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

JULIEN M. CHRISTENSEN

REGARDING CLI-80-5 ISSUE (2),

ANGRY CONTENTION NO. IV, SHOLLY

CONTENTION NO. 14(b), AAMODT

CONTENTION NO. 2, AND

CEA CONTENTION NO. 13

(OPERATOR TRAINING)

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OUTLINE

The purposes and objectives of this testimony by Julien M. Christensen, an engineering psychologist and human factors specialist, are to respond to Issue (2) of Commission Order CLI-80-5, ANGRY Contention IV, Sholly Contention 14(b), Aamodt Contention 2 and CEA Contention 13 insofar as they address the adequacy of Licensee's training of its operators. Dr. Christensen, who has some 35 years of experience in his field, has participated in an independent review of Licensee's Operator Accelerated Retraining Program, has reviewed Licensee's program for use of simulator training and has participated in human factors reviews of the TMI-1 control room. Applying his experience to his knowledge of the TMI-1 operator training program, his testimony is that Met Ed has enhanced the capability of its operators through both its OARP and simulator training programs and through its application of the latest human factors techniques in reviews of the control room design. It is Dr. Christensen's opinion that the combination of comprehensive classroom and simulator training programs and human factors design techniques yields at TMI-1 an operations team with the capability to intelligently operate the plant under both normal and abnormal conditions, and with the know-how and confidence to avoid potential "mindsets" and to make appropriate decisions in potentially stressful situations.

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My name is Julien M. Christensen. I am a consultant in engineering psychology specializing in human factors design techniques, with some thirty-five years of experience in this field. I received a Ph.D. in experimental psychology from The Ohio State University in 1959, studying under Professors Paul M. Fitts and Robert J. Wherry, who were responsible, respectively, for much original work in human factors and in statistical methods and industrial psychology. The course of study was specially designed and today would be called engineering psychology since the major emphasis of the program was on people's behavior in relation to the equipment and systems that engineers design and develop.

I spent the period from 1945 to 1974 in the Human Engineering Division of the Air Force Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio, where I served as a research scientist, as a practicing human engineer who worked daily with design engineers, and as an administrator of research and development programs. During my last eighteen years there, I was the Director of the Human Engineering Division at the Aerospace Medical Research Laboratory. The programs of that Division developed during my tenure have contributed very significantly to the understanding of how to design equipment and systems so that they could be operated safely and effectively. The results of the program form a substantial part of the content of well-known and widely used human engineering source materials such as the Human

Engineering Guide to Equipment Design and MIL-STD-1472 (Human Engineering Design Criteria for Military Systems, Equipment and Facilities). The programs that I directed have also contributed directly to the safety and effectiveness of many non-Department of Defense programs. The new NUREG/CR-1580, "Human Engineering Guide to Control Room Evaluation," for example, relies heavily on these materials.

From 1974 to 1978, I served as Professor and as Chairman in the Department of Industrial Engineering and Operations Research, College of Engineering at Wayne State University. I resigned in 1978 to return to Ohio and to my current position. I am currently an adjunct Clinical Professor of Psychology at Wright State University.

I have served as a consultant to many governmental agencies and to industry on human factors problems associated with safe and effective operations. A partial list includes National Bureau of Standards, National Academy of Sciences, National Institute for Occupational Safety and Health, National Research Council, National Safety Council, U.S. Air Force, U.S. Army, U.S. Navy, National Aeronautics and Space Administration, Standard Oil of New Jersey, United Air Lines, Ford Motor Company, Burns and Roe and the GPU subsidiaries, Metropolitan Edison and GPU Service Company.

I have published extensively in the area of safety and have served on such safety-related bodies as the Board of Governors of the American Society for Safety Research and the

Editorial Board of the Journal of Safety Research. I have received numerous awards for contributions to human factors and am a Fellow in two national societies and a Diplomate in a third.

I have been requested by Metropolitan Edison Company to address the following general issue and contentions insofar as they challenge the adequacy of Met Ed's training of its operators. In particular, I have been asked for my views on the Aamodt contention which raises a concern that operators may not function well under stress and the CEA contention which questions whether mindset may adversely affect operator actions.

> CLI-80-5, ISSUE (2)
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> 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).
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> ANGRY CONTENTION NO. IV
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> The Licensee lacks the management capability to operate a Nuclear Generating Station without endangering the public health and safety.
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> SHOLLY CONTENTION NO. 14(b)
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> 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:
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> . . .
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> (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.

CEA CONTENTION NO. 13

CEA contends that there is a specific need for the establishment of training for operators that addresses the problem of a 'mindset' that denies information indicative of serious reactor problems. In support of this contention, CEA submits that such a mindset contributed to the gravity of the 3/28/79 accident, as reported in NUREG-0600, and that the routine occurrence of abnormal transients will tend to condition operators to a mindset that underestimates the significance of (sequences of) abnormal transients. CEA contends that specific training provisions designed to address this 'mindset' problem are necessary prior to the re-start of TMI-1 in order to prevent the development or presence of such a mindset among TMI-1 operators from contributing to a serious accident at TMI-1.

At the outset I should make clear the degree of my involvement with Met Ed and TMI-1. Initially I was contacted in October 1979, and asked to serve on a committee, chaired by Dr. Robert Uhrig, which was constituted for the purpose of reviewing Met Ed's Operator Accelerated Retraining Program (OARP). I was one of five members and was given specific responsibility for the areas of "Man-Machine Interaction" (human factors engineering) and "Use of Simulators in Operating

Training." A very thorough review was made of Met Ed training programs and facilities, and numerous conferences were held with Met Ed operators, training personnel, and administrative and managerial personnel. Exhaustive discussions were held within the Committee and, as required, appropriate Met Ed people were asked to sit with the Committee to provide information and answer questions.

The general mode followed in the evaluation by the Committee was based on that of the Accreditation Board for Engineering and Technology (formerly the Engineers Council for Professional Development (ECPD)). This model requires that the agency or institution being evaluated conduct a rigorous self-examination, based on detailed requirements established by the Committee. It is the procedure that the departments of engineering in colleges and universities are required to follow when they apply for accreditation. It is thorough; it is objective, and has been shown to yield reliable, valid evaluations of engineering training programs. In my view, it was highly successful in this application at TMI because it brought together and coordinated the efforts of the Met Ed educators and a committee of outside experts to conduct a critical self-examination.

In addition to my involvement with the Uhrig Committee, I have served, along with Professor Sheridan of MIT, as a human factors advisor for the GPU Services Company to MPR Associates,

Inc. MPR is the Washington-based firm of engineers that GPUSC has retained to evaluate the TMI-1 control room and develop a plan for bringing it up to date in terms of operability and maintainability. With that as background, I will now turn to the areas on which I have been asked to comment.

Consideration of man-machine relationships reveals that human factors engineering and training both have significant contributions to make to assure that the man-machine interactions are safe and effective. The two complement one another. Thus, to a degree at least, one can compensate for shortcomings in design (which implies insufficient human factors engineering) by giving extra training, including training in making unnatural or difficult assessments and responses.

In a similar fashion, one can greatly ease the burden on the training program by providing properly human-engineered displays and controls and consoles laid out so as to facilitate correct perceptions, valid decisions and error-free implementation of those decisions. Trade-offs between human engineering and training are obviously possible, although precise formulas for making such trade-offs await development. These are still "judgment calls," to borrow a term from the sports arena.

At TMI-1 the task has been attacked from both of the above points of view. On the training side, the OARP program is a positive response that, in the judgment of the training experts

of the Uhrig Committee, will add significantly to the capabilities of the operators. I have examined the revised simulator program and believe that it will add substantially to the effectiveness of the training program. The simulator program has been broadened not only to facilitate initial learning but also to help assure that skills, once learned, do not deteriorate and that unusual circumstances are recognized and dealt with properly. The revision and additional development of the simulator part of the training curriculum should significantly enrich the program and serve as a source of positive motivation to the operators.

In addition to the simulator program changes already in place, GPUSC is engaged in research and development of computer-centered training programs. These reactive programs are presented on CRT's and offer an interesting, informative and stimulating challenge to the operators. The materials that can be displayed on these training devices is restricted only by the imaginations of those who develop the programs. The technique is extremely flexible and offers the possibility of almost immediately developing and offering training as a result of such inputs as "lessons learned." It greatly enhances the responsiveness of the training program. This approach, in my opinion, represents receptiveness to new ideas and a capability among the training and education personnel of GPUSC that assures a bright future for Met Ed training programs.

With respect to the other side of the coin (human factors engineering), GPUSC has contracted with MPR to perform a detailed analysis of the TMI-1 control room from the operators' point of view. As mentioned previously, GPUSC has retained Professor Sheridan of MIT and me to serve as human factors advisors to MPR. I have been extremely impressed with the capabilities of the MPR engineering personnel, including their complete willingness to employ appropriate human factors procedures in the evaluation of the control room. In addition to analysis of the detailed design features of controls, dials, annunciators, graphic records, panel layout and integration, workplace layout and environmental conditions, MPR has conducted numerous "walk-throughs" in which teams of operators have addressed a full-scale mock-up of the TMI-1 control room and been asked to implement the procedures that they would follow to handle selected critical events.

Thus, Met Ed has attacked the problem vigorously and with imagination, clearly recognizing the intimate interaction that exists between human factors engineering, and training. The result of this dual consideration should have a very positive effect on operator capability and should help assure an operation that is both safe and effective. I say this mindful of the concerns raised by the contentions that stress or "mindset" could detract from appropriate response by well-trained operators.

By stress, I mean the reaction to stressors. Stress can be induced by such environmental stressors as heat, vibration, poor lighting, etc., by work overload (or, also some would say, by work underload), by unexpected events, by harrassment of supervisory personnel, and by numerous other factors. There is no practical way that all stressors can be eliminated from this or any meaningful job and even if they could, it would not be desirable. Most active, well-trained individuals react positively to a modest amount of certain types of stress; it represents a challenge and it can actually be facilitative.

There is no conceivable way that nuclear power plant operators can be exposed to each stressor and conceivable combinations thereof (stressors usually come in groups, not individually). However, this does not mean that qualified operators cannot handle stressful situations. In fact, because of their training, ingenuity and so on, human operators are great assets in times of emergency. However, their adequate response to emergencies depends upon several factors.

First, the operator must be adequately trained with respect to fundamental knowledge and basic skills and must be given regular refreshment in those fundamentals and skills. The OARP classroom program and the simulator program were directly relevant and provided the necessary training in these areas.

Second, while no operator can conceivably be exposed to every possible emergency situation, it helps to expose each to

a wide variety of such situations. The expertise and confidence engendered by such training will transfer positively to unforeseen conditions. The TMI-1 operators' simulator program is designed to develop these sorts of capabilities and attitudes.

Third, in order for an operator to respond adequately under stressful conditions, it is important that he be kept aware not only of the current state of affairs but also of preceding events -- be "on top of the situation," so to speak. This is one of the chief difficulties with systems that are virtually completely automatic because, when something does go wrong in an automated system, the operator has insufficient information regarding the etiology of the event to handle it effectively. A review of the TMI-1 control room showed that information required to initiate operation of the automated systems is displayed for use by the operators. With this information the operators are able to keep up with developing situations. Operator response may be required and is readily accomplished if the automatic systems malfunction or if supplemental manual actions are required. While there are few guidelines as to the exact balance between automatic and manual functions that is best for a given situation, a combination of automatic and manual is generally preferable.

Fourth, stress can be induced in the members of a team who are not accustomed to working with one another. Questions

arise regarding division of responsibilities, competence, etc. Met Ed makes a conscious effort to keep the same operators as members of each team. I favor this management decision.

Fifth, environmental factors such as excessive temperature, noise, poor lighting, etc. can serve as stressors. MPR, with the help of Dr. Sheridan and myself, has made a survey of such factors for TMI-1. We are developing a plan for designing a working environment that will minimize the effects of physical stressors.

Finally, Met Ed has provided its operational staff special training in decision-making under conditions of uncertainty. I have reviewed the nature of that course given for Met Ed by the Management Analysis Company of San Diego, California. The program gave instruction in the scoping of problems and the structuring of decision trees. This training should be a valuable adjunct to operators' technical training in that it will provide a model that can be followed to deal especially with those stress-inducing events that the operator has not previously encountered. It should help prevent operators from developing inflexible "mind sets" and help them to maintain an open, searching, contemplative, rational attitude when dealing with unforeseen events. Met Ed plans to continue training and retraining of its operating staff in decision-making analysis.

In sum, I have been impressed by the various actions that the managements of GPUSC and Met Ed have taken to assure that TMI-1 will be operated safely. It is my judgment that these

actions will achieve their objective. In reaching my opinion, I take into account a number of actions which I have observed and/or participated in:

1. An Operator Accelerated Retraining Program (OARP) has been developed and instituted. This program includes significant improvements in the simulator sub-program. It has had an impact on all current operators and will significantly affect the structure of the training programs for future operators.
2. An outstanding engineering firm, MPR Associates, has been retained to develop a program for modifying and updating the design and layout of the TMI-1 control room, including attention to environmental parameters.
3. A company, expert in the scoping and structuring of operational problems, has provided operators and other personnel special training in decision-making.
4. Licensee's training personnel have familiarized themselves with the latest techniques with respect to part-task trainers and computer-based reactive pedagogical techniques and are developing programs to further enhance the expertise of Met Ed operators.
5. Finally, while I am unfamiliar with pre-TMI-2 accident conditions at GPUSC and Met Ed, there appears to be a general attitude of enthusiasm and

dedication to the task at hand that is infectious and, if maintained, should do much to assure that TMI-1 will be operated in a safe, efficient manner.