



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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Mr. Scott Halverson
Chairman, Utility Simulator Users Group
Calloway Nuclear Plant
P. O. Box 149
St. Louis, MO 63166

Dear Mr. Halverson:

Thank you for agreeing to act as the Utility Simulator Users Group contact for the enclosed survey on current practices in operator training with simulators. Please disseminate the survey as you feel appropriate and return any responses to me no later than February 15, 1996. If you have any questions regarding this survey please feel free to contact me at 301-415-1073.

Thank you, in advance, for your cooperation.

Sincerely,

A handwritten signature in cursive script that reads "MABiamonte".

Mary Ann M. Biamonte, Training
and Assessment Specialist
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CSNI / PRINCIPAL WORKING GROUP N° 1
EXPANDED TASK FORCE ON HUMAN FACTORS

SURVEY ON CURRENT PRACTICES
IN OPERATOR TRAINING WITH SIMULATORS

INSTRUCTIONS

DEFINITIONS

QUESTIONNAIRE

September, 1995

INSTRUCTIONS

This questionnaire has been developed by the Expanded Task Force on Human Factors (ETF-HF) of the Principal Working Group n° 1 (PWG-1), which depends on the Committee on the Safety of Nuclear Installations (CSNI).

The survey is part of the Task n° 5: "Role of simulators in Operator training" which is developing the ETF-HF.

The goal of the survey is to identify the role of simulators in the Operator training programs from a human factors point of view (human engineering, organization and management, communications, etc.) for the various OECD countries. The intent is to collect this information by means of the description of techniques and criteria used for establishing and evaluating that role, with emphasis on those issues potentially more difficult or not completely solved yet and which have not been covered completely by previous Nuclear Energy Agency (NEA) studies.

The survey is divided into five sections:

The first section is an introduction for obtaining a general view of the availability and main characteristics of simulation facilities in every country and their relation with the operating nuclear power plants. In other words, a context for a better understanding of the answers to the subsequent sections.

The second section intends to gather information on the currently more frequent applications of training simulators.

The third section is devoted to the design of the six phases of a Systematic Approach to Training from the point of view of the use of simulators.

The fourth section is focused exclusively on the use of operating experience in Operator training with simulators.

Finally, the fifth section solicits insights related to different aspects of the Operator training with simulators which could be considered more difficult or not completely solved yet.

In conclusion, the first section solicits objective data on simulators in each country. The other four sections are oriented toward nuclear industry experience in the use of simulators for Operator training, with some questions related to the Regulatory Body requirements in this area. These last four sections could be treated in a more limited context (a specific Organization, Training Centre, etc) depending on the characteristics of each country.

So, taking into account the above paragraph, it would be desirable (also depending on the characteristics of each country) that these questions were answered by both regulatory and industry representatives as appropriate, by preparing a single response from each country. Notwithstanding, if several Training Centres of the same country want to complete the questionnaire, then please, provide separate responses for each one.

Please, answer all the questions in each section of the survey. If some questions do not apply to your country, please indicate that it does not apply on the survey form.

Annexed you can find a glossary of terms used throughout the questionnaire. The definitions are based, mainly, on the terminology used in the following reports:

* CSNI Report n° 128/Task force related to HF n° 5: "Approaches to training programmes in NEA member countries" (1986).

* IAEA/TECDOC-525: "Guidebook on training to establish and maintain the qualification and competence of NPP operations personnel" (1989).

Finally, realising that to answer to this questionnaire is a high time consuming and not easy task, we want to thank, in advance, your effort in completing it.

DEFINITIONS

Operator: In the context of the questionnaire, Operator means any Member of the Control Room Shift Team (Reactor Operator, Shift Supervisor, etc.).

Full-scope training simulators: A full-scope simulator represents in real time the most range of operations which can be performed from the main control room. It consists of a control room which simulates the nuclear steam supply system and the balance of plant systems, including all major nuclear, conventional, service and safety systems.

Replica training simulators (or Plant-specific simulators): Replica simulators are those full-scope simulators based on a reference plant, which incorporate detailed models of the reference plant and its systems, including a replica of the control room design. These simulators respond as the plant would to normal and off-normal conditions in real time.

Part-task simulators: A part task simulator is designed for training on a specific part of plant operations or for training in special phenomena. Specific systems and phenomena may be simulated more accurately than in a full-scope simulator and they are used to provide training in a particular Control Room activity, usually including replica controls and instruments.

The system activities to be simulated are usually chosen based on the need of frequent retraining in very important or difficult tasks.

Basic principles simulators (or Compact simulators): Basic principles simulators are used to provide plant system overview training with less detail than a full-scope simulation.

The plant system model is usually generic and somewhat simplified and the emphasis is on training to understand plant dynamics.

Simulation scope may be limited to major systems, components and functions or may be essentially the complete plant. The control room or panels very often have a fundamentally different design

in comparison with conventional control room design; keyboards are used to enter some control actions and CRT's are used to display much of the simulated plant responses.

Concept simulators: Concept simulators are used to train in particularly difficult concepts by isolating them from other considerations, being specially useful in reinforcing theoretical training in concepts. For the purpose of this training neither replica controls and instruments nor real time response is needed.

Special-purpose simulators: Several types of special-purpose simulators are in use, most notably thermohydraulic simulators (glass model). This simulator is used primarily to demonstrate basic thermohydraulic principles and plant phenomena. There is also a combination of simulation and expert system to maintain the skills of its control room staff in the SGTR event, where the trainee interfaces the package through keyboard and screens.

IGD (Interactive Graphic Simulator): Is a computer system that allows the behaviour of a given industrial process to be reproduced, providing the capacity for real time display and interaction with the systems and components involved via graphic interface.

The main objective of the system is to serve as a powerful and flexible didactic medium for the acquisition of concepts related to the operation of the different systems, providing a high capacity for the analysis and diagnosis of the associated-phenomena.

On-site Simulation Facility: In this questionnaire, a Simulation Facility is considered on-site when it is located close to the plant site (not necessarily inside the security fence), in such way that Operators' daily life outside the plant does not result disturbed during training days.

Off-site Simulation Facility: In this questionnaire, a Simulation Facility is considered off-site when it is located far from the plant site, in such way that Operators need to make special arrangements (trip, accommodation, ...) for attending training sessions.

Systematic Approach to Training: A logical progression from the identification of the competencies required to perform a job to the development and implementation of training to achieve these competencies, and subsequent evaluation of this training.

Systematic Approach to Training, Training Analysis: The gathering of information necessary to design the entire training program. This consists of a needs analysis which looks at the tasks being done, the people doing them, and the organizational context in which the job takes place.

Systematic Approach to Training, Training Program Design: When training programs reach the design stage, measures of job performance are established and learning objectives are designed based on the tasks selected for training. The training settings are selected and, at this stage, tests are usually chosen based on the learning objectives.

Systematic Approach to Training, Training Program Development: The activities of both instructors and trainees are defined during the development stage of training programs. In addition, the most appropriate method/s are chosen for instruction. Training materials are selected and/or developed. The technical content of each part of the training program is reviewed by an appropriate subject matter expert. The training program is validated by trying it out on a group of trainees. Revisions are made as necessary.

Systematic Approach to Training, Training Program Implementation: Implementation involves instructors' training, trainees' selection and training delivering.

Systematic Approach to Training, Trainee Assessment: Evaluation of the trainees during the whole training period.

Systematic Approach to Training, Training Program Evaluation: Evaluation is a continuous monitoring tool throughout the entire training process. It is used to measure, control, and improve the training program. Evaluation can also be considered a final step of review, specially when a new or improved training program has been implemented. Evaluation provides information about training program areas that need improvement.

Skill: The ability to perform a job-related activity that contributes to the effective performance of a task.

Knowledge: Understanding of facts, principles, or concepts. Knowledge includes cognitive (mental) processes necessary for applying information.

Needs Analysis: A process of identifying potential or existing training needs by examining gaps between performance requirements and existing performance.

Job Analysis: The analysis process used to determine the duty areas and tasks comprising a particular job. The results are typically presented as task inventories together with associated data describing task performance (e.g. frequency of task performance, importance) and the job position.

Performance Standards: The measurable requirements for personnel performance.

Training Setting: The environment in which training is conducted and learning occurs, such as classroom, laboratory, workshop, on-the-job training, simulator.

Learning Objective: A statement that specifies measurable behaviour that a trainee should exhibit after instruction. This statement includes the conditions and standards for performance.

Job Performance Measure: Tests used to evaluate a trainee's proficiency on a specific job task.

Training Method: The method by which a trainee is provided with the means and the opportunity for achieving learning objectives, e.g. lectures, demonstrations/practices with models and mock ups, discussions, walk-throughs, self-study.

Training Materials: Written materials, audiovisual media, models and mock ups, etc.

Lesson Plan: A document that presents an overview of the purpose and an outline of the instruction covered in a lesson, including such items as the learning objectives, training methods and materials, trainee activities, and resources.

Severe Accidents: Core damage accidents.

QUESTIONNAIRE

Questionnaire sections

0. Organization/s replying to the questionnaire
1. General Information (related to the whole Country).
2. Current practices with simulators closely related to operator training.
3. Systematic Approach to Training: considerations regarding the use of simulators.
 - a) Training analysis.
 - b) Training program design.
 - c) Training program development.
 - d) Training program implementation.
 - e) Trainees assessment.
 - f) Training program evaluation.
4. Use of operating experience for operator training with simulators.
5. Specific topics on operator training with simulators.
 - a) Team training techniques.
 - b) Training for stress.
 - c) The theoretical basis underlying training.
 - d) Habits acquired during training sessions with simulators.
 - e) Simulator training on normal and emergency conditions during shutdown and low power operation.
 - f) Simulator training on severe accidents.
 - g) Simulator training on accidents caused by fires, floods, earthquakes, etc.

QUESTIONNAIRE

SECTION 0: Organization/s replying to the questionnaire

1. Name of Organization/s
2. Contact Person/s
3. Address and contact information (telephone, fax)

QUESTIONNAIRE

SECTION 1: General Information (related to the whole Country).

1. Number of nuclear reactors (Units) in operation.
2. Number of Sites with at least one Unit in operation.
3. Number of full-scope (replica and no replica) simulators used for operator training.
4. Number of replica simulators used for operator training.
5. Number of part-task simulators used for operator training.
6. Number of basic principles simulators used for operator training.
7. Number of concept simulators used for operator training.
8. Number of special-purpose simulators used for operator training.
9. For how many Units is the training done on replica training simulators?
10. For how many Units is the training done on full-scope (replica and no replica) training simulators?

QUESTIONNAIRE

IMPORTANT QUESTION

Are your answers to the subsequent sections (2 to 5) of the questionnaire related to a specific Organization or Training Centre in your Country?

Yes ___ No ___ (Mark with X your answer)

If yes, indicate the name of the Organization or Training Centre and describe briefly the simulation facility referred to in answer to the questions below (f.i. located on-site or off-site, type of simulator/s, sample photograph, reference NPP/s, NPP/s which receive training in this facility, size and composition of the simulator instructional and support staff, etc.) and, also, describe this/these NPP/s (f.i. type (PWR, BWR,..), vendor, start of operation, degree of automation, Operators which constitute the Control Room Shift Team, sample photograph of the control room/s, etc.).

QUESTIONNAIRE

SECTION 2: Current practices with simulators closely related to operator training.

1. Based on your experience, describe advantages and disadvantages of the location of the Simulation Centre with regard to the plant: on-site versus off-site. Specifically, describe those factors which have some influence on the Operators' attitude towards the simulator training and in the quality of the simulator training.

2. a) During simulator training sessions, what factors (time, communications, etc.) influencing the interactions between Control Room Operators and other Plant Personnel (Operations Department outside of Control Room Personnel, Maintenance or Instrumentation and Control Departments, Technical Support Centre, etc.) are simulated?

b) Do these other Plant Personnel participate in the training sessions?

Describe the present training format pertaining to involvement of non Control Room Personnel in simulator training sessions and explain why this format is used.

3. What environmental conditions (normal and emergency lighting, humidity, noise, vibrations, sounds generated by equipments, etc.) that could be experienced by the reference plants, are usually simulated in the Simulator Rooms?

Describe the use of such effects at your simulator centre and explain why they are, or are not, incorporated into simulator training sessions.

QUESTIONNAIRE

SECTION 2: Current practices with simulators closely related to operator training.

4. Do Control Room Operators receive simulator training for operations outside the Control Room, for example: operations from Remote Shutdown Panels?

Describe this type of training as it exists at your Simulator Centre and explain why it is, or is not, used in training sessions.

5. a) How frequently are the changes taking place in plant (plant design changes, procedures changes, etc.) incorporated to the replica or full-scope simulator?

Describe any process or mechanism in place at your Simulator Centre to incorporate changes to the replica or full-scope simulator.

- b) Do simulator model modifications require separate approval while the simulator is being used for training?

6. a) Identify the members of the Control Room Shift Team (Reactor Operators, Turbine Operators, Shift Supervisors, etc.) and indicate the time (in hours) dedicated to simulator training by each member in their initial training program.

Specify, when applicable, the time spent with each type of simulator.

- b) Indicate the time (in hours) dedicated to simulator training by each member of the Control Room Shift Team in their continuous training program.

Specify, when applicable, the time spent with each type of simulator.

- c) What is the minimum time, if any, required by the Regulatory Body?

QUESTIONNAIRE

SECTION 2: Current practices with simulators closely related to operator training.

7. a) Indicate the percentage of simulator training time by the different Members of the Control Room Shift Team devoted to i) normal, ii) abnormal and iii) emergency conditions in their initial training program.
- b) Indicate the percentage of simulator training time by the different Members of the Control Room Shift Team devoted to i) normal, ii) abnormal and iii) emergency conditions in their continuous training program.
- c) What are the minimum percentages, if any, required by the Regulatory Body?
8. What is the role and the policy of the Regulatory Body regarding the use of simulators for Control Room Operators licensing and training?
9. a) What standards (ANSI/ANS 3.5, IAEA, etc.) are simulators built to and maintained?
- b) What exceptions are typically taken to the standard?
- c) What types of simulators are used that are not included in industry standards?
10. a) Describe the role of part-task simulators in your current training programs.
- b) Describe the role of special-purpose (analytic) simulators in your current training programs.

QUESTIONNAIRE

SECTION 2: Current practices with simulators closely related to operator training.

11. Have the current operator training programs been conditioned by the availability and capabilities of the simulator(s) or, alternatively, has(ve) the simulator(s) been specified and acquired after analyzing and designing the training programs?

Explain.

12. What extensions of simulator training are envisaged for the future?
13. a) Based on your experience, describe the uses of the simulators for activities other than training (plant drills, procedures validation, design changes validation, testing programs, acquisition of human data, licensing activities, reference plant systems "tuning", etc.).
- b) What is the involvement of Control Room Operators for those applications?
14. What are the applications of simulator training for jobs other than Operations?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

a) Training analysis.

1. Are job and task analysis (or any other type of task identification technique) used for establishing a list of task, performance standards, learning objectives and training methods?

If yes, describe the technique used.

2. a) What are the criteria that determine the limits or scope of the job analysis for the Control Room Operators?.

b) From your point of view, what should the role of risk-based criteria be for determining such limits or scope? Explain your answers.

3. Are there any special requirements for Job and Task Analysis which are imposed by the possibility of associated simulator training?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

b) Training program design.

1. What are the criteria for specifying simulator training rather than another training setting (classroom, laboratory, workshop, on-the-job, etc.)?

2. What are the criteria for selecting different types of simulator (full-scope, replica, part-task, basic principles, concept, special-purpose)?

3. a) What are the criteria for selecting a replica simulator?
b) What are the fidelity requirements?

4. What are the specific pre-requisites for operators undertaking simulator training?

5. Does the possibility of simulator training impose any constraints on the definition of learning objectives?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

c) Training program development.

1. In the case of non-replica simulators, is it necessary to take parallel training actions, and if so, what kind?

Explain your answer.

2. Do you use specific procedures for the training simulator, actual plant procedures or a combination of both?

Explain your answer and give reasons for the choice.

3. What are the criteria for selecting normal, abnormal and emergency scenarios to be trained with simulators? Are they risk-based criteria?

Explain your answer.

4. How are lesson plans and support documentation developed for simulator training?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

d) Training program implementation.

1. What selection, initial training, and continuing training is arranged for simulator instructors?
2. What are the arrangements for instructor monitoring of, and feedback to, trainees during simulator sessions?
3. a) What specific training modes such as simulator freeze, playback, running at higher speed than real time, activity recording, video recording, etc. is made use of during initial training?
b) What specific training modes such as simulator freeze, playback, running at higher speed than real time, activity recording, video recording, etc. is made use of during continuous training?
4. What limits of simulation impede planned training sessions or examination scenarios?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

e) Trainee assessment.

1. a) What methods and procedures are used for initial trainee assessment during and after simulator sessions?
- b) What methods and procedures are used for continuous trainee assessment during and after simulator sessions?

2. List and describe the main areas or groups of skills and knowledge of the trainee assessed in training simulators (for example: "control board awareness, event diagnosis, immediate actions /entry-level actions, subsequent actions, control board manipulations, use of procedures/technical specifications/reference data, communications, supervisory ability, team skills" (IAEA-TECDOC-525)).

Identify, when applicable, the types of simulator used for assessing each one.

3. Describe the ranking of importance, if any, given to the main areas or groups of skills and knowledge taken into account for a trainee assessment.
4. a) Based on your experience, describe difficulties you have had for assessing the individual skills and knowledge of a trainee while operating within a whole Control Room Shift Team during simulator sessions.
- b) Describe the measures adopted to overcome these difficulties.

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

e) Trainee assessment.

5. a) Based on your experience, describe influences on trainees performance during simulator sessions resulting from the attendance of personnel such as utility managers, regulatory body inspectors, etc.

b) Based on your experience, describe current practices and influences on trainees performance resulting from the instructors involvement in training sessions (location in the Simulator Room, communications with trainees, participation, ...).

6. a) Are training simulator examinations used in order to grant initial license to operators?

Explain.

b) Are training simulator examinations used for requalification?

Explain.

7. How is examination integrity preserved during the examination/scenario preparation period?

8. What performance monitoring or data acquisition features of the simulator are used during simulator examinations?

QUESTIONNAIRE

SECTION 3: Systematic Approach to Training: considerations regarding the use of simulators.

f) Training program evaluation.

1. Describe the approach used for evaluating the simulator training program and main results.
2. What program is in place for validation and continuous verification of the simulator performance?
3. What types of performance discrepancies are most frequently identified by operators during training sessions?
4. What types of performance discrepancies are most frequently identified by examiners or inspectors?

QUESTIONNAIRE

SECTION 4: Use of operating experience for operator training with simulators.

1. How is operational experience feedback incorporated into the design of simulator training programs (experience reviewed, schedule, people involved)?

2. Has your organization developed any kind of program by which simulator operator training is correlated with real operating events?.

Explain.

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

a) Team training techniques.

1. a) Are job and task analyses used for defining the role and responsibilities of the Members of the Control Room Shift Teams and, in general, of the various levels of staff who are charged with operation of the plant? Explain your answer.

b) Are job and task analyses used for establishing performance standards, learning objectives and training methods for Team skills training?

Explain your answer.

2. List and describe Team skills (communication, management of resources, team cooperation, team leadership, feedback, conflict resolution, team decision-making, etc.) which are trained using simulators. Identify, when applicable, the types of simulator used for training each one.

3. Are any guides used for conducting and evaluating Team skills training simulations?

Explain your answer.

4. Based on your experience, describe advantages and disadvantages of Team training with the participation of the same (usual) Members every time or with changes in the Shift Team compositions.

5. Are simulator sessions used for the optimization of Control Room Team Shifts taking into account the characteristics (aptitudes, attitudes, ...) of each Operator? In other words, are simulator sessions used for deciding which Members are going to constitute each Shift Team?

Explain your answer.

6. Are there any licensing examinations applied to the whole Control Room Shift Team in addition to the individual licensing examinations?

Explain.

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

b) Training for stress.

1. Is any part of the simulator training programme specifically devoted to train Control Room Operators to operate under stress?

Explain your answer.

2. Are stress levels induced and measured during simulator training sessions?

If yes, describe the methods and results.

3. Based on your experience describe any measures adopted during simulator training to counter stress.

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

c) The theoretical basis underlying training.

1. Are any models of human behaviour being used in designing and implementing training programs?

If yes:

- i) refer to or describe the models,
- ii) indicate the areas in which these models are being applied (for example: signal detections, decision-making, etc.),
- iii) give the main results.

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

d) Habits acquired during training sessions with simulators.

1. Describe, based on your experience, undesirable habits which could be acquired by trainees during training sessions with simulators (for example: due to limited number of simulated scenarios, due to lack of physical or functional fidelity, due to the use of conservative codes for simulation instead of best estimate codes, etc.) and discuss their potential consequences on safety.

2. Describe, based on your experience, any measures adopted to avoid acquisition of those undesirable habits or to prevent use of them.

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

e) Simulator training on normal and emergency conditions during shutdown and low power operation.

1. What use is made of simulators for Control Room Operator training in normal, abnormal and emergency conditions during shutdown and low power operation (simulated scenarios, trained skills, training techniques, ...)?

2. What are the criteria (risk-based criteria, deterministic criteria, results of need analyses, simulation availability, etc...) supporting the above mentioned use of simulators?

3. Are job and task analysis (or any other type of task identification technique) used for establishing a list of task, performance standards, learning objectives and training methods on shutdown and low power operation?

Explain.

4. What are your plans for the future in this area?

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

f) Simulator training on severe accidents.

1. What use is made of simulators for Control Room Operator training in severe accidents (simulated scenarios, trained skills, training techniques, ...)?

2. What are the criteria (risk-based criteria, deterministic criteria, result of need analyses, simulation availability, etc...) supporting the above mentioned use of simulators?

3. Are job and task analysis (or any other type of task identification technique) used for establishing a list of task, performance standards, learning objectives and training methods on severe accidents?

Explain.

4. What are your plans for the future in this area?

QUESTIONNAIRE

SECTION 5: Specific topics on Operator training with simulators.

- g) Simulator training on accidents caused by fires, floods, earthquakes, etc.
1. What use is made of simulators for Control Room Operator training in accidents caused by fires, floods, earthquakes, etc. (simulated scenarios, trained skills, training techniques, ...)?
 2. What are the criteria (risk-based criteria, deterministic criteria, result of need analyses, simulation availability, etc...) supporting the above mentioned use of simulators?
 3. Are job and task analysis (or any other type of task identification technique) used for establishing a list of task, performance standards, learning objectives and training methods on accidents caused by fires, floods, earthquakes, etc.?

Explain.

4. What are your plans for the future in this area?