Evaluation of Training Programs: A Pragmatic Perspective

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Abstract

The Canadian nuclear regulatory agency endorses the Systematic Approach to Training (SAT) as the most reliable method of providing effective, efficient training to Nuclear Power Plant (NPP) personnel. However the benefits of SAT cannot be realized unless all five phases of SAT are implemented. This is particularly true with respect to evaluation. Although each phase of SAT builds on the preceding one, the evaluation phase continuously feeds back into each of the others and also provides the means to verify the entire training programme building process. It is useful, therefore, to examine the issues relating to the what, why, who, when and how of training programme evaluation.

"What" identifies the various aspects of the training programme to be evaluated, including the need for training, the training standard, the task list, trainer competence, test results, training results, program acceptance and numerous indicators that identify a need for evaluation. "Why" addresses legal and regulatory aspects, resource management, worker and public safety, worker and trainer competence and morale, and the cost/benefit of the training program. "Who" examines the need to involve trainers, trainees, plant subject matter experts (SMEs), and both plant and training centre supervisory and management staff. "When" addresses time-related concerns such as the importance of ensuring at the outset that the training program is actually needed, the necessity of responding promptly to local, national and world events, changes in legal and regulatory responsibilities, and the overriding importance of timely, routine training program evaluations. "How" describes the process of conducting a training program evaluation, and addresses the relationships of these five aspects of evaluation to each other.

The Benefits of Continuous Training Program Evaluation

The primary purpose of this paper is to emphasize the benefits of continuous training program evaluation by examining and discussing the evaluation elements shown in Table 1. It is evaluation that determines whether or not the resources committed to training have been used wisely and have produced the desired results at acceptable cost. Evaluation is the mortar that holds the bricks of the training program together and facilitates building them into a coherent, auditable and useful training program. Therefore training program evaluation should start with the first indication of a perceived training need and should continue for as long as the training program is in use. An understanding of these benefits will encourage plant management to "buy in", to accept ownership of training, and to provide the high quality training leadership required to help assure plant and public safety.

Job Performance Discrepancies

Job performance discrepancies may be identified by technical or safety problems, pro-active requests for training from the plant, peer audits, or by input from the regulator to plant management. When a job performance discrepancy is identified it is essential to verify that the problem is not due to other causes before accepting the need for training.[1]

At least six other factors, including personal capacity, working conditions, results measurement, motivation, work standards and feedback to workers will affect on-the-job performance. Each of these must be evaluated and discarded before accepting that a performance discrepancy is due to a worker skills or knowledge deficiency and can therefore be resolved through training. This can be accomplished best by plant management and staff working in consultation with training centre personnel to perform a root cause analysis that will establish what the discrepancy is, why it is important and whether it is due to a knowledge and skills deficiency or some other factor. At this point many other variables should also be closely examined, including such things as: is there a simpler solution, is the skill used often, would a job aid suffice, could the workers do this task in the past, and is this an attitude problem.

The primary reason for performing this up-front training needs analysis is to exercise due diligence, ie to ensure that safety concerns will be adequately addressed, that worker competence will be assured and that regulator requirements will be met. These concerns may arise through input from the regulator or any other governmental body, or from the regulations relating to the operation and licensing of the plant. Wise resource management also demands this evaluation to prevent wasting resources on unnecessary training, to avoid the negative effects that unneeded training may have on worker morale, and to ensure that necessary training is accomplished. Finally good business practice requires a positive cost-benefit result from all activities.

The Training Standard

A viable training standard which is appropriate to the utility is a prerequisite to establishing any successful training program.[2] [3] As a minimum, a training standard should address the following:

1. Training programs are effectively organized, directed and supported.
2. Training staff possess the necessary subject matter expertise, experience and instructional skills to discharge their assigned duties.
3. A job analysis determines the job performance requirements and serves as the basis for the development of learning objective and Job Performance Measures (JPMs).
4. Training sessions and training materials consistently convey the knowledge and skills needed to meet the learning objectives.

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[1]Robert F. Mager and Peter Pipe, **Analyzing Performance Problems or You Really Oughta Wanna,** 2nd edition,1984, Lake Publishing Company, Belmont, California, USA.

[2]R. Droll and J.D. Wilkinson, **Regulatory Evaluation of Utility Training Programs: The Need For a Standard**, June, 1994, Canadian Nuclear Society 15th annual conference proceedings, Montreal, Quebec, Canada.

[3]J.D. Wilkinson, **A Systematic Approach to Training in the Nuclear Power Industry: The Need for a Standard**, April, 1995, Instrument Society Of America International Conference, 50th Anniversary, Toronto, Ontario, Canada.

5. Training delivery employs principles of good instructional presentation to consistently and clearly convey accurate and current information.
6. Trainees are evaluated regularly and fairly on their mastery of the learning objectives and receive prompt feedback on their performance.
7. A systematic method is used to evaluate and revise training programs so that on-the-job competency is attained and maintained.

The training standard must be reviewed periodically against the needs of the utility and by comparing it to other training standards such as those published by the International Atomic Energy Agency (IAEA)[4], the Institute of Nuclear Power Operations (INPO)[5], the United States Department of Energy[6], and the U.S. Nuclear Regulatory Commission[7]. The responsibility for completing this evaluation should be shared by training department specialists and plant supervision and should accommodate input from trainers, trainees, management, peer audits and external agencies such as WANO and the regulator. The purpose of evaluating the utility training standard is to help ensure that the training needs of the utility and the requirements of the regulator and/or the accreditation body can be adequately addressed. A high quality training standard helps ensure the adequate, appropriate training required to produce competent workers at acceptable cost.

The Use of SAT

The five phase SAT process is a logical, repeatable, and pragmatic approach to training which facilitates developing the high quality training required to meet the need for competent staff. It can be used to address both initial and continuing training. Since the full benefits of SAT cannot be realized unless all five phases of SAT are implemented it is important to evaluate the training program continuously, from initial analysis through design, development and pilot presentations, to full implementation following a reliable SAT model[8]. An annual evaluation of the implementation of SAT is desirable if the program is in continuous use.

This evaluation of the use of SAT may be done jointly by plant and training department staff, or by external agencies, but in any case it is essential to verify that each phase has been fully executed. For the analysis phase this means verifying that the original analysis is still valid, or conversely, that operational experience and/or changes to the job or equipment have made some training redundant and/or new training essential. Similarly each of the design, development and implementation phases must be examined to ensure that the required changes have been or are being implemented. Finally it is essential to ensure that all aspects of the evaluation phase are being addressed. In Canada the regulator expects full implementation of SAT.

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[4]A Guidebook, **Nuclear Power Plant Personnel Training and Its Evaluation**, IAEA-TECDOC-525, 1995 Revision, Vienna, Austria.

[5]Criteria ACAD 91-015, **The Objectives and Criteria for Accreditation of Training in the Nuclear Power Industry**, INPO,December 1991, Atlanta, Georgia, USA.

[6]DOE Standard, DOE-STD-1070-94, **Guidelines for Evaluation of Nuclear Facility Training Programs**, June 1994, U.S. Department of Energy, Washington, D.C.,USA.

[7]NUREG-1220, **Training Review Criteria and Procedures**, 1992, U.S. Nuclear Regulatory Commission, Washington, D.C., USA.

[8]INPO 85-006, **Principles of Training System Development**, February 1985, Institute of Nuclear Power Operations, Atlanta, Georgia, USA.

From the perspective of both the utility and the regulator, a careful review of the degree of implementation of SAT is a powerful tool for verifying that a viable, technically adequate training program has been designed, developed and implemented and is being maintained. The utility perspective will also include meeting the requirement of the regulator for the use of SAT and verifying that the economic benefits derived from high quality training are being achieved. The ultimate goals are of course a competent, safe work force and public safety.

The Task List

A "Task" is defined as a highly specific action that has a definite beginning and end, is observable and measurable, and is independent of other actions. A "Job" is made up of several tasks which may be grouped in various work areas. Job changes, sudden performance degradation, new equipment, new procedures, new or changed laws or regulations, local, national and world significant events, other operating experience and time are all possible indicators of the need to evaluate and revise the task list. This revision should be done in two phases by plant Subject Matter Experts (SMEs) who have current knowledge and experience, with assistance from the training department, and possibly other consultants with respect to law and regulation changes. The pro-active phase involves an evaluation by SMEs, assisted as necessary by training department staff, of the relevance of each task at least once every three years. The reactive phase requires a systematic evaluation of the indicators listed above in a timely manner to identify redundant tasks, new tasks and tasks which must be revised. In both cases the objective is to add new tasks, remove redundant tasks or to clarify existing tasks in order to ensure that necessary knowledge, skills and performance training are not overlooked and that redundant training is avoided.

The Task List for a given "Job" is produced as a result of a job analysis at a particular point in time and will become obsolete if it is not evaluated and upgraded regularly. Therefore these evaluations are required to help ensure worker competence, and worker and public safety, and to satisfy the regulator's concern for the use of SAT. In all cases a current task list will help minimize operating costs by eliminating unnecessary training.

Classroom Tests and Job Performance Evaluations

Written classroom tests (WCOs) and verbal and performance evaluations of on-the-job training (OJT) are used to verify that the required knowledge, skills and performance have been learned. The quality of those tests and the results obtained from them are significant indicators of training program validity.

Classroom knowledge tests should be evaluated by training centre staff, in two ways, each time they are used. Before using a test trainers should ensure that the questions reflect the knowledge requirements of the tasks that are being trained. After administering the test it is essential to review trainee comments about the test and to evaluate the grade achieved by each trainee for each question in order to verify that the question content, quality and level of difficulty are acceptable. Depending on the type of questions used, a pass rate that is too high may indicate that the test is too simple or even that the training was unnecessary. A very low pass rate may indicate a poorly written or irrelevant question, ineffective, unwanted or unneeded training, poor training material, low trainee and/or trainer effort, or even personality clashes between trainer and trainees.

The content of the Job Performance Measures must reflect the knowledge, skills and performance demanded by the tasks, and the JPM evaluation component must test these capabilities. It is essential therefore for plant subject matter experts to evaluate the JPMs each time that a task change occurs in response to any of the factors listed in the previous section, and to ensure that the JPM will test the required, current knowledge, skills and

performance. This should be done both before and after each JPM is administered and whenever any task is changed. The evaluation skill and technical knowledge of the OJT evaluator are particularly critical elements in ensuring both the quality and fairness of the evaluation and the safety of the trainee. The results of the JPM evaluation will reflect upon the quality of the training, the adequacy of the learning or practice time, the effort of the trainee, and the ability of the evaluator.

A continuous review of feedback from trainees and trainers and periodic reviews of the task list will help ensure that all relevant knowledge, skills and performance are being presented and tested appropriately and accurately in a high quality training program. This will help meet the safety concerns and worker competence requirements of the regulator. It will also help ensure cost-effective training and operation.

Training Objectives

Training objectives (TOs) include the terminal objectives for each element of the training program and the learning objectives (LOs) that spring from each terminal objective. These objectives must address all knowledge, skills and performance that the trainee is expected to master.

Since training is a plant responsibility, and the TOs will have been established initially by plant SMEs with assistance from the training department, it is logical that whenever a task is revised by the plant SMEs and training staff the same, or equivalent persons would also revise the appropriate TO and LOs. It is essential, however, that the knowledge, skills and performance dictated by the new or revised task be identified first. In the case of classroom training, the instructors should revise the test questions affected by the task change or new task and revise the TO and LOs accordingly. For on-the-job training using JPMs, the on-the-job trainer will examine the JPM affected by the task change and modify the TO and the LOs to accommodate the new knowledge, skills and performance required by the revised or new task.

Since the TOs and LOs constitute the frame which supports all of the training material, they must be kept current to ensure the relevance and accuracy of the training program with respect to the task list.

Training Materials

Training materials include lesson plans, classroom course notes, handouts, audio-visual aids, JPMs and the plant procedures used with JPMs and all test items. The evaluation of this material should be continuous, and should always take account of feedback from the trainees, the trainers, the plant, and outside sources. As above, a major cue to the need for training material revision is any changes which are made to the tasks. Other indicators stemming from the task changes are test or JPM revisions, and new or changed TOs and LOs and tests.

A part of any evaluation of training materials is to ensure that all new or revised tasks, TOs and LOs are addressed and that accuracy, relevance, currency and clarity are maintained. The classroom material such as course notes, handouts and audio-visual aids should be evaluated and revised by the training department trainers, audio-visual experts, and training supervisors while the JPMs must be revised by the appropriate subject matter experts and plant supervisors, with assistance as required from the training department.

Trainer Competence

The technical currency and competence of the trainer are fundamental to adequate training.[9] Indications of the state of that competence and currency will come from the trainees after each course, from tests and OJT results, from plant line management comments, from evaluations of trainer performance in the classroom or when delivering OJT, and from the trainers themselves through requests for upgrading or refresher training. A more long term indicator may be trainee performance on the job after returning to the workplace. Careful evaluation of these indicators by both training department and plant management is required to verify any suggested trainer performance degradation. Further verification must be obtained through discussing these indicators with the trainer.

These evaluations of trainer competence and currency must be regular, systematic, and fair to both the trainer and the organization. Whilst the situation will dictate the actual frequency, annual trainer performance evaluations are essential. The pro-active evaluation of trainer competence and currency facilitates the early detection of training problems, assists trainers to improve their performance and ultimately leads to better, more efficient training. The maintenance of a high level of trainer competence is a regulator requirement.

Training Program Acceptance

The acceptance of the training program by the trainees is a strong indicator of program quality and relevance. Trainee acceptance is essential to successful training and will be shown clearly by trainee attitudes, attendance, performance, and learning during training. The trainers will be the first to sense the acceptance or rejection of the training program by the trainees. Evaluating the acceptance of the training program by the trainees is therefore a valid, albeit delayed and therefore potentially costly, method of verifying the "need" for the training and the quality of the training program.

Acceptance by plant management can be measured through post-training feedback obtained by the training department. The degree of acceptance will be shown by plant management attitude toward, and financial support of, the training program. If that acceptance from both plant management and the trainees is not obvious the validity of the training program is extremely doubtful.

Some serious negative results of unnecessary training, besides the waste of human and other financial resources, include the creation of negative attitudes toward training, a loss of trust in the training system, and a general malaise with respect to quality and morale. Thus the evaluation of this aspect of training should be carried out continuously by all concerned, with particular emphasis at the completion of given milestones and of the entire training program. However the onus remains with the plant and training department management to ensure that the training is meeting a real need at an acceptable cost. Again this is an essential part of ensuring worker morale and competence, job quality, worker and public safety, and cost-effective training.

Training Results

The fundamental reason for providing training is, of course, to create a needed ability that the trainees are presently lacking or to refresh an existing ability. The immediate results of that training are shown by combinations of classroom knowledge tests, skills tests, and field

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[9]Ronald L. Jacobs and Michael J. Jones, **Structured On-the-Job Training - Unleashing Employee Expertise in the Workplace**, 1995, San Francisco, California, USA

performance evaluations. However the ultimate results obtained from the training are demonstrated on the job, in the workplace, via improved ability, safety, competence and efficiency.

Indications of the level of attainment of the training objectives will come from the newly trained workers and the plant line and upper management. New or improved abilities, increased production, and fewer accidents or significant events may be indicators of the positive effects of the training. However, to objectively evaluate the results of any training program it is necessary to measure both before and after the training.[10] The before-training measurement may be achieved by actual testing or may be indicated by the workers having reached a prerequisite job category for entering the training program. The after-training measurements must be made against the objectives that were set for the training program, by determining, "Did the training satisfy the training need?". A further test of the success of the training requires a cost-benefit analysis to determine if the results obtained justify the cost involved. If the workers can perform tasks which they could not previously perform, or they can perform tasks more efficiently or safely than before training and the return on investment is considered acceptable, then the training can be judged effective.

Although it is the plant line and upper management who must ultimately make this evaluation, the training department management should be involved to ensure that they are providing the required training at acceptable cost. This is particularly important if the training department is working with the plant on a "fee for service" basis. Worker feedback is essential. This evaluation should probably be completed about three to six months after the training is completed in order to allow the newly trained workers to use the training and to practise and hone their newly acquired skills.

The benefits of evaluating the results of training include ensuring that the required worker competence and currency has been achieved, that the cost of the training was acceptable, and that requirements of the regulator or various certifying organizations, such as INPO or ISO have been met.

The Evaluation Process

The evaluation process used by a training organization, or by any group providing training, is the collection of evaluation elements that are examined to verify the quality of the training being provided. Examples of these have been examined briefly in the above. As training needs change it will be appropriate to examine some or all of these evaluation elements to ensure that they are still suited to the particular evaluation process. Indicators of the need to review the evaluation elements that are being used include a lack of useful feedback regarding training quality, various evaluation elements falling out of use, unsatisfactory training results on the job, and a loss of plant management commitment to training. The continuous use of an appropriate training standard will simplify this review of the evaluation process. An annual review of the evaluation process by training department staff will help to identify and remove weaknesses, and ensure that useful training program evaluations continue to be completed.

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[10]Donald L. Kirkpatrick, **Evaluating Training Programs, The Four Levels**, 1st edition, 1994, Berrett-Koehler Publishers, Inc., San Francisco, California, USA.

Summary

This paper has examined five aspects of training program evaluation, ie what, why, who, when and how, in relation to a number of training issues. It has demonstrated that the benefits of continuous training program evaluation, include:

- better training program accuracy, currency, relevance and usefulness,
- improved worker competence and morale,
- greater assurance of worker and public safety,
- acceptable return on training investment, and
- enhanced ability to meet certifying organization criteria.

It has also shown that continuous training program evaluation facilitates satisfying regulator requirements for the use of SAT, worker competence and worker and public safety.

GLOSSARY

AV Aids	Any audio-visual materials used to augment training, including slide and overhead projection, computerized overhead projection, videos, flip charts, movies, exhibits, etc.
FFS	Fee For Service - Training provided by a training organization on a contract basis in which the plant provides the funding for the training.
Job	A job is made up of one or more tasks that fit logically together.
JPM	Job Performance Measure - An instrument that defines the required performance of a qualified worker for a given set of tasks.
LO	Learning Objectives - Statements which identify the training content, the conditions, and the standards for satisfactory performance for each segment of learning required to meet a terminal objective.
OJT	On-The-Job Training - One-on-one training, at the job site, that is planned, structured and organized, and is carried out by a qualified trainer using recognized training techniques.
PTFB	Post Training Feedback - Feedback obtained from the worker and line management several months after training has been completed and used on the job, as a means of verifying the effectiveness of the training.
SAT	Systematic Approach to Training - A five phase process consisting of analysis, design, development, implementation and evaluation used to produce effective, efficient high quality training.
SME	Subject Matter Expert - A qualified worker who is working regularly in a particular expertise area and is recognized as having superior knowledge and skills in that area.
Task	A task is a highly specific action that has a definite beginning and end, is observable and measurable, and is independent of other actions.
TO	Terminal Objective - A global statement which identifies an ability that must be achieved, the conditions under which that ability will be demonstrated and the standard of performance that must be met.
WCO	Written Checkout - Any test that is completed in writing at the end of a training session.
Training Standard	A statement of objectives and criteria which define the requirements of an adequate training program.
Training Program Evaluation	A continuing process of assessing all facets of a training program, from concept to completion, against a suitable training standard, to help assure worker competence, and worker and public safety.

TABLE 1 - TRAINING PROGRAM EVALUATION ELEMENTS

WHAT TO EVALUATE	INDICATORS	HOW TO EVALUATE	WHEN TO EVALUATE	WHO EVALUATES	WHY EVALUATE
Job Performance Discrepancies	Technical or safety problems in the plant. Pro-active request from plant. Regulator input. Peer Audits.	Meet with plant management, verify performance indicators. Apply Mager test.	Before beginning to build the training program.	Plant management with help from training centre.	Due diligence. Public safety. Verify need. Prevent waste.
Training Standard	External comments. Trainer comments. Trainee comments. Plant Management comments. Regulator comments.	Compare to world, utility and regulator standards. Must be appropriate to utility needs.	Tri-annually.	Training Specialists, Plant Management.	Verify standard is appropriate. To meet regulator requirement.
Use of SAT	Five SAT elements: *Analysis, Design,* Development, Implementation, Evaluation.	Detailed program review, using SAT model. Look for evaluation indicators.	Continuously during program setup and pilot run. Annually.	Training Centre, Plant Trainers. External. Regulator verifies.	Ensure complete use. Verify training adequacy. Regulator requirement.
Task List	Job Changes. New Equipment (E). New Procedures (P). New Laws/Regs (L&R). SERs. Operating Experience. Time.	Identify tasks wrt new or modified E, P, L & R. Compare to existing task list, identify new, redundant and changed tasks. Examine SERs wrt tasks not done.	New equipment, laws procedures, regulations. Significant Event Reports (SERs). Triannually.	Plant SMEs. Consultant input for laws and regulations. Assistance from Training Department.	Ensure all tasks identified. Avoid unnecessary training. Worker competence. Workers & public safety. Satisfy regulator requirements.
Tests, WCOs, and JPM.	Task changes.	New or revised tasks require new or revised test questions.	Before and after every use when tasks change.	Trainers.	Ensure test relevance and adequacy.
Test results	Pass rates too high or too low. Trainee comments. LM comments.	Review patterns of results for each question. Review patterns of pass/fail rates for courses and trainees. Review all comments.	After every test. Annually to detect major patterns.	Trainers on a micro scale. Training supervision on a macro scale. Plant Line Management at Job Level.	Detect unwanted patterns and results.
Training Objectives:					
TOs	Task changes. Test changes.	New task will require new or revised TOs.	When tasks change. Annually.	Trainers with plant SME input.	Ensure TOs address all tasks.
LOs	TO changes.	New or revised TOs will	When TOs are changed.	Trainers with plant SME	To ensure LOs match TOs intent and meet testing

LOs	TO changes. Test changes	New or revised TOs will require new or revised LOs.	When TOs are changed. Annually	Trainers with plant SME input.	To ensure LOs match TOs intent and meet testing requirements.
Training Materials:					
Course notes	Trainee comments. Trainer comments. New E, P, L & R. New/changed tasks. Test changes. TO & LO changes. External comments.	Verify all TOs and LOs are accommodated. Verify technical accuracy and currency. Check clarity.	After every use. When tasks, TOs, LOs & tests change. When SERs appear. Annually.	Trainers with plant SME input.	Ensure accuracy, currency, relevance, clarity & usefulness to Trainees.
A.V. Aids	Course notes changes. Low quality. T&T comments.	Oral and visual examination of each item wrt need, quality and usefulness to the Trainees.	Before every presentation. Annually.	Trainers.	Ensure usefulness to Trainees, ie they facilitate learning.
OJT Instructions & Aids	New E, P, L & Rs. Task changes. TO & LO changes. T&T comments.	New needs may require new JPMs. T&T comments indicate revisions.	Whenever tasks or procedures change. After every use. Annually.	Plant SME, with help from Training Department.	Provide accuracy & relevance required to ensure worker competence & safety. Minimize costs. Satisfy regulator.
Trainer Competence	Trainee comments. Trainer comments. Trainer performance monitoring results. Input from Plant Line Management (PLM). Trainee learning.	Verify Trainee & Plant comments with Trainer. Discuss needs with Trainer. Regular, systematic on-site monitoring.	After each course via CESs. Annually or more often as required.	Training Supervision and/or Plant Line Supervision.	Ensure Trainers can help Trainees reach training goals. Develop Trainers. Cost control. Regulator requirements.
Program acceptance	Trainee attitudes in training and in workplace. PLM comments.	Trainee input. Ask customer. FFS inputs. Ask Trainers.	Continuously. During & after every course. At completion of every program.	Training Supervision. Trainers. Trainees. PLM.	Ensure "need" has been met at acceptable cost. Ensure worker competence and public safety.
Training results	PLM & PUM comments. Worker comments. SERs.	Did the training fill the need? Is cost justified? Can workers do the job safely & competently? Can it be done better or at lower cost now?	About 3 to 6 months after Trainees return to their job sites.	PLM with input from Training centre. Training Management Trainers. Workers.	Ensure worker competence & safety, public safety and cost/benefit. Regulator requirements. Certification requirements.
The Evaluation Process	Lack of useful feedback. Unsatisfactory training results.	Examine each aspect of evaluation for completion and use.	Biannually. As required.	Training Department staff.	To ensure useful evaluations are being completed.