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Use of systematic approach to training in radiological safety and nuclear security education

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Abstract
Systematic Approach to Training (SAT) is standard methodology for achieving training objectives. There is accumulated expertise in using SAT applications in training and in these context in fields of radiological sources safety and nuclear security. There is a need to benefit from such effective methods in Radiological safety and nuclear security education. This study review lessons learned from SAT in training and process of benefiting from these training methods into radiological sources safety and nuclear security. So, we reviewed articles and publications with key words of Systematic approach to training and radiological sources safety and nuclear security training. The basic findings is that its mandatory to have the belief of there is always an existing threat to radiological sources and that all members of the institution have to share in developing the training plans and educational needs which can be covered using systematic approach to training methods. The overall conclusion is that systematic approach to training methods is effective in raising awareness and developing the retained knowledge about safety and security of radiological sources.

Keywords: systematic approach to training, sat, education, radiation safety

Introduction

Systematic Approach to Training (SAT) represents a perfect tool for a successful and effective training with its different stages of analysis of training needs, design of training programs, development of training materials, implementation of training and evaluation of training effectiveness (Fig. 1) [(1)]. All these stages are improved and refined by a feedback process. There has been an experience in using SAT in human resources development (HRD) in Radiological and nuclear security (NS). This work is to highlight the challenges and lessons learned from using SAT in training for Radiological safety and nuclear security.

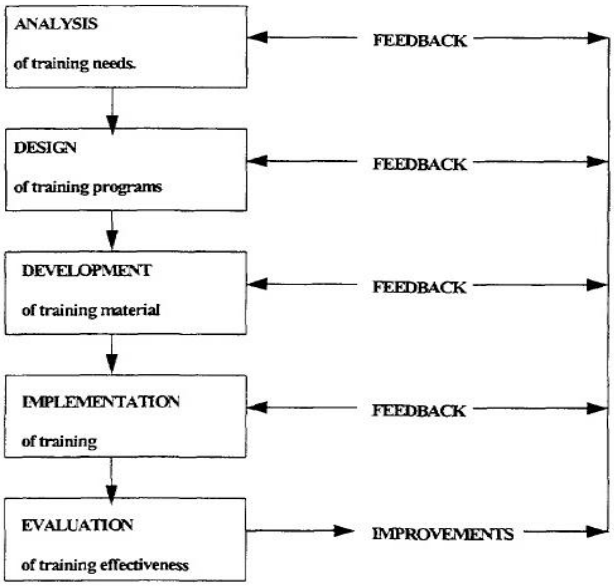

Fig 1: Overview of the SAT process.

Systematic Approach to Training is basically a logical progression from identification of the competencies required to perform a job to the development and implementation of training to achieve these competences and evaluation of such training. In other words, it's a methodology which applies quality assurance (QA) to training and thus assures the competences of staff. SAT is widely applied and used as a QA on training for technical positions. Using it as basis for training on nuclear security has proven to be effective and successful for professionals who are dealing with radioactive materials too.

With SAT the competences in Nuclear Security can be identified and met in an objective manner. In a another word, it can demonstrate that all required competences in Nuclear Security have been attained. SAT is a very reliable tool to overcome competence gaps which affects Nuclear Security through Education.

SAT consists of five interrelated phases (Fig. 2), which are:

Analysis — This phase comprises the identification of training needs and of the competencies required to perform a particular job.

Design — In this phase, needed competencies are converted into training objectives. These objectives are organized into a training plan

Development — This phase comprises preparation of the training materials that will be used to achieve the training objectives.

Implementation — In this phase, training is conducted by using the developed training materials.

Evaluation — During this phase, all aspects of the training program are evaluated on the basis of the data collected during each of the other phases. This is followed by suitable feedback leading to training program improvement which will better the training outcomes.

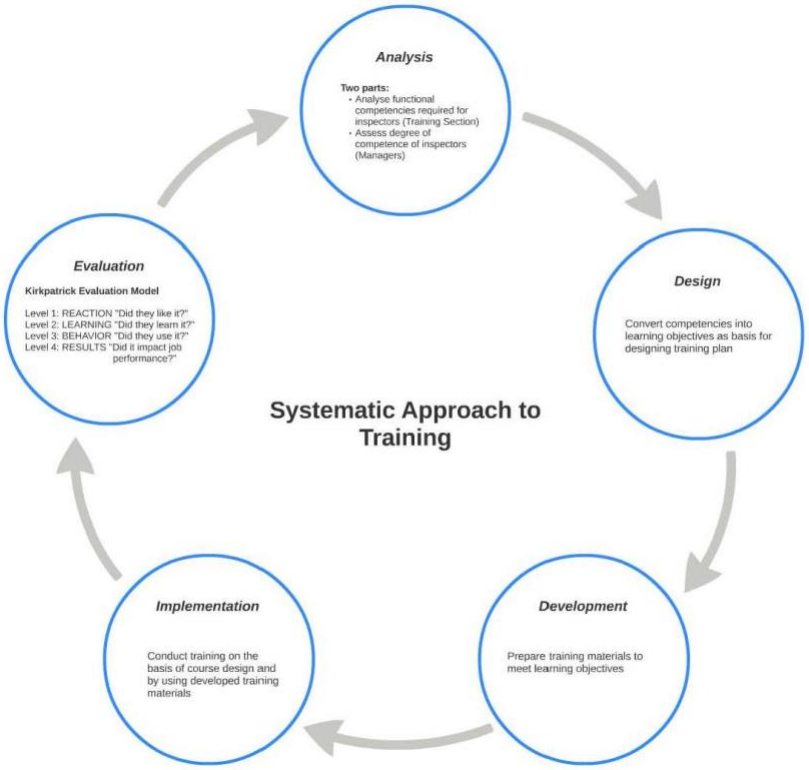

Fig 2: Systematic Approach to Training

Reasons to adopt SAT methodology are diverse. The most common reasons vary from country to country such as there is recognized need to enhance training using international best practices, the outcomes improvement necessitate use of international experience, and overall the SAT methodology proved useful, also might be a recommendations from domestic or international training audits or Nuclear regulatory body requirements or recommendations, or as Quality Assurance requirements. SAT in essence promotes and strengthens Nuclear Security Culture, safety culture and quality culture. It assures training consistency, contributes to the acceptance of Nuclear Security measures and nuclear power as a whole. SAT provides confidence to Nuclear Security as part of plant management that the training addresses actual needs in an efficient manner. It enables involvement of plant managers and line managers in a simple manner to monitor and evaluate personnel training. Also, it minimizes the risk that important elements of training will be omitted and provides assurance, in the case of those events which have training-related root causes, that training will address these root causes. It also helps an operating organization to provide assurance to the regulatory authority that the organization training programs provide the required competencies.

Since Nuclear Security Culture arguably not as much developed as Nuclear Safety Culture in most countries, it has been demonstrated that SAT provides a strong tool for establishing new training programs or upgrading existing ones in such a manner that it provides assurance that the job incumbents acquire and maintain all the necessary competencies related to nuclear security:

- Training programs are continually evaluated and improved,
- Necessary changes in the training can be made efficiently,
- Resultant training programs have inherent QA features. As SAT has inherent QA features, it provides a management tool for quality assurance of training and education in the context of Nuclear Security.

International Experiences

SAT provides quality assurance over the training events and makes training more effective as compared to traditional or conventional training, since competences needed for human resource development plan in nuclear security would be covered and assured to be achieved.

Control of management on training using SAT provides the means of applying quality assurance for the process and outcomes of training. Using SAT in preparing the HRD plan in Nuclear Security is needed to enhance training to the best international practices, regulatory requirements and quality assurance. SAT also promotes safety and security through assuring training consistency and that there are no important training aspects possibly omitted.

Development of SAT in Nuclear Security education will be influenced by many factors including:

- Country needs, conditions, requirements and traditions,
- Organizational culture of an operating organization or nuclear power plant,
- Education and training infrastructures/systems,
- Regulatory requirements,
- Training environment into which SAT was introduced,
- Experience in the use of SAT in the given country/Organization,
- Support for training in the given country/organization,
- Active involvement of line management in training activities,
- Training facilities available,
- Educational expertise available,
- Areas in which training is provided,

- Educational resources available (instructors, materials, funding, etc.),
- Training delivery techniques used.

So as for the SAT steps followed are explained as:

i) Analysis

Job competencies in Nuclear Security analysis is usually the starting step for the evolution of the analysis phase, as where an outside expert or educational organization decides what technical knowledge the trainee needs to know to do the job. It ends with an analysis called job task analysis, involving the job incumbents, which provides in detail all the competencies required by the trainee.

- Technical skills are included in the analysis. This includes examining how knowledge is applied at the workplace and the skills required for Implementation of Nuclear security and also other topics such as personal safety.
- JCA of the full range of the human factors skills required to perform Nuclear security requirements while performing the tasks of the job.
- An analysis of the attitudes towards nuclear security measures that are required, defining the approach that should be taken when performing the job, including the assurance of nuclear security measures and also safety when performing the job.
- Ending up with a complete definition of the knowledge required in the context of Nuclear security, how that knowledge is to be applied (skills) and the individual's approach (attitude) when applying the knowledge to perform adequately the tasks of the job. Additional competencies will be developed to allow the job incumbent to adapt to job-related changes and thus evolve with the job, which ultimately support the overall onsite and organization nuclear security.

ii) Design

The design phase of SAT evolves in a way that reflects the milestones of the analysis phase:

- The beginning — a very loose, broad definition of the training objectives, based on what the trainee should know at the end of the complete course; written by individuals with little knowledge of the job tasks.
- Training objectives more clearly defined and produced for the training sessions within the training course, performed by supervisors or job incumbents (This continues during the evolution of the design phase.)
- Long training courses are divided into modules with clearly defined training objectives. This allows theoretical training to be integrated with periods where some tasks of the job are performed at the workplace.
- Skill based training objectives are included; training settings include simulation, workshop and directed on-the-job (skills) training. Assessment criteria are designed in conjunction with all training objectives
- Attitudinal training objectives are included; training settings include case-studies and role playing.
- Computer based and self-study training settings used to achieve knowledge based training objectives, small training modules designed so that particular subjects are covered in different levels of detail Evaluation processes are designed to assess training effectiveness and the transfer to the job of the knowledge, skills and attitudes acquired through training
- The end — individuals participate actively in defining their learning needs, for both individual and team work components; a wide range of training settings is available, designed to suit the method that will be used to develop the required competence.

iii) Development

The development phase of SAT also evolves in a way that reflects the milestones through which the analysis and the design phases pass.

- The beginning — training material is copied from theoretical documents, in large quantities; presentations are not closely related to the training objectives, based perhaps on the knowledge and experience of the lecturer; no training material designed for the purpose is used.
- Training material prepared by individuals with some plant knowledge related more closely to the training objectives; still no training material designed for the purpose is used.
- Training material prepared with the active participation of supervisors or job incumbents, closely related to the training objectives; use of training material and plan designed for the purpose. More valid and reliable test items.
- Skills training material developed to support skill-related training objectives; for example, OJT guides including job performance measures developed.
- Computer based and self-study training material developed to support knowledge based training objectives, and small training modules produced to cover particular subjects at different levels of detail.
- Attitudinal training material developed to support attitudinal training objectives; training techniques include case-study and role playing.
- The end — training material developed to support the wide range of training settings and techniques available; the most appropriate media available for training material presentation and learning are used, with additional material available to support trainee learning by tutorial, guided training or coaching; integrated plant database available to support training material development.

iv) Implementation

As in the previous phases, the Implementation phase of SAT also evolves to reflect the milestones passed in the analysis, design and development phases.

- The beginning — training implemented using lecture based presentations; lecturers do not possess plant knowledge but do possess presentational skills; no assessment of trainee learning performed and no feedback to the trainee takes place on the level of knowledge achieved; unstructured OJT.
- Lecturers possess plant knowledge but not necessarily instructional skills; present lecture based training material; some assessment of trainee learning of some of the learning objectives performed, but little feedback to trainee on the level of knowledge achieved.
- Training instructors possessing both plant knowledge and presentational skills used exclusively to present training material and to perform tutorials and assessment of trainee learning of all learning objectives; feedback and corrections to trainee knowledge included. Skilled instructors used to provide skills based training using

simulated, mock-up or actual plant situations; an assessment of the level of skill attained is performed with feedback of results to the trainee.
- Instructors with facilitation skills lead attitudinal training events, ascertain the level achieved and relate that to the attitudes required when performing the tasks of the job.
- The end — training delivered to the individual using the techniques and settings most suitable to training being undertaken; training undertaken at a pace suitable to the individual; continuous assessment carried out and fed back to the trainee; tutorials and monitored on-the job performance, with feedback provided by instructors, peers and supervisors and line management as appropriate.

v) Evaluation

The evaluation phase of SAT also evolves following the milestones passed by the other phases but linked primarily to design and implementation.
- The beginning — no evaluation performed.
- Parts of the training program evaluated, concentrating on the opinions (so-called "happiness sheets") of the trainees, results primarily being used to improve the implementation phase.
- Complete training program is evaluated, still concentrating on the opinions of the trainees, with the results used to improve all SAT phases; minor changes to the training programme result.
- Complete training program evaluated, supplementing the opinions of the trainees with the results achieved in the trainee assessments; these are used to improve all SAT phases; significant changes to the training program result.
- Complete training program is evaluated incorporating feedback also from supervisors; modifications to the training program occur in an effort to ensure the training is relevant for job performance.
- Evaluation of training programs linked to the improvement of performance on the job.
- The end — continuous evaluation of training by trainees, trainers, supervisors and management; results linked to the improvement not only of job performance but also of nuclear power plant technical and economic performance.

Adoption of SAT steps for these training events greatly improved the quality of training on Nuclear Security. The expertise from using SAT greatly supported universities to conduct objectively structured and quality education programs in Nuclear Security. Challenges and lessons learned from applying SAT in training for Nuclear Security were many; such as finding out that training hasn't met all training needs which was dealt with by enhancing training to the trainers and by reviewing the competences needed for each job. At end of training, assessment addressed training items, but sometimes it failed to accurately evaluate outcome of training in terms of achieved competences. This problem is dealt with by thoroughly going through the assessment questions so as to reflect the needed changes in the training process and contents.

Conclusion

SAT use in training and education in the context of Nuclear Security is effective in delivering the training and assuring a quality outcome. There are some challenges but using SAT as a Quality Assurance made important lessons.

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