LIC 12/22/80

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289 SP
	)	(Restart)
(Three Mile Island Nuclear Station, Unit No. 1)	)	
	)	

LICENSEE'S TESTIMONY OF

FRANK L. KELLY

REGARDING CLI-80-5 ISSUE (2),

ANGRY CONTENTION NO. IV, SHOLLY

CONTENTION NO. 14(b), and AAMODT

CONTENTION NO. 2

(LICENSED OPERATOR TRAINING)

OUTLINE

The purposes and objectives of this testimony by Frank L. Kelly, an independent consultant on training for nuclear power plant staffs, are to respond to Issue (2) of Commission Order CLI-80-5, ANGRY Contention No. IV, Sholly Contention No. 14(b) and Aamodt Contention No. 2 insofar as they address the adequacy of Licensee's training programs for TMI-1 licensed operators. The testimony describes Mr. Kelly's involvement in assessments of Licensee's training program as it existed at the time of the TMI-2 accident and in audits of Licensee's Operator Accelerated Requalification Program (OARP) which since the accident has been attended by all TMI-1 licensed operators. The testimony further describes Mr. Kelly's role in developing and providing to all OARP participants a comprehensive oral and written examination of the type generally administered by NRC as a prerequisite to operator licensing. In the opinion of Mr. Kelly, who has more than twenty-six years of experience in nuclear power plant startup and test, operator qualification and regulatory evaluation of operator proficiency, Licensee's OARP-trained operators generally are well trained to handle TMI-1 under both normal and off-normal conditions and will demonstrate their proficiency in NRC-administered tests.

My name is Frank L. Kelly. My education and experience are included as Appendix A to this testimony. Briefly, I have over twenty-six years in the nuclear industry, engaged in the startup and operation of nuclear power plants, the administration of nuclear power plant training programs and the evaluation of nuclear power plant operator proficiency. I graduated from the University of Vermont in 1954 with a Bachelor of Science degree in Electrical Engineering and completed graduate school course credits in Nuclear Engineering at the University of Pittsburgh in 1959.

My industrial career has spanned the period 1954 through the present with key assignments being Chief of the USNRC Operator Licensing Branch (then USAEC) from 1967 to 1969 and later, manager of all Westinghouse Electric Corporation nuclear training programs prior to founding the PQS Corporation in 1979. I am a registered professional nuclear engineer and a member and past Secretary of ANS-3, the American Nuclear Society's main standards writing committee on the conduct of operations at nuclear power plants.

PQS Corporation, incorporated in the State of New York in 1979, provides the power industry with review and audit services for power plant staffing and training programs. Since its creation in 1979, PQS has provided these various services to seventeen (17) utilities for their nuclear power plant training programs, including one European utility (NOK - Switzerland).

I have been asked by Met Ed to describe my involvement with the TMI-1 training programs and, based on my experience, to respond to the following issue and contentions insofar as they address the adequacy of licensed operator training at TMI-1:

CLI-80-5, ISSUE (2)

> Whether the operations and technical staff of Unit 1 is qualified to operate Unit 1 safely (the adequacy of the facility's maintenance program should be among the matters considered by the Board).

ANGRY CONTENTION NO. IV

> The Licensee lacks the management capability to operate a Nuclear Generating Station without endangering the public health and safety.

SHOLLY CONTENTION NO. 14(b)

> The Licensee's management capability, in terms of organizational, staffing, and technical capabilities, is not sufficient. Specifically, the following deficiencies in Licensee's management capability are contended:
>
> . . .
>
> (b) Licensee's operations and technical staffs are not sufficiently qualified to safely operate TMI-1.

AAMODT CONTENTION NO. 2

> It is contended that TMI-1 should not open until the performance of licensee technicians and management can be demonstrated to be upgraded as certified by an independent engineering firm. This upgrading should include 100% test performance of job description with provision for retraining and retest, or discharge of those who cannot consistently and confidently master all necessary information for safe conduct of their job description under all anticipated critical situations as well as routine situations.

PQS's first association with Metropolitan Edison Company came in April 1979. We were requested to review the operator training and requalification programs at Three Mile Island. Based upon this review, PQS concluded that Met Ed's operator training and requalification programs were representative of the industry, but could be improved in certain respects. Accordingly, PQS recommended 1) and expansion of the training organization, 2) certain modifications to the requalification program, 3) increased usage of the B&W simulator, 4) modification of the scope of all of the Operator training programs, and 5) additional evaluation examinations prior to NRC licensing examinations. All of these recommendations have been incorporated into the overall TMI training programs.

In response to the criticisms of its operators as a result of the TMI-2 accident, to demonstrate that, in fact, its operators were well qualified, to satisfy NRC, and to provide the public with confidence in its operators' qualifications, Met Ed in the Spring of 1979 announced that it would require all of its operators to be reexamined for licensing by NRC prior to the restart of TMI-1. Further, the Company announced that in preparation for the requalification exams, all operators would be required to participate in an intensive review program, the Operator Accelerated Requalification Program, which would cover all subject areas of concern to a licensed operator of a nuclear plant. This action was, of course, unprecedented, since licensed operators ordinarily are required to pass NRC examinations only once to be licensed on a plant and thereafter are subject only to periodic requalification programs administered by the licensee and audited by NRC. This step -- not unlike an engineering firm requiring each of its licensed engineers to retake and pass the professional engineers exam, or an accounting firm requiring all its certified accountants to retake and pass the CPA exams, or a law firm requiring all its attorneys to repass the bar exam -- was a remarkable commitment by the Company. More remarkable to me, however, was the positive response by the operators at Met Ed. To me, this is indicative both of their commitment to the Company and their pride and confidence in their capabilities. My contact with the operators bears this out.

Following initiation of the OARP, PQS periodically monitored the program's progress. We audited the scope, content and schedule of the program and the program's self-evaluation process, observed classes, interviewed individual trainees and reviewed records. The scope and content of the program met the objectives which Met Ed established and committed to in Section 6 of the Restart Report. Thus, the program was properly developed and implemented to achieve these objectives, which were designed to ensure that the licensed operators were trained to safely and efficiently start TMI Unit #1. The program implementation included formal classroom lectures, B&W simulator training and written and oral evaluations of trainee progress. One area reviewed in some detail was the training given in heat transfer and fluid dynamics. Detailed lesson plans were provided and found to be very good presentations and quite practical in nature, considering the complexity of the subject matter. Our audit of the self-evaluation process conducted by the Company of its own training program revealed that it was a meaningful effort. We agreed, for example, with some evaluators who had given less than 3.0 grades to specific presentations and, as a result, recommended that these presentations be repeated. Met Ed subsequently complied with this and other recommendations which we made. We were impressed by our observation of a class lecture on transient and accident analysis. Class participation was required, and the operators appeared to be greatly interested in this effort. Overall class attention was at a high level, due in considerable part to the quality of the instruction. Our interviews with individual trainees also yielded considerable insight into the program. Based on our interviews, we recommended to the Company, for example, that certain subject areas, such as reactor theory -- because of its particular concern to operators -- should be emphasized and reviewed in refresher lectures as well. We also confirmed that operators were anxious about the oral examination section of anticipated NRC exams and desired oral examination exercises. As I discuss below, oral examinations played an important role in our mock NRC examinations of the operators. Our review of the records showed some delay in completing records of makeup quizzes, although the records generally were both accurate and complete. In sum, our view was that the OARP was a comprehensive, well administered program, that operators displayed great pride in their positions as qualified operators and that, based on training and self study, these individuals would successfully complete NRC's examinations and be well qualified operators.

In December 1979 PQS was assigned by Met Ed the task of preparing and administering complete written and oral examinations to the licensed reactor operators (ROs) and senior reactor operators (SROs) at TMI Unit 1. The purpose of those examinations was to exercise the operators with an examination of the type given by NRC to operator candidates in order to prepare the operators for such an exam and to provide the Company with a comprehensive examination of its licensed operators and candidates by an independent testing entity.

During the period April 2 to April 11, 1980, PQS administered written and oral audit examinations to twenty-seven TMI-1 previously NRC-licensed ROs and SROs and four RO License candidates. The examinations were developed based on our knowledge and experience with NRC operator examinations, were formatted similar to NRC's techniques, and spanned all subject areas which NRC examinations of operators would be expected to encompass. Copies of both the RO and SRO examinations are attached as Appendices B and C to this testimony.

PQS examined the ROs in the following areas:

- Principles of reactor operation
- Principles of heat transfer and fluid flow
- Features of facility design
- General operating characteristics
- Instruments and controls
- Safety and emergency systems
- Standard and emergency operating procedures
- Radiation control and safety

As can be seen by review of Appendices B and C, the tests PQS administered were broad in scope but required detailed knowledge in each of the subject areas. We sought to make the PQS exam, while similar to the anticipated NRC exam, more demanding. These examinations were graded based upon the new NRC failure criteria which requires an overa average of 80% and no less than 70% in any one category. (NRC's criterion prior to the TMI-2 accident had been an overall grade of 70% and no specific minimum grade for any individual category.)

The overall average for the TMI operators on our RO examination was 86.5%, with group averages greater than the 80% in all the specific categories. Some operators failed to achieve the required grades and these individuals were required to follow a remedial program. This program was developed and implemented, with written examinations administered by the TMI Training Department to evaluate the results of the remedial program. All individuals successfully achieved the required grades in the specified deficient categories.

In the case of the SROs, PQS examined sixteen individuals as to their knowledge of not only all the subjects covered by the RO Exam but also the following subjects:

- Reactor theory
- Radioactive materials handling, disposal and hazards
- Specific operating procedures
- Fuel handling and core parameters
- Administrative procedures, conditions and limitations

Again, as with the RO examinations, the grading required an overall average of 80% and no less than 70% in any given subject. The group overall average on the PQS exam was 84.1% and no average in any particular category was less than 80%. Two individuals failed to achieve passing grades and were required to follow a remedial course of study. Again, as with the RO examinations, a remedial program was developed and implemented and written examinations administered with required grades being achieved by each individual.

PQS administered in addition to the RO and SRO examinations a separate written test to all RO and SRO candidates covering the TMI-2 event and principles of the small break LOCA concept. For this examination, we required -- as we understand NRC will require -- a 90% grade to pass. The average grade attained was 87.1% with fifteen of the thirty-one participants achieving grades less than 90%. It should be noted that a 90% passing grade on any examination is a rather stringent requirement, since 1) only 80% overall and 70% on each NRC license examination category is required, and 2) a college degree can be awarded upon the achievement of a "C" (75%) average. PQS nevertheless recommended that these fifteen (15) individuals be given formal classroom re-training in the areas of required knowledge and then be administered a written examination by the TMI Training Department. The re-training is scheduled for January, 1981 and all individuals enrolled will be required to achieve grades of greater than 90% on these examinations.

The final segment of the PQS examination was an oral exam for all candidates. These examinations were similar to those administered by USNRC operator license examiners - one-on-one orals, four to five hours in duration. During the examination, each candidate was required to tour the Unit #1 plant and control room, to exhibit familiarity with the equipment and explain how and why he would conduct (or in the case of the SRO, direct) routine, abnormal and emergency operations. The grading system employed by PQS for the oral examination was pass/fail. Of the thirty-one individuals examined, twenty-eight passed and three failed.

Based upon the results of our audit examinations, PQS has concluded that overall, the TMI-1 licensed ROs and SROs demonstrate a high degree of knowledge of how to safely and effectively operate the unit. This is attributable in large part to the scope and depth of the OARP program and to the manner in which it was conducted by instructors who professionally and conscientiously taught trainees who sincerely and enthusiastically participated. Based on my knowledge of, and experience with, licensed operators throughout the industry, I judge the TMI-1 operators collectively to be retrained and evaluated to a much greater extent relative to what we judge to be an industry norm.

APPENDIX A

TO

LICENSEE'S TESTIMONY OF FRANK L. KELLY

REGARDING CLI-80-5 ISSUE (2),

ANGRY CONTENTION NO. IV, SHOLLY

CONTENTION NO. 14(b), AND AAMODT

CONTENTION NO. 2

(LICENSED OPERATOR TRAINING)

Professional Qualifications

of

Frank L. Kelly

FRANK L. KELLY

EXPERIENCE

Summary

Twenty-six (26) years in the nuclear industry engaged in nuclear power plant startup and test, operator qualification and regulatory evaluation of operator proficiency.

Specific Experience Highlights:

1. PQS CORPORATION - One (1) year.

   Founder and President.

2. NUCLEAR REGULATORY COMMISSION - Seven (7) years.

   Chief, Operator Licensing Branch. Responsible for the formulation and evaluation of operator and senior operator examinations, administered to operators of power, test and research facilities. Developed and implemented NRC policies for the use of nuclear power plant simulators utilized as training devices.

3. OPERATOR & SENIOR OPERATOR QUALIFICATION & EVALUATION - Ten (10)yrs.

   Directed efforts and participated in the selection, training and evaluation of operators while in supervisory positions with Westinghouse Electric Corporation and two (2) nuclear service consulting firms.

4. MANAGEMENT OF NUCLEAR POWER PLANT TRAINING SIMULATOR - Three (3) yrs.

   Responsible for the startup and operation of the Westinghouse Nuclear Training Center, Zion, Illinois, USA.

5. STARTUP & OPERATION OF NUCLEAR POWER PLANTS - Five (5) years.

   Responsible for the startup and operation of nuclear power plants, test reactors and research facilities - NRC licensed on six (6)plants

EDUCATION

- BS Electrical Engineering, University of Vermont
- Graduate study - MS Nuclear Engineering, University of Pittsburgh

REGISTRATIONS/LICENSES

Nuclear Engineer, State of California, Registration #NU883

PROFESSIONAL AFFILIATIONS

American Nuclear Society-Past Chairman, Reactor Operations Division

COMMITTEES/ADVISORY GROUPS

Present Secretary, ANS-3, Subcommittee on Reactor Operations (authors of ANS Standards N18.7, N18.1 and ANS 3.5).

APPENDIX B

TO

LICENSEE'S TESTIMONY OF

FRANK L. KELLY

REGARDING CLI-80-5 ISSUE (2),

ANGRY CONTENTION NO. IV, SHOLLY

CONTENTION NO. 14(b), AND AAMODT

CONTENTION NO. 2

(LICENSED OPERATOR TRAINING)

PQS Corporation

RO Written

Examinations

PQS CORPORATION

REACTOR OPERATOR LICENSE EXAMINATION

Facility Three Mile Island #1

Reactor Type PWR - Babcock & Wilcox

Date Administered ________________

Examiner F.L. Kelly

Applicant ________________________

Category Value	% of Total	Applicant's Score	% of Cat. Value	
9.5	13.[illegible]	______	______	A. PRINCIPLES OF REACTOR OPERATI
8.0	11.7	______	______	A/. PRINCIPLES OF HEAT TRANSFER A FLUID FLOW
8.5	12.4	______	______	B. FEATURES OF FACILITY DESIGN
8.0	11.7	______	______	C. GENERAL OPERATING CHARACTERIS
7.5	11.0	______	______	D. INSTRUMENTS AND CONTROLS
8.0	11.7	______	______	E. SAFETY AND EMERGENCY SYSTEMS
10.0	14.6	______	______	F. STANDARD AND EMERGENCY OPERAT PROCEDURES
9.0	13.1	______	______	G. RADIATION CONTROL AND SAFETY
68.5	100.0			
9.0	N/A	______	N/A	T. TMI INCIDENT AND SMALL BREAK CONCEPT

FINAL GRADE ______________________%

DO'S AND DON'TS FOR EXAMS

DO'S

1. Read the questions carefully.
2. Note the number of points allotted to each question.
3. Question the examiner if in doubt.
4. Pace yourself - don't spend hours drawing fancy sketches.
5. Show all calculations.
6. Look for any two-part questions which may not be labeled as such.
7. Recognize whether definition or explanation (discussion) is required.
8. List more than two reasons if some or few are requested.

DON'TS

1. LEAVE ANY BLANKS
2. Read hidden meanings into the questions.
3. Show the examiner your answers for his concurrence.
4. Write your name on every sheet.

A. PRINCIPLES OF REACTOR OPERATION (9.5)

1. 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 <u>after</u> Xenon has peaked. (1.0)

2. Two identical reactors are taken to the "just critical" level. Reactor "A" has a rod speed of 50 steps per minute, while Reactor "B" has a rod speed of 25 steps per minute. (Assume continuous rod withdrawal). (1.5)

   a. Which reactor will achieve criticality first.

   b. Which reactor will have the highest level of source range counts at criticality.

   c. Which will have the highest critical rod height.

   Explain your answers.

3. Would the insertion of 0.1% ΔK/K to the reactor at 10^{-8} amps on the intermediate range result in the same change in power level as the same insertion at 80% of full power. Explain your answer. (1.0)

4. a. Sketch and explain the startup recorder trace for one minute following a rod withdrawal amounting to an increase in K_{eff} (each time) of .005 from the following initial conditions: (1.5)

   I. K_{eff} = 0.9, counts = 100

   II. K_{eff} = 0.99, counts = 1,000

   III. K_{eff} = 1.00, counts = 5,000

   b. Calculate the SUR for case III. (0.5)

5. Would control rod worth be greater: (1.5)

   a. When the moderator is at 150°F or 500°F.

   b. When it is next to a withdrawn control rod or surrounded by inserted control rods.

   c. When C_B is 500 ppm or 1500 ppm.

A. PRINCIPLES OF REACTOR OPERATION (CONTINUED)

6. As the reactor is operated, plutonium 239 is gradually formed from uranium 238. Describe: (1.5)

   a. The formation process

   b. How this formation affects reactor control

A/. PRINCIPLES OF HEAT TRANSFER AND FLUID FLOW (8.0)

1. Briefly explain the following heat transfer and fluid flow terms: (2.5)

    a. Natural circulation

    b. Reactor coolant saturation condition

    c. Nucleate boiling

    d. Sub-cooling

2. The following units are used with what important nuclear and/or thermal parameters: (1.0)

    a. KW/ft

    b. MWD/T

    c. KW/liter

    d. Btu/hr-ft^2

3. Sketch a DNB curve. Label the abscissa and ordinate and identify the various regions shown on the curve. (1.5)

4. a. Describe the phenomena known as "pump cavitation". (0.5)

    b. What symptoms would alert the TMI operators to such a condition for the RCPs. (1.0)

5. a. With TMI-1 operating at full power what are the hottest and average fuel rod temperatures which exist in the core. (1.0)

    b. In the event of a LOCA, what temperature should the Zircaloy clad be limited to and for what reason. (0.5)

B. FEATURES OF FACILITY DESIGN (8.5)

1. List the purpose(s) of the Makeup and Purification System. (1.5)

2. Sketch a simplified system schematic diagram of the proposed HPI Cross-connect. Label components and indicate flow directions. (2.0)

3. Why are there two (2) vibration transducers on the DHR heat exchangers and only one (1) on the DHR pumps. (1.0)

4. With regard to the Core Flood System:

   a. Briefly describe the purpose of the system. (1.0)

   b. List normal operating pressure, temperature and volume conditions. (0.5)

   c. What system valves are controlled from the main control board. (0.5)

5. Sketch a one-line diagram of the BOP 480 volt distribution system. Indicate the systems and/or components fed by the system. (2.0)

C. GENERAL OPERATING CHARACTERISTICS (8.0)

1. Describe how and why the following RCS chemistry parameters are controlled during startup and full-power operation. (1.5)

   a. Oxygen

   b. Chlorides

   c. pH

2. With regard to the EFW pumps, approximately how long will each pump require to reach full flow. (0.5)

3. Explain how and why the Moderator Temperature Coefficient is affected by changes in RCS boron concentration. (1.0)

4. The Reactor is operating at 10% power when the turbine bypass valves for "A" SG fail open. Two (2) minutes later the operator isolates the turbine bypass valve(s). Sketch the following parameters from the initial valve failure to four (4) minutes later for: (2.5)

   a. Reactor power

   b. SG level

   c. PRZ level

   d. FW flow

5. Describe the means of solid condition operation verification which operators can determine from the control room. (1.0)

6. a. Describe (a formula is acceptable) how the following isotopes are formed and where they would be most commonly be found in the reactor systems: (1.0)

      1) N-16

      2) SM-149

      3) Krypton-85

   b. List the half-lives of each of these isotopes. (0.5)

D. INSTRUMENTS AND CONTROLS (7.5)

1. Concerning the nuclear instrumentation:

   a. Describe the reaction by which the detectors produce a signal corresponding to neutron radiation. (1.0)

   b. Does gamma radiation affect the signals from detector. Explain why or why not. Assume detectors are properly calibrated and operated. (1.0)

2. Describe the principle of operation of the RCS Saturation Margin Monitor, including the inputs to the monitor. (1.0)

3. Upon loss of both feedwater pumps, the ICS positions the control valves EF-V30A/B to maintain SG H_2O level. What level is maintained and where is this indicated:

   a. With reactor coolant pumps available. (0.5)

   b. With reactor coolant pumps not available. (0.5)

4. With regard to cold, safe shutdown, list ten (10) pertinent instruments which have been selected for placement on a separate panel outside the control room. (2.0)

5. At 90 minutes and again at 113 minutes into the TMI-2 event, operators observed anomalous increases on the intermediate range NIs.

   a. Approximately what was the order of magnitude of the increases. (0.5)

   b. Explain the cause of these increases. (1.0)

E. SAFETY AND EMERGENCY SYSTEMS (8.0)

1. a. Outline all of the Unit #1 Emergency Feedwater System modifications. (2.0)

   b. List the signals which will automatically start the "A" motor driven EFW pump and the turbine driven EFW pump. (1.0)

2. Explain the purpose of the PRZ Heater Emergency Power Supply System. (1.0)

3. What RPS trips are bypassed when in the Shutdown Bypass Mode. (1.0)

4. Recently, Crystal River Unit #3 suffered the loss of the +24 volt power supply to the non-nuclear instrumentation, with the reactor at 100% power. List the cause of the loss of voltage and briefly describe the significant events that occurred due to the condition. (2.0)

5. List the following full power RPS trip setpoints, with four (4) RCS pumps in operation: (1.0)

   a. Nuclear power (% of rated power)

   b. High Reactor coolant pressure

   c. Lo Reactor coolant pressure

   d. RCS maximum temperature

   e. High Reactor building pressure

F. STANDARD AND EMERGENCY OPERATING PROCEDURES (10.0)

1. With regard to a normal Reactor startup and approach to criticality, list: (2.5)

   a. Maximum SUR

   b. Minimum overlap between source and intermediate range indication.

   c. Action required if criticality is schieved prior to rods reaching _____%ΔK/K below ECP. (Fill in the blank, also.)

   d. Exceptions to the rule that CRA Safety groups be at upper limits whenever positive reactivity is being inserted.

   e. Number of licensed operators in the control room.

2. Prior to TMI-1 modifications, during a transient which results in overcooling of the RCS, PRZ level decreases and the operators open MU-V16B and start a second make-up pump to restore PRZ level. With the installation of the HPI cross-connects, would such operator action be appropriate. Explain your answer. (1.0)

3. During a TMI-1 startup, in-core quadrant tilt indicates +6%. What operator action, if any, is necessary for this condition. (1.0)

4. With the plant operating at full power, certain precautions and limitations apply. Provide the following information and operator action pertaining to these: (1.5)

   a. The control room computer becomes inoperable

   b. Maximum PRZ level

   c. Minimum boron concentration

   d. Maximum core thermal power

   e. A limiting condition for operation can not be met

F. STANDARD AND EMERGENCY OPERATING PROCEDURES (CONTINUED)

5. During full power operation, an explosion and fire occurs local to the control room of Unit #1, resulting in thick, acrid smoke filling the control room. Supervision determines that evacuation is necessary. Prior to evacuation, operators must perform certain duties. List those duties. (1.5)

6. a. List the symptoms which would alert the operators to the occurrence of an OTSG tube rupture. (1.5)

   b. If HPI actuates on lo RCS pressure during the event, what immediate operator action is necessary. (0.5)

   c. In an attempt to determine which OTSG has the rupture, the Chemistry Department is directed to sample both and analyze for what types of radioactive isotopes. (0.5)

G. RADIATION CONTROL AND SAFETY (9.0)

1. It is necessary to you to work in an area where you may receive an amount of radiation which will cause you to slightly exceed your 10CFR Part 20 routine quarterly limits. Is this permitted, and if so, what conditions must be met for you to do this. (1.5)

2. List four (4) different types of radiation and give typical situations in which <u>each</u> may be encountered at the TMI Station. (1.5)

3. What respiratory devices would provide adequate protection against: (1.0)

   a. Radioactive gas

   b. Radioactive particles

   c. Tritium

4. A TMI plant chemtech accidently spills a freshly taken primary coolant sample on the floor.

   a. Discuss what actions he should take. (1.5)

   b. If a protable monitor reads 50 mrem/hour γ two feet from the spill, what is the contact level of radiation. (1.0)

5. With regard to "leaky" fuel elements, how could operators detect a leak which occurs in a TMI fuel element: (1.5)

   a. In the core at full power

   b. In spent fuel storage

   c. Which is new fuel being received

6. Assume that an emergency unscheduled entrance into the reactor building is necessary. Describe what considerations (clothing, instruments, people, exposure limits) must be factored into the entry. (1.0)

T. TMI-2 INCIDENT AND SMALL BREAK CONCEPT (9.0)

1. List three objectives of the training program on the above subject which was administered to TMI and other operating B&W plant operators. (1.0)

2. Explain why the availability of steam generator feedwater and RCS pump operation have little effect in the event of a large LOCA but may have a significant effect in a small break. (1.0)

3. During the TMI-2 event, the operators had no <u>direct</u> indication of saturation conditions. What <u>indirect</u> means of determining that the condition existed were available to them. (1.0)

4. With all RCPs secured after a reactor trip, how do the TMI operators verify that natural circulation is occurring. (1.0)

5. Within the first eight minutes of the TMI-2 event the PRZ level indications went off-scale high. What was the cause of the increasing PRZ level. (0.5)

6. List four (4) objectives of the emergency core cooling system after actuation and of operator action on a loss of coolant accident. (1.5)

7. What plant indications or conditions would alert you as an operator to whether a trnasient is an overcooling situation of the RCS or a small break. (1.0)

8. A number of operating procedures contain the statement "verify emergency feedwater flow". What indications do you as an operator have with which you can verify this flow. (1.0)

9. List the major mechanical failures and errors that created or aggravated the TMI-2 incident. List minimum of four (4). (1.0)

APPENDIX C

TO

LICENSEE'S TESTIMONY OF

FRANK L. KELLY

REGARDING CLI-80-5 ISSUE (2),

ANGRY CONTENTION NO. IV, SHOLLY

CONTENTION NO. 14(b), AND AAMODT

CONTENTION NO. 2

(LICENSED OPERATOR TRAINING)

PQS Corporation

SRO Written

Examinations

PQS CORPORATION

SENIOR REACTOR OPERATOR LICENSE EXAMINATION

Facility Three Mile Island #1

Reactor Type PWR - Babcock & Wilcox

Date Administered ______

Examiner F.L. Kelly

Applicant ______

Category Value	% of Total	Applicant's Score	% of Cat. Value	
9.0	20.0	___	___	H. Reactor Theory
7.5	17.5	___	___	I. Radioactive Materials Handling Disposal and Hazards
9.0	20.9	___	___	J. Specific Operating Characteristics
8.5	19.8	___	___	K. Fuel Handling and Core Parameters
9.0	20.9	___	___	L. Administrative Procedures, Conditions and Limitations
43.0	100.0			

FINAL GRADE ______ %

H. REACTOR THEORY (9.0)

1. With the Reactor at a low power, just critical condition, a sudden reactivity addition of 0.15% ΔK/K occurs. Calculate the stable periods resulting, for both BOL and EOL. (2.0)

2. Explain the difference between: (1.0)

   a. $K_{effective}$ and K_{excess}

   b. Beta and $Beta_{effective}$

3. Assume 1000 neutrons are born from thermal fission. List, in sequence, what may happen to these neutrons. Assume a Reactor with a K_{eff} of 1.0. (1.5)

4. Define and give approximate BOC and EOC TMI unit reactor numbers for: (2.0)

   a. Resonance escape probability

   b. Neutron lifetime

   c. Minimum DNBR (typical flow channel for design transient)

   d. Redistribution

5. Explain how and why the worth of control rods can be variable throughout normal startup and operating reactor conditions. Include EOC effects in your discussion. (1.5)

6. Explain the effects of core burnup on: (1.0)

   a. Delayed neutron fraction

   b. Fuel temperature coefficient of reactivity

I. RADIOACTIVE MATERIALS HANDLING, DISPOSAL AND HAZARDS (7.5)

1. Listed below are two equations used in radiation calculations. Identify each term and give an example of when each equation might be employed. (2.0)

   a. $D = 6CE$

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

2. A fifty (50) year old worker is assigned to the maintenance crew. His accumulated radiation history is 70 Rem.

   a. According to 10CFR Part 20, can he be allowed to work in "hot" areas. Explain why or why not. (1.5)

   b. If so, under what conditions could he receive a dose of 2.5 Rem to save a piece of vital equipment. (1.0)

3. a. List the sources of Tritium in the RCS. (1.5)

   b. At BOL conditions, what is the <u>major</u> contributor of Tritium. (0.5)

4. With regard to radioactive liquids and gases, explain the term "controlled release". (0.5)

5. With regard to the Defective Fuel Detection System, certain background radiation is considered that affects the sensitivity of the detectors. Briefly describe the background contributors. (1.0)

J. SPECIFIC OPERATING CHARACTERISTICS (9.0)

1. a. Assume the plant is operating at a steady state power of 100% in manual control (completely). System demand is reduced to 80% power over a two minute period. Sketch traces (superimposed) of:

   1) Tc

   2) T_H

   3) T_{avg}

   4) ΔT

   5) Reactor power

   Show approximate magnitudes of each parameter prior to the ramp and at steady state conditions. Assume operators do nothing but observe the transient. (2.0)

   b. Explain the theory behind why the transient in (a) above behaves as you have shown it. (1.0)

2. Given a set of Xenon transient after Reactor trip curves for TMI, explain why the Xenon peak is greater and the time to reach the peak is progressively longer for each curve with trips from low power (25%) to full power. (1.0)

3. List five (5) sources of non-condensible gases which may be present in the Reactor Coolant System. (1.0)

4. pH in the TMI RCS is maintained at an alkaline level.

   a. What would be the effects of too low a pH. (0.5)

   b. What would be the effects of too high a pH. (0.5)

   c. What are the purposes of the POWDEX system. (1.0)

5. During the TMI-2 event, EFW was delayed eight (8) minutes. What effect, if any, did this situation have upon the total transient and the subsequent operator actions. (1.0)

K. FUEL HANDLING AND CORE PARAMETERS (8.5)

1. During an approach to criticality a 1/M curve may be used for guidance. Explain the theoretical basis for the 1/M plot. (1.0)

2. It is stated that reactor temperature coefficients are directly related to the water to metal ratio existing in the core. Explain why this is so. (1.0)

3. Sketch plots of thermal neutron flux along the length of a fuel rod for HZP BOL and HFP BOL conditions. If the plots differ, explain why. (1.0)

4. Complete the following Cycle 5 core physics data table: (2.0)

	BOC	EOC
• Power deficit (HZP to HFP)		
• Doppler coefficient (100% power)		
• Boron worth (HFP)		
• Moderator coefficient (HFP)		

5. Outline the TMI operating policy on radioactive liquid and gaseous discharges to the environment. (1.5)

6. During a refueling operation, the transfer canal seal plate gasket fails.

   a. What would the symptom(s) of this failure be. (1.0)

   b. As SRO in charge, what immediate actions would you direct. (1.0)

L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS (9.0)

1. a. List four (4) examples of conditions which require one (1) hour notification to the NRC. (1.0)

   b. Who is responsible for initial determination that an event is reportable. (0.5)

2. For each of the following situations, list your response as responsible shift SRO and the reasons for your actions. Include applicable Tech. Spec. time limits. (2.0)

   a. An operator reports that testing has revealed that the sprinkler system in the diesel generator room is inoperable.

   b. During a routine outage, you are requested to authorize the movement of a spent fuel shipping cask into the Unit #1 Fuel Handling Building.

   c. The Reactor has been operated at ~88% power for two and one-half hours, in the soluable poison mode. The Reactor Engineer requests power increase to 95%.

   d. Prior to an approach to criticality, at BOC conditions RCS temperature is indicating 522°F and operators proceed to go critical.

3. Explain the bases for 2 (b) and 2 (d). (1.0)

4. a. What are the four (4) emergency class identifications. (1.0)

   b. For the following events, assign the proper class identification to each. (1.0)

      I. Reactor trip with unanticipated automatic ECCS actuation.

      II. Off-site monitoring reports ≥ 100 MR/hr gamma at one (1) location.

      III. Primary to secondary leakage of 50 gpm.

      IV. Hi alarm on RML-7

      V. A DC-8 crash at the Harrisburg airport.

L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS (CONTINUED)

5. With regard to Abnormal Procedure 1203-28, "Post Accident H_2 purge":

   a. What level of H_2 in the Reactor building constitutes a need for purging. (0.5)

   b. What two (2) radioactive isotopes are analyzed in preparation for release. (0.5)

   c. If the ratio of these two isotopes is <2000 which isotope is used as controlling the purge flow rate. (0.5)

   d. For determination of actual release rate, the equation $R = (A)(F)(4.72 \times 10^2)$ is used. Define R, A, and F and their proper units. (1.0)