing reference RE7856 and 7857 added to key. Their use for CPIS also added in a. and b.

COMMENT 12:

3.04.a (Key) "if Tc fails low, should the linear power trip be bypassed? Tc and input to Ni's?" Reference: Excore Neutron Monitoring System.

RESOLUTION:

Revised key as follows:

a. CPC sensor failure
   CPC aux trips: (1) DNBR (2) LPD (1.0)
   Bypass the affected CPC (.5)

COMMENT 13:

3.05.a. and b. (Key) "Upper and lower sequential permissive interlocks might also be listed."

RESOLUTION:

Will accept these interlocks if listed, but will not take credit off they are not there.

COMMENT 14:

3.08.a "NI-Calculator-Power Deviation Alarm is an unfamiliar term. We will provide reference logic diagram and correct terms" 3.08.b. "cause vs prevent"

RESOLUTION:

(a) After review of P&ID's, will accept above (as per CE reference material) or "linear power deviation alarm." (b) corrected key to read..."cause a DNBR trip."

COMMENT 15:

3.09(a) Main feed pump speed is not an input to control of FCS.

RESOLUTION:

Accepted. Key corrected.

COMMENT 16:

4.01 (Key) "answer is fairly deep in the procedure."

RESOLUTION:

Question performance was fairly high - not accepted.

COMMENT 17:

4.02 (Key) "no reference given".

RESOLUTION:

Typo - key corrected - no change to answer.

COMMENT 18:

4.07.a (Key) "asked for indications, answer key gives alarms. Indications given in SO23-3-5.29 (1.2)."

RESOLUTION:

Will accept either.

COMMENT 19:

4.06 (Key) "procedure referenced states: (2 or more) vice (more than one), and (10 or more) vice (more than 9)."

RESOLUTION:

Will accept either.

Master
exam & key

U. S. Nuclear Regulatory Commission
Reactor Operator License Examination

Facility: San Onofre 2/3
Reactor Type: PWR-CE
Date Administered: October 2, 1984
Examiner: J. P. O'Brien
Candidate: ______________

INSTRUCTIONS TO CANDIDATE:

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%. Examination papers will be picked up six (6) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% of Category Value	Category
25.0	25.0	______	______	1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
25.0	25.0	______	______	2. Plant Design Including Safety and Emergency Systems
25.0	25.0	______	______	3. Instruments and Controls
25.0	25.0	______	______	4. Procedures - Normal, Abnormal, Emergency, and Radiological Control
100.00		______		TOTALS

Final Grade ______%

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

____
Candidate's Signature

SECTION 1

PRINCIPLES OF NUCLEAR POWER PLANT OPERATION,
THERMOCYNAMICS, HEAT TRANSFER AND FLUID FLOW.

1.01 QUESTION (2.5)

Consider a motor driven centrifugal two-speed pump. Slow speed is one-half of fast speed.

a. How do the following characteristics vary when the motor is switched from slow to fast speed?

i) Flow (0.5)
ii) Discharge head (0.5)
iii) Motor kilowatts (0.5)

b. How does the temperature of the fluid (water) being pumped affect the pumping power requirement? (1.0)

1.01 ANSWER (2.5)

a. i) Flow is proportional to speed so flow is doubled. (0.5)

ii) Discharge head is proportional to speed squared so head goes up by a factor of four. (0.5)

iii) Motor kilowatts (power) is proportional to speed cubed so power goes up by a factor of eight. (0.5)

b. As the temperature of the pumped fluid decreases, fluid viscosity increases requiring more power to maintain flow. As temperature increases, the opposite is true. (1.0)

Reference:

GP-HTFF Notes - Volume III - Chapter 2-D.

1.02 QUESTION (3.5)

a. Explain why the main turbine exhausts to a vacuum. (1.0)

b. What is a "condensate depression"? (1.0)

c. Is condensate depression desirable or undesirable? (0.5) Explain. (1.0)

1.02 ANSWER (3.5)

a. Increases the efficiency of the cycle. (1.0)

b. Amount of subcooling (°F) below saturation temperature of (1.0) the condensate in the condenser.

c. Desirable (0.5) - some is good to prevent cavitation in the condensate pump. Too much is not good because it decreases overall thermal efficiency. (1.0)

Reference:

General Physics - Nuclear Power tech. notes Volume III, Chapter 2, Section H.

1.03 QUESTION (2.5)

The effects of Xenon are important in reactor operation.

a. Explain the term equilibrium Xenon. (1.0)

b. Discuss the effects on reactivity that would occur should the reactor be taken to power shortly after Xenon has peaked. (1.5)

1.03 ANSWER (2.5)

a. Equilibrium Xenon; Xe production = Xe removal. (1.0)

b. Since Xenon has peaked and is now in a decay mode, positive reactivity is now being inserted (0.7); if reactor is now brought to power, rapid Xenon burnout is occurring (0.7) thus control rod motion must be carefully undertaken to avoid exceeding power rate of increase limits. (0.1)

Reference:

GP-Physics notes - Volume I, Chapter 5, Section D.

1.04 QUESTION (3.0)

During an outage, 10% of all steam generator tubes are plugged.

How much change in the full power steam pressure should you expect? Show your calculation. (Assume T_{avg} = 593°F, T_{stm} = 553°F initially)

1.04 ANSWER

Qsg=UiAn (Tave - Tseci) -UfAn (Tave - Tsecf) (0.5)

or (Tave - Tsecf)/(Tave - Tseci) = $\frac{Ui}{Uf} = \frac{1}{.9}$

or (593 - Tsecf)/(593 - 553) = $\frac{1.0}{0.9}$

$593 - \frac{(40)}{(.9)}$ = Tsecf = 548.7°F (1.0)

From stm tables, $Pstm_{final}$ = 1034 psig, $Pstm_{intial}$ = 1071 psia. (1.0) Therefore, pressure decreases 37 psia. (0.5)

Reference:

General Physics - Nuclear Power Tech. Volume III, Chapter 2, Section E.

1.05 QUESTION (2.5)

The reactor has been operating at 50% for several days. CEAs are in manual control. An EH system malfunction causes the turbine control valves to open slightly, causing an increase in steam flow. With no operator action, RCS Tavg drops several degrees and then levels out.

a. What caused the initial drop in Tavg? (1.0)

b. Why did Tavg level out? (1.5)

1.05 ANSWER (2.5)

a. Tavg dropped initially because steam demand exceeded reactor. (1.0)

b. Tavg levels out eventually because the drop in Tavg adds positive reactivity which causes reactor power in increase. (0.5)
As power increases, the fuel temperature coefficient adds negative reactivity. (0.5) Eventually reactor power equals steam demand, and the positive reactivity added by Tavg reduction is compensated for by negative reactivity from fuel temperature coefficient. (0.5)

Reference:

GP-Physics Notes - Volume I, Chapter 4, Section D.

1.06 QUESTION (3.0)

Two identical reactors are taken to the "just critical" level. Reactor "A" has a rod speed of 30 inches per minute, while Reactor "B" has a rod speed of 15 inches per minute (assume continuous rod withdrawal).

a. Which reactor will achieve criticality first? (~~1.0~~ 0.25) EXPLAIN (0.75)

b. Which reactor will have the highest level of source range (~~1.0~~ 0.25) EXPLAIN (0.75) counts at criticality?

c. Which will have the highest critical rod height? (~~1.0~~ 0.25) EXPLAIN (0.75)

1.06 ANSWER (3.0)

a. Reactor "A", (0.25) since rods will reach critical position twice as fast as "B" rods; reactivity insertion is faster. (975)

b. Reactor "B", (0.25) because neutron population, with all delayed neutron effects, will have multiplied over a longer period of time. (0.75)

c. Both will be the same. (0.25) Identical reactors will achieve criticality at the point where K = 1, regardless of how fast that is achieved. (0.75)

Reference:

GP-Physic Notes - Volume, Chapter 5, Section A.

1.07 QUESTION (1.0)

Two isotopes of nickel are placed on opposite ends of a scale. Isotope A has a half-life of 5 years while isotope B has a half-life of 5,000 years. Which way will the scales tilt? Explain, assuming that each isotope contains exactly one curie of radioactivity.

1.07 ANSWER (1.0)

Towards isotope B. The longer the half-life, the more material required to produce one curie of activity.

Reference:

GP-Physics Notes - Volume 1, Chapter 3, Section A and B.

1.08 QUESTION (1.0)

Saturation conditions are being approached in the Reactor Coolant system. List at least four (4) indications of the saturated conditions in the RCS.

1.08 ANSWER (1.0)

-	Core Protection System trips and pretrips
	Subcooled Margin Monitor
	Core Exit Thermocouples and pressure compared to steam tables
	T_h and pressure compared to steam tables
	Low RC pump motor amps
(any	Erratic RC pump motor amps
4	Erratic temperature indications
0.25	Noise and vibration
ea)	High pressurizer level
	Low core Delta P
	Low steam generator Delta P
	Erratic excore nuclear instrumentation readings
	QSPDS (FOR UNIT 3 ONLY)

Reference:

GP Nuclear Power Plant Tech. Volume III, Chapter 3, Section C.

1.09 QUESTION (3.5)

Explain why the worth of a Control Element assembly could change if:

a. The moderator temperature changes. (1.25)

b. Its radial position in the core is changed. (0.75)

c. Another CEA is inserted right next to it. (0.75)

d. Another CEA is inserted some distance away from it. (0.75)

1.09 ANSWER (3.5)

a. When the moderator temperature is increased the moderator becomes less dense (and boron content per cubic inch gets smaller), so that the average neutron will travel further before being absorbed. Therefore more neutrons can migrate to the vicinity of the control elements and more neutrons are absorbed in elements, causing a larger element worth and vice versa. (1.25)

Must include density change in moderator and boron atom density change - also include increase in worth for increase in temp.

b. Worth proportional to $flux^2$ - if moved to higher flux position, will have greater worth and vice versa. (0.75)

c. Other CEA will depress flux in region and reduce worth of CEA if immediately beside it. (0.75)

d. Can increase, decrease, or no change depending upon whether it causes flux at CEA position to increase, decrease, or remain the same. (0.75)

Reference:

GP-Nuclear Physics - Volume II, Chapter 4, Section D.

1.10 QUESTION (2.5)

Frequent mention is made in the technical specifications and elsewhere that safety limits are placed on Departure from Nucleate Boiling Ratio (DNBR) and Linear Heat Ratio (LHR).

a. Describe the failure mechanism if either limit is exceeded (DNBR less than 1.2, LHR greater than 21.0 kw/ft.). (1.5)

b. If one limit is violated, does this mean that the other limit is also violated? Explain. (0.5)

c. How is the plant protected from exceeding these limits, assuming no operator action? (0.5)

1.10 ANSWER (2.5)

a. Exceeding the DNBR limit could reduce heat transfer at the clad surface and lead to localized burnout and failure of the cladding resulting in release of the fission products to the RCS. Exceeding the LHR limit will lead to high centerline fuel temperatures and melting of the fuel. Possible fuel rod rupture could result from resulting high internal pressure. (Burnout) (1.5)

b. No, the limits and failure mechanisms are not related. (0.5)

c. The trip function setpoints of the Plant Protective Systems (PPS), including the CPC, are selected to ensure that Anticipated OPERATIONAL OCCURANCE ~~more~~ during the life of the plant, THEY do not cause the limits for DNBR and LHR to be exceeded. (0.5)

Reference:

a. Nuclear Physics, Reactor Theory Notes, Volume IV, Section 4; C-E PWR SYS THERMAL-HYD DESCRIPTION P.7 and P.14-15.

END OF SECTION 1

SECTION 2

PLANT DESIGN INCLUDING SAFETY AND
EMERGENCY SYSTEMS

2.01 QUESTION (2.5)

a. What are the purpose of the pressurizer spray bypass flow? (0.5)

After extensive operation, gases will tend to accumulate in the steam space of the pressurizer;

b. Why will the gases tend to build up in the pressurizer? (1.0)

c. How is the gas buildup removed. (1.0)

2.01 ANSWER (2.5)

a.
- To maintain the temperature of the spray piping minimizing thermal transients of the spray head. (0.25)
- To provide a turnover of the water inventory in the pressurizer. (0.25)

b. In the pressurizer, gases tend to come out of (solution) due to the spray and the higher temperature existing in the pressurizer. The solubility of gases in water decreases as temperature increases. Spray flow tends to agitate the spray water and liberate the dissolved gases in the pressurizer. (1.0)

c. The pressurizer steam space can be vented or degassed through the purge path provided by the pressurizer steam space to the Reactor Coolant gas vent system (RCGVS) (1.0). or Gases can be vented from the PZR or reactor vessel to either quench tank or RB atmosphere. ~~(0.5)~~ (0.25)

Reference:

#39-PZR & PZR Control System P. 3, 5 and 6.

2.02 QUESTION (3.5)

Indicate what ESFAS actuation signals will be energized by the following:

a. 2 out of 4 containment pressure greater than 5 PSIG. (1.5)

b. 2 out of 4 low steam generator 1 level less than 25%. (0.5)

c. 1 out of 4 high high containment pressure greater than 10 PSIG. (0.5)

d. 3 out of 4 low pressurizer pressure less than 1700 PSIA. (1.0)

2.02 ANSWER (3.5)

a. Containment isolation signal (CIAS) and Main Steam Isolation Signal (MSIS) and Safety Injection Actuation Signal (SIAS). (1.5) & CCAS CRIS

b. ~~Auxiliary~~ Feedwater Actuation signal-1 (EFAS-1), assuming low S/G1 pressure or 50 PSID(0.5) only if S/G > 729 psi
or
none - unless low S/G 1 press (0.5)

c. None. (0.5)

d. ~~CIAS~~ CCAS and SIAS. (1.0) (CIAS only if cont. pres > 2.9#)

Reference:

#16-Engineered Safety Features System Page 5 - 12.

2.03 QUESTION (1.5)

Explain how the containment spray system reduces the containment temperature and pressure, and the airborne activity in the containment after a large LOCA.

2.03 ANSWER (1.5)

The CSAS initiates operation of the Containment Spray System (CSS) which is designed to remove heat and iodine from containment by spraying cool, borated water through the containment atmosphere, thus limiting containment temperature and pressure following a LOCA or main steam line break. (1.0) The Spray Chemical Addition System is started to add controlled quantities of sodium hydroxide, making the spray solution more likely to dissolve and retain elemental radioiodine. (0.5)

Reference:

#16 ESFS Page 6.

2.04 QUESTION (2.0)

a. Explain hot the main condenser hotwell level is controlled. (2.0)

2.04 ANSWER (~~3.5~~ 2.0)

a. . High level drawn-off to the cond. storage tank. (1.0)

. Low level make-up from cond. storage tank. (1.0)

~~The steam now exists through the flow nozzles.~~

Reference:

#9 Condensate feedwater system page 12.

2.05 QUESTION (4.0)

Concern the emergency diesel system:

a. What are two indications, the operator in the control room, has to indicate that the emergency diesel has failed to start? (1.0)

b. What three conditions will cause the emergency diesel to automatically start? (1.5)

c. How many fuel oil storage tanks are there and what is their capacity based on? (1.5)

2.05 ANSWER (4.0)

a. i) Incomplete sequence, ~~and indication of other diesel carrying both buses.~~ (0.5)

~~(any 2 0.5 ea)~~ ii) Diesel failure to start alarm 63~~0~~A33 or 63~~0~~A36. (0.5)

iii) Lack of voltage (0.25) or speed indication. (0.25) ~~(0.5)~~

b. i) Safety injection actuation signal (SIAS). ~~(0.5)~~ 0.75

~~ii) Auxiliary feedwater actuation signal (AFAS). (0.5)~~ EMERGENCY (EFAS)

iii) Loss of voltage to its respective bus (LOP). ~~(0.5)~~ (0.75)

c. There are 4 diesel generator fuel oil storage tanks, two per plant. (0.5) They provide onsite storage and delivery of fuel oil for at least 7 days of continuous operation at full load. (1.0)

Reference:

#15 - Emergency Diesel Generator System. Page 1, 4, 15, 48.

2.06 QUESTION (3.0)

Loss of Instrument Air is a serious operating event. For the following air line ruptures, explain how the compressed air system will response.

a. Before the Air Dryer Inlet Header. (1.0)

b. On the Service Air Header. (1.0)

c. On the Instrument Air Header. (1.0)

2.06 ANSWER (3.0)

a. The service air valve would close, the check valve would close and a N_2 backup would keep the instrument air header (at approximately 70 psig). (1.0)

b. A break on the Service Air Header would cause the service air priority valve to close (at approximately 70 psig). (1.0)

c. A break on the Instrument Header would cause service air priority valve to close. The results would still be a loss of the instrument air system. (1.0)

Reference:

#47 service and instrument air system P. 1-26.

2.07 QUESTION (3.5)

Concerning the Component Cooling Water System

a. List six (6) of the loads for a critical loop of CCW. (2.0)

b. During a normal plant cooldown (less than 350°F). What is the major heat load on a critical loop of (CCWS). (0.5)

c. Explain how the CCWS would respond to a loss of offsite power under these conditions (Rx shutdown, RCS temp. between 350°F - 130°F. (1.0)

2.07 ANSWER (3.5)

a.
- One high-pressure SI pump and the shared standby HPSI.
- One low-pressure SI pump
- One containment spray pump
- One shutdown heat exchanger
- One letdown heat exchanger
- Two containment emergency air coolers
- One control room emergency chiller
- One CCW pump and its shared standby CCW pump
- One fuel handling building post-accident cleanup unit.

(any 6 0.33 ea)

b. Shutdown heat exchanger. (0.5)

c. CCW pump will trip and will restart with the ESF load sequencer (1.0)

Reference:

#7-Component cooling water system.

#45-SI and shutdown cooling system.

2.08 QUESTION (3.0)

With respect to the EFAS, which steam generator(s) will receive emergency feed [1, 2, both, or neither] given the following plant indications? Explain in each case.

a.

SG-1		SG-2
15%	level	20%
650psi	pressure	750psi

b.

SG-1		SG-2
15%	level	20%
650psi	pressure	610psi

c.

SG-1		SG-2
15%	level	20%
650psi	pressure	580psi

2.08 ANSWER (3.0)

(0.5) a. #2 only.

(0.5) With steam generator level below 23%, feed is initiated unless pressure is below 729 psi.

(0.5) b. Neither.

(0.5) Since both steam generators are less than 729 psi and do not satisfy a 50 psid condition to initiate feed to the steam generator with the higher pressure.

(0.5) c. #1 only.

(0.5) Since 50 psid condition will secure feed to lower pressure steam generator.

Book 1 Training Sys. Description AFW sys.

2.09 QUESTION (2.0)

Draw a sample one line diagram of the auxiliary feedwater system including sources of water, chemicals and where the water is being supplied to.

2.09 ANSWER (2.0)

- See attached sheet Figure 2-1.

Point breakdown as follows:

1. 2 electric drive pump, 1 comb-driven pump (0.25)

2. Chemical addition (NH_3, N_2H_4) (0.25)

3. Mini-flow line to CST (0.25)

4. X-connect downstream of HV 4713 and 4712 (0.25)

5. X-connect for P140 (0.25)

6. Flow control valve arrangement (0.5)

7. Identify flow to S/G-1 and S/G-2 (0.25)

Reference:

#2 - Auxiliary Feedwater System

END OF SECTION 2

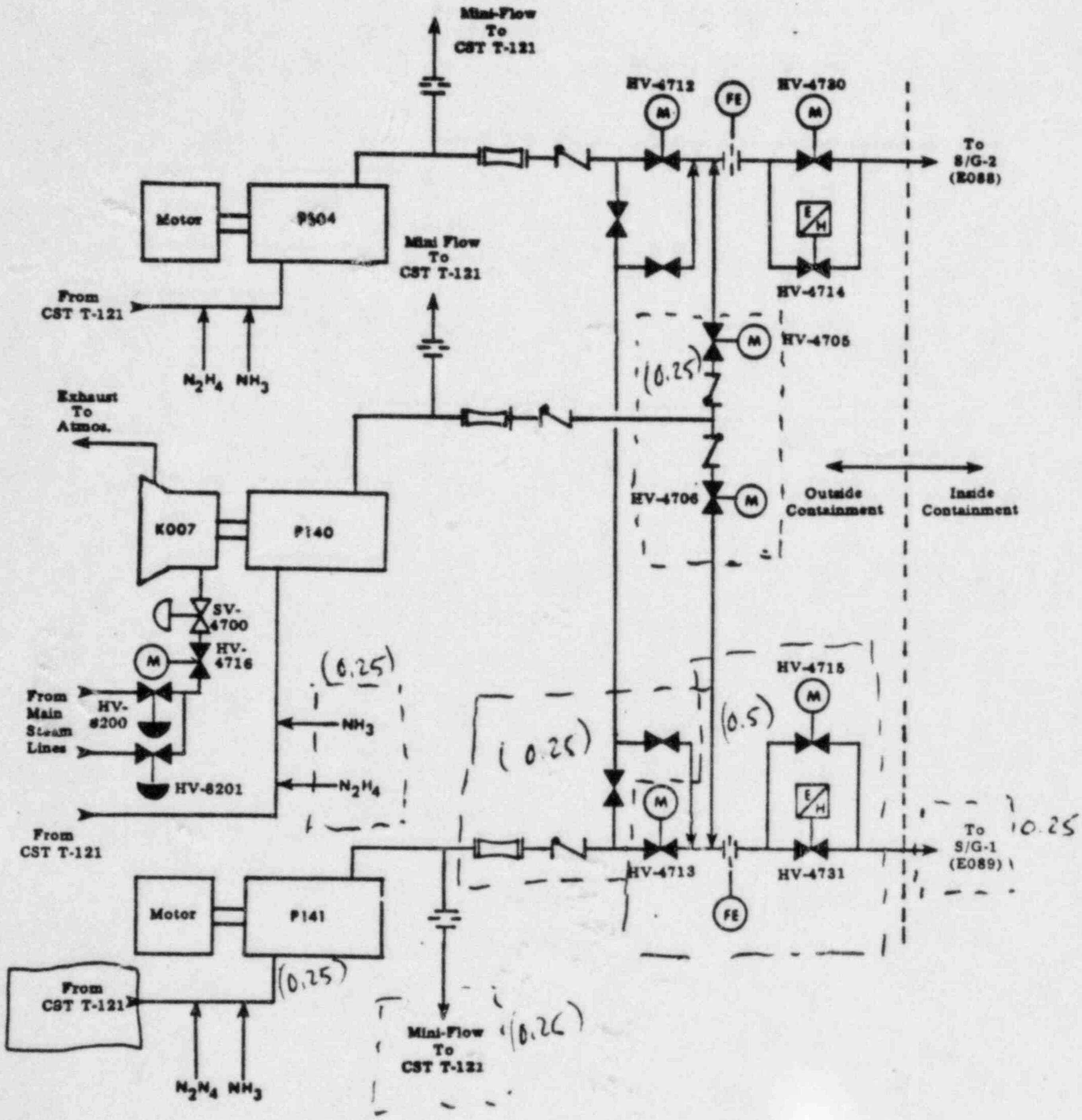

Figure 2-1

Simplified Diagram of the Auxiliary Feedwater System

AUXILIARY FEEDWATER SYSTEM

SECTION 3

INSTRUMENTS AND CONTROLS

3.01 QUESTION (2.0)

A basic component that can be used in both level and flow sensing instruments is the delta-P or DP cell. Explain how a pressure difference can be the means to detect:

a. tank levels (1.0)

b. flows in piping systems (1.0)

3.01 ANSWER (2.0)

Level - the pressure at the bottom of a column is higher than at the top due to the weight of the liquid in the column (height x density of liquid). The difference in pressure between the bottom and the top of a tank is thus proportional to the weight of the liquid. (1.0)

Flow - if the flow is directed through a nozzle, venturi, or orifice, the liquid velocity must increase in the smaller area portion of the device. If velocity increases and total energy remains the same, the pressure must be reduced at the point whith higher velocity. Therefore, the pressure difference between the upstream side and vena contracta is a function of the velocity of the liquid flowing through the device, and flow rate if velocity times the area (P proportional to velocity squared). (1.0)

Reference:

General Physic - HTFF notes Chapter 2, Section D.

3.02 QUESTION (1.0)

Choose the most correct answer with respect to the Steam Bypass Control System. The quick open block is generated when

1. the reactor is below 85%;

2. T_{ave} is below 566°F;

3. one of the two feedwater pumps is lost;

4. the system is placed in manual.

3.02 ANSWER (1.0)

The answer is #2. or #4 (0.5) or #2 + #4 (.25)

Reference(s)

1. System Descriptions #48, "Steam Bypass Control System."

3.03 QUESTION (2.5)

a. Which area Radiation Monitor Detectors are safety-related? (1.0)

b. Briefly discuss the design purpose of each. (1.5)

3.03 ANSWER

a. • Radiation Detectors 7820-1 and -2 for the post accident monitoring of containment radiation levels. (~~1.0~~)(0.5)
• RE-7856 + 7857 → (CPIS) (0.5)

b. Are designed for extreme post accident RB atmosphere conditions (0.5) and to provide indication alarms (0.5) and containment purge isolation on high radiation levels. (0.5)

Reference:

#1 - system descriptions - 'ARMS'.

3.04 QUESTION (3.0)

During equilibrium full power operation describe how a single RPS channel will respond to the following input failures. Also, identify which channels should be by passed.

a. Cold leg temperature indication fails to 0°F on both input channels. (1.5)

b. Pressurizer pressure indication fails to 1700 psia on the narrow range indication. (1.5)

3.04 ANSWER (3.0)

aux trip of DNBR/LPD (0.75)

3.2 a. (CPC sensor failure)(~~+.5~~) bypass the affected CPC (~~+0.5~~)(0.75) ~~and linear power trip. (+0.5)~~

b. CPC {LPD / DNBR} trips (+.75) bypass affected CPC (+0.75). If the answer includes low pressure trip and bypass pressure trip. (-0.5) (0.0 min 1.5 max)

Reference(s)

1. System Description #42, RPS and CPC sec II.

3.05 QUESTION (3.0)

Explain the differences between the "AS" and "MS" modes of control in the CEDMCS. Include any applicable interlocks.

3.05 ANSWER (3.0)

AS MODE:

a. RRS controls CEA motion demand, direction and rate (high or low). (0.5) *

b. CWP, AMI, AWP interlocks are effective.* (1.0)

MS mode

a. Operator controls CEA motion demand and direction. Low rate (0.5) is not available.

b. AMI & AWP interlocks are not available. CWP is available.* (1.0)

* upper & lower seq. permissive interlocks unit 3 has high withdrawal interlock precaud.

Reference:

#13 - Control Element Drive Mechanism Control System

3.06 QUESTION (3.5)

During 100% power operations a reactor trip occurs.

a. Identify and explain 2 indicators in the control room an operator would have if the Steam Bypass Control System (SBSC) valves were to open excessively. (2.0)

b. How would the operator control the SBCS to maintain stable plant conditions if the valves were opened excessively? (1.5)

3.06 ANSWER (3.5)

a. S/G pressure low would be due to excessive RCS temperature drop caused by excessive cooldown. Tave dropping below noload Tave due to excessive cooldown. Low PZR pressure caused by Tave dropping. (any 2 of 3, 1.0 ea)

b. The operator should place the SBCS in manual (0.75), and control S/G pressure at approximately 1000 psig (therefore, T_c will be at 545). (0.75)

Reference: #48 - System Description - SBCS.

3.07 QUESTION (2.0)

How do the ex-core SAFETY CHANNEL nuclear detectors account for the portion of the detector output signal derived from gammas over their range of operation?

3.07 ANSWER (2.0)

In the low neutron flux range a PULSE HEIGHT DISCRIMINATOR is used in the pulse counting circuit to eliminate the lower amplitude gamma pulses from the higher amplitude caused by operation of the fission chammber detector tube. (center tube only) (1.0)

In the Intermediate range, the gamma signal is removed by RMS averaging in the cambelling circuit. (0.5)

At higher power ranges the contribution of the gamma signal is small with respect to the total signal (less than .5%) thus it is not necessary to discriminate against gamma.

Reference:

#17 system description - excore NI's.

3.08 QUESTION (3.5)

During normal 100% power operation, explain how and why the failure of the following safety grade inputs will affect RPS channel A. (Include any meter response or alarms.)

a. The middle NI on channel A fails 75% low (reading only ¼ the correct value).

b. The channel A cold-leg temperature input were to fail 40°F high.

c. The channel A RCP speed indicator for pump IB were to fail and give a zero-speed indication.

3.08 ANSWER (3.5)

a. A failed middle NI will cause the CPC to estimate a very high axial peaking factor (the CPC takes 3 readings and produces 20 nodes). The failed NI will not affect the total power calculation since power is maximum of NI and calculator. The failed NI will cause a DNBR and LPD trip. Also, the failed NI will cause an NI-Calculator power deviation alarm. (1.5)

b. The high cold leg temperature will cause the calculator power to drop causing a ~~NI-calculator power deviation~~* The high cold leg temperature may cause a DNBR trip, since T_c is an input to the DNBR calculation; or an auxiliary trip may occur because T_c is higher than 580°F which would ~~prevent~~ cause the DNBR trip. (1.0)

c. A low RCP speed will cause the calculated power to read low resulting in a NI-calculator power diviation. The low RCP speed will also cause a DNBR trip since slow is a DNBR input. (1.0)

Reference: * proper terminology is Linear power deviation channel 1, 2, 3, 4.

#17 system descriptions EXCORE NI's and #42 system descriptions RPS and CPC's.

3.09 QUESTION (3.5)

a. List the plant parameters that are used as inputs to the Feedwater Control System (FWCS) (1.0)

b. How is the Reactor Trip Override (RTO) sensed by the FWCS and explain what changes occur in the FWCS. (2.5)

3.09 ANSWER (3.5)

a. . Steam Flow

.33 ea

(0.~~25~~) . Feed Flow

. Steam Generator Level

. ~~Main feed pump speed.~~

b. RTO is sensed by a status of the under voltage coils in the CEDMCS. (1.0) When a reactor try occurs (1) the feedwater regulating valve closes (0.5), (2) the feedwater bypass valves setpoint goes to 5% (0.5), (3) Main feed pump speed set point goes to 5% (0.5).

Reference:

#2 System Description Feedwater Regulatory System

3.10 QUESTION (1.0)

While exercising the control rods at 80% power a CEA drops into the core.

Explain why all of the CPC channels will not show the same margin to DNBR trip or to a kW/ft trip (assume that Rx trip does not occur).

3.10 ANSWER (1.0)

The CEAC's will send a penalty factor to each CPC for the dropped rod being different than the rest of the subgroup which will lower DNBR and kW/ft margins to trip. (0.5) The CPC that uses the dropped CEA as a target rod will also receive an additional penalty for the CEA subgroup being inserted. (0.5)

Reference

#42 System Description RPS and CPC's

END OF SECTION 3

SECTION 4

PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

4.01 QUESTION (2.0)

Explain the probable cause and the corrective action for an increasing VCT level following isolation of the CVCS charging and letdown system (Letdown valves TV-0221 and HV-9204 shut, charging pumps secured).

4.01 ANSWER (2.0)

Cause:

a. RCP seal leakoff still going to VCT (1.0)

b. Corrective action: open the 1" drain line on the VCT (1.0)

Reference:

SO23-3-2.1, page 12

4.02 QUESTION (2.0)

List the most likely source of the following isotopes if found in the RCS.

a. Co^{60}.

b. Cs^{137}.

c. N^{16}.

d. A^{41}.

e. Fe^{59}.

f. I^{131}.

4.02 ANSWER (2.0)

a. Co^{60} - Activated corrosion product.

b. CS^{137} - Fission product.

c. N^{16} - From activation of O^{16}. (0.33 ea)

d. A^{41} - From activation of air in RCS.

e. Fe^{59} - Activated corrosion product.

f. I^{131} - Fission product.

4.03 QUESTION (3.0)

You are conducting a normal reactor startup following a short maintenance period. ECP is calculated, and all initial conditions are met. You are withdrawing the CEA's in sequence to criticality.

a. If criticality is: projected to occur before reaching the - 0.5 delta k/k CEA height or criticality has not occurred when ~~were~~ withdrawn to +0.5 delta k/k position, what immediate actions will you take in accordance with the Reactor Startup procedure (SO23-3-1.1)?

4.03 ANSWER (3.0)

a. Stop CEA withdrawal.

b. Insure 1.5% delta k/k subcritical.

(any 4
0.75 c. Insure shutdown margin I.A.W. SO23-3-3.29.
ea)

d. Have Chemistry Department take boron sample.

e. Recalculate ECP.

f. Notify SRO Ops. Supervisor.

Reference:

SO23-3-1.1 Rx Startup.

4.04 QUESTION (1.5)

A safety-related component is to be disabled, and a Work Authorization issued on it.

a. When must the redundant component be verified to be operable? (0.75 pts.)

b. When must the associated third of a kind component be verified to be operable? (0.75 pts.)

4.04 ANSWER (1.5)

a. Prior to disabling the component and prior to issuing the Work Authorization. (0.75)

b. After disabling the component but prior to issuing the Work Authorization. (0.75)

Reference:

SO23-0-13, page 4.

4.05 QUESTION (2.5)

a. If all RCPs are tripped from 100% power and are not restarted, how long will it take for natural circulation to become established? (0.5 pts.)

b. What four criteria are required to be used to indicate that inadequate core cooling may be occurring? (2.0 pts.)

4.05 ANSWER (2.5)

a. 7-9 minutes depending on decay heat (2 min tolerance) (0.5 pts.).

b. 1. RCS subcooling less than 10 F. (0.5)

2. Erratic Nuclear Instrumentation. (0.5)

3. Core Exit T/Cs more than 58 F above existing hot leg (0.5) temperatures.

4. Hot leg temperatures not decreasing, or _620 F (0.5 pts. each part, 10% tolerance on numbers). (0.5)

Reference:

SO2-3-2.31, page 4.

4.06 QUESTION (3.5)

What actions are required if two NSSS channels of a parameter reach their Reactor Trip Setpoint, but all of the CEA's do not fully insert?

4.06 ANSWER (3.5)

a. Push all four manual reactor trip pushbuttons. (1.0)

b. If more than one CEA does not insert, emergency borate. (0.5)

2 or more

c. If more than nine CEA's do not insert, emergency borate, denergize LC B-015 and B-016, initiate EFAS #1 and #2, and manual trip the turbine. (2.0)

or 10 or more

Reference:

SO23-3-5.1, page 4.

4.07 QUESTION (3.5)

a. Name 4 indications of a S/G tube leak.

b. During a SG tube rupture, why must the hot less temperature be less than 545 F prior to isolations the effected SG?

c. What actions should be taken to cooldown the RCS following a SG tube rupture if the MSIV for the effected SG fails to shut? (Assume below 535 F)

4.07 ANSWER (3.5)

a. (Any 4 0.25 ea.)

- S/G blowdown Monitor Radiation Hi.
- Condensore Air Ejector Airborne Radiation Hi.
- Main Steam Line Monitor Radiation Hi.
- PZR pressure/level low.
- VCT leak level low.

b. To prevent lifting the S/G safety valves. (1.0)

c. Shut the unaffected S/G's MSIV (.75) and use its atmospheric dump valve to cooldown. (.75)

Reference:

SO23-3-5.29, page 9, 2 and attachments.

4.08 QUESTION (2.5)

You are operating at 75% power, and have normal indications. A half an hour in to the watch you receive VCT low level alarm, and you check the CVCS lineup and find the following:

- Letdown pressure is normal (or a little low).
- VCT level is lowering and full VCT makeup is in progress.
- Charging pressure is less than RCS press.
- Pressurizer level is lowering.
- 2nd charging pump has just started.

a. What is the most likely cause of this transient?

b. What are your immediate actions?

4.08 ANSWER (2.5)

a. A leak in the CVCS system (0.75) (possibly before the charging pump).

b.
- Close HV-9204, Letdown Isolation Valve. (1.0)
- Verify 2nd charging pump is operating and restore PZR level. (0.75)

Reference:

SO23-3-5.28

4.09 QUESTION (2.0)

a. Describe how the operating personnel can detect a fuel element failure. What instrument(s) might be the first indication? (1.5)

b. Include how they would be able to distinguish it from radioactive corrosion products. (0.5)

4.09 ANSWER (2.0)

a. An increase in the activity of the RCS would be an indication of a fuel element leaking (1.0). THe letdown process radiation monitor in the CVCS would be the first indication of this. (0.5)

b. Have chemistry draw a sample measure I-131/133 ratio or (Isotropic analysis). This will confirm fuel element failure. (0.5)

Reference:

SO23-3-5.14

4.10 QUESTION (2.5)

a. What parameters are required to be monitored if a reactor coolant pump seal failure is suspected? (2.0 pts.)

b. What parameter values would definitely indicate that one full pressure seal has failed on one RCP? (0.5 pt.)

4.10 ANSWER (2.5)

a. Seal cavity pressures, seal temperatures, CBO flow, CBO temperature (2.0 pts.).

b. Seal Cavity pressure in the cavity above and below the failed seal equalize (0.5 pt.)

Reference:

SO 3-3-5.26, page 2, Attachment 5.1.

END OF SECTION 4

$f = ma$

$v = s/t$

Cycle efficiency = (Network out)/(Energy in)

$w = mg$

$s = V_o t + 1/2\ at^2$

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

$A = A_o e^{-\lambda t}$

$PE = mgh$

$V_f = V_o + at$

$w = e/t$

$\lambda = \ln 2/t_{1/2} = 0.693/t_{1/2}$

$t_{1/2}eff = \dfrac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$\Delta E = 931\ \Delta m$

$I = I_o e^{-\Sigma x}$

$\dot{Q} = \dot{m} Cp \Delta t$

$\dot{Q} = UA \Delta T$

$Pwr = W_f \Delta n$

$I = I_o e^{-\mu x}$

$I = I_o\ 10^{-x/TVL}$

$TVL = \dagger.3/\mu$

$HVL = -0.693/\mu$

$P = P_o 10^{sur(t)}$

$P = P_o e^{t/T}$

$SUR = 26.06/T$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$SUR = 26\rho/\ell^* + (\beta - \rho)T$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$T = (\ell^*/\rho) + [(\beta - \rho)/\bar{\lambda}\rho]$

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

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

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

$M = 1/(1 - K_{eff}) = CR_1/CR_o$

$M = (1 - K_{effo})/(1 - K_{eff1})$

$SDM = (1 - K_{eff})/K_{eff}$

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

$\bar{\lambda} = 0.1\ \text{seconds}^{-1}$

$\rho = [(\ell^*/(T\ K_{eff})] + [\bar{\beta}_{eff}/(1 + \bar{\lambda} T)]$

$I_1 d_1 = I_2 d_2$

$I_1 d_1{}^2 = I_2 d_2{}^2$

$P = (\Sigma\phi V)/(3 \times 10^{10})$

$\Sigma = \sigma N$

$R/hr = (0.5\ CE)/d^2(\text{meters})$

<u>Water Parameters</u>

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.

<u>Miscellaneous Conversions</u>

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)