OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

October 8, 1979

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Docketing and Service Branch

Dear Sir:

I have reviewed your draft Regulatory Guide, "Radiation Protection Training for Light-Water-Cooled Nuclear Power Plant Personnel," and would like to offer several comments. Since I have had experience in developing a training program for health physics technicians, I feel qualified to make these recommendations.

1. Your guide states in the last paragraph on page 1 that it "does not cover training necessary to qualify an individual as a radiation protection professional." I suggest that you consider such a regulatory guide in the future since guidelines for training health physics technicians are badly needed.

2. The guide recommends specific topics to be included in the training program, but it does not give sufficient reference material to be used in preparing the program. Many useful texts and reports are available and I suggest including a comprehensive list of these.

3. The training program I proposed for health physics technicians includes specific tasks that must be demonstrated on-the-job called "practical factors." I recommend including the requirement that similar tasks be included with examples given in the guide.

4. Section 3(a) states that the program should be fully documented, however, the requirements for documentation are not designated in the guide.

5. The courses outlined in Table 1 do not include basic radiological physics such as the different types of radiation or the units of dose. This material should be added to make other concepts such as shielding and instrumentation more understandable.

6. Section 6 recommends a minimum passing grade of 80% for successful completion of the training. I do not recommend identifying a minimum passing grade since the difficulty of exa will vary significantly among reactor plants.

In general, I am pleased to see this draft regulatory guide, and I feel that it could contribute significantly to improving overall knowledge of personnel at nuclear facilities in the area of radiological health. Enclosed are two reprints of an article I prepared for *Health Physics* describing a training program for health physics technicians. I would be very happy to see a draft guide designed to improve the training and qualifications of health physics technicians.

I look forward to seeing revisions to this regulatory guide or the final product.

Sincerely,

John E. Till

John E. Till, Ph.D.

JET:arc

Enclosures

Health Physics Pergamon Press 1977. Vol. 32 (May), pp. 423–428. Printed in Northern Ireland

A UNIFORM APPROACH FOR ON-SITE TRAINING AND QUALIFICATION OF HEALTH PHYSICS TECHNICIANS*

JOHN E. TILL

Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830

(*Received* 19 *August* 1976; *accepted* 21 *September* 1976)

Abstract—Estimates have shown that in the U.S. approx. 75% of the health physics technicians received their training through courses offered by their employer. The quality and the extent of this training vary considerably among nuclear facilities. This paper describes a uniform approach for on-site training and qualification of health physics technicians applicable to all nuclear facilities. The program consists of four levels of qualification: Health Physics Technician Trainee, Technician I, Technician II and Senior Technician. The training is divided into modules that are composed of formal lectures, practical factors, experience, and a comprehensive examination. The minimum time required from hiring of inexperienced trainees to qualification as Senior Technicians is approx. 24 months. A qualification guide lists each step a technician must complete in the training program and provides documentation which facilitates audits by internal and external groups. Although items in the program would differ between facilities, the program provides specific titles for technicians, based on their training and experience, which would be applicable throughout the nuclear industry.

INTRODUCTION

On-site training programs for health physics technicians have not been well documented in the literature and therefore no uniform qualification procedure or documentation for training exists in the nuclear industry today. Health physics training programs which have been reported in the literature generally recommend curricula that require enrollment in a university or technical school (Le63; St72). However, most of the health physics technicians who have entered the profession have had no previous formal health physics training. Estimates show that in the U.S. 75% of the health physics technicians received their formal training through courses provided by their employer (Ka72).

Because significant variations exist in training methods which are currently being used throughout the nuclear industry, the title "Health Physics Technician" is not readily identified in intra-industrial applications. While there is both the desire and the need for recognition of the health physics technician as a member of the health physics profession, standardization and documentation of health physics technician training have not been provided.

This paper proposes an efficient and effective health physics training program applicable to on-site implementation at facilities throughout the nuclear industry. Additional items may be added to the program to fulfill specific needs at each facility. The proposed program provides both standardized levels of qualification and documentation of the training that the technician has completed.

An effective training program should incorporate the following basic elements:

(1) The program should be well defined, list specific instructions that are easily understood, and provide a clear objective of the end product in terms of demonstrated knowledge and skills.

(2) The program should be divided into small steps consisting of formal instruction, demonstrated skills, and examinations, so that the trainee can see regular progress along the qualification path.

(3) The program should include a method

* Publication No. 982, Environmental Sciences Division, ORNL.

† Operated by Union Carbide Corporation for the Energy Research and Development Administration.

for spot checks by responsible management to verify the effectiveness of the training.

(4) The program should provide documentation as a record that the technician did receive training on a particular topic at a specified time.

(5) The program should incorporate incentives and rewards to encourage the technician to progress as rapidly as he can.

If any one of these elements is missing or incompletely applied, the effectiveness of the training program will be significantly reduced.

The remainder of this article describes a health physics technician training program that incorporates the basic elements discussed above and which could be readily adopted as a guide for establishing uniform, documented technician training throughout the nuclear industry. The importance of industry-wide acceptance of such a standardized training technique is also addressed.

METHODS AND MATERIALS

In this training program, health physics technicians are divided into the following four categories based on the level of qualification that they have achieved: Technician Trainee, Technician I, Technician II and Senior Technician. Trainees advance from one level of qualification to the next upon successful completion of a training module. Each module consists of formal instruction demonstrated skills or practical factors, examinations, and experience. The modules are illustrated in Fig. 1.

New employees who are to become health physics technicians are given a basic orientation course in radiation health and safety. The purpose of this course is to orient the employee in emergency procedures and radiation protection so that he can safely enter the facility and continue his training. This basic orientation course qualifies the employee to enter radiation areas and contamination zones without being accompanied by a qualified health physics technician.

New employees designated for further health physics training but without prior health physics experience are given the title Health Physics Technician Trainee and begin training with the Technician I module immediately after he completes the basic orientation course. Employees who have had prior experience may, after their training and experience have been evaluated, be placed in an appropriate higher level of qualification.

Each module includes a series of lectures. Lectures that present practical aspects of health physics are given on the job while those discussing the theory of radiation and radiation protection are more formally presented in a classroom. Although specific lectures may vary from one nuclear facility to another, lectures which this author considers basic for training health physics technicians at reactors, fuel reprocessing plants, laboratories engaged in nuclear research, and other large scale nuclear facilities are listed in Table 1. The length of time (in hours) that is recommended for each lecture is also indicated in Table 1.

Written material given to the technician to supplement each lecture consists of the text of the lecture, sample problems, and review questions. This material is specifically tailored for on-site training and focuses on practical

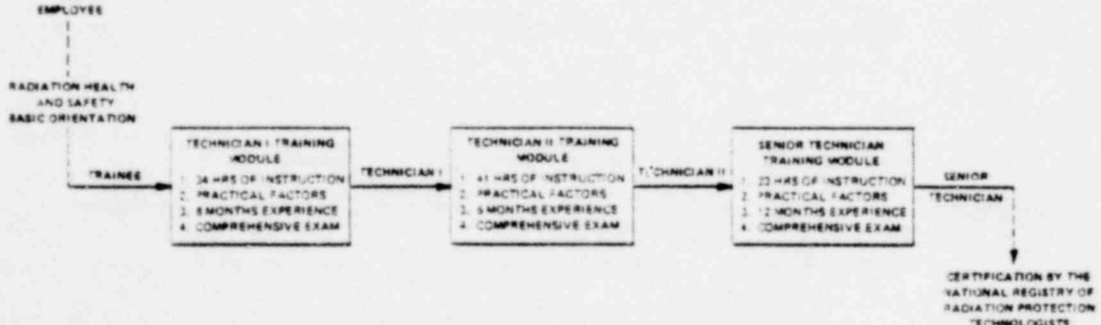

Fig. 1. Health physics technician training modules.

Table 1. Recommended lectures applicable to training health physics technicians throughout the nuclear industry[a]

Radiation Health and Safety Basic Orientation		Health Physics Technician I Module		Health Physics Technician II Module		Senior Health Physics Technician Module	
Basic radiological health	(8)[b]	Administrative procedures for radiation monitors	(1)	Atomic and nuclear physics	(4)	Advanced radiation biology	(2)
Biological effects of radiation	(2)	Advanced instrumentation and instrument maintenance	(6)	Chart of the nuclides	(1)	Background radiation	(2)
Emergency procedures	(2)	Building and grounds familiarization	(2)	Fire protection	(8)	Basic counting statistics	(2)
General safety and industrial hygiene	(2)	Chemical safety	(2)	Fractions	(2)	Counting corrections	(2)
Instrument familiarization	(4)	Contamination control	(1)	Fundamentals of mathematics	(4)	Detector theory	(4)
OSHA	(1)	Decontamination procedures	(2)	Graph development and interpretation	(2)	Nuclear safety	(1)
Personnel monitoring	(1)	Health and Safety Policy Manual and procedures manual	(2)	Radiation emergency training	(4)	Radiation attenuation	(2)
Protective clothing	(4)	Laboratory work	(4)	Radioactivity and radioactive decay	(2)	Radiation dosimetry	(2)
Radiation exposure limits	(1)	Nasal monitoring	(1)	Thumb rules for radiation monitoring	(2)	Radiological health handbook	(2)
Radiation monitoring	(1)	Posted area requirements	(2)	Use of calculator	(2)	Waste handling	(4)
Radiation work permits	(1)	Radiation exposure control	(1)				
Respiratory protection	(2)	Shielding	(3)				
		Survey techniques and reports	(3)				

[a] This list recommends lectures needed for a basic understanding and application of health physics.

[b] Numbers in parentheses denote the approximate time required for each lecture in hours.

aspects of health physics related to the particular nuclear facility administering the program. Several training manuals have been published (Mo72; Si70; St66) and are available for developing the information discussed in the lectures and the written material given to technicians in training.

Lectures which must be repeated frequently and which deal with the theory of radiation and radiation protection are shown on videotape. Videotaped lectures cover such subjects as routine administrative procedures, radiation detection theory, mathematics, and atomic and nuclear physics. The use of videotape requires less time for instructors to prepare and formally present classroom lectures and provides an ongoing and consistent training program which can best accommodate employee turnover.

In addition to more efficient use of instructional time and program flexibility, the videotape method also affords the trainee several advantages. He can obtain the written text of the lecture and review the videotape without the necessity of an instructor's presence. However, qualified instructors are always available to answer questions and explain more difficult material. Lessons are divided into 5–10 min segments which trainees can view during normal working hours. Material may be studied as long as the technician feels necessary before he takes a written examination. This flexibility affords optimal use of the work force and encourages progress based on individual ability.

Proficiency in practical factors—those important routine duties that the technician is expected to perform without supervision after he has been qualified—must be demonstrated in the presence of a technician having a higher level of qualification. Practical factors are a significant element in the training program because the technician must illustrate that he can apply skills that he has learned in the lectures to routine duties in the plant. They are also a mechanism whereby the employer can evaluate the performance and confidence of a technician on the job before the technician is given responsibility and authority. Practical factors should be specific and should identify each task that is considered to be important in the routine duties of the technician.

A minimum of 6 months (or 12 months as

QUALIFICATION GUIDE
HEALTH PHYSICS TECHNICIAN I

Date Training Began ________ Name ______________________

	Date Completed	Signature of Supervisor
I. Radiation Health and Safety Basic Orientation	________	____________

II. Lectures

Title	Date Completed	Signature of Instructor
1. Administrative procedures for radiation monitors	________	____________
2. Advanced instrumentation and instrument maintenance	________	____________
3. Building and ground familiarization	________	____________
(See Table 1 for additional lecture requirements)		
Lecture quality control check	Date	Supervisor

III. Practical Factors

	Date Completed	Signature of Qualified Technician
1. Demonstrate a knowledge of emergency alarms, the proper action to take in the event of each alarm, evacuation routes, and emergency shutdown procedures.	________	____________
2. Demonstrate the proper use of self-contained and forced air respiratory equipment.	________	____________
3. Identify all radiation area and contamination area signs and explain when each is used.	________	____________

(Additional practical factors reflecting the responsibilities of a Technician I should be included.)

Practical factor quality control check ________ Date ____________ Supervisor

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IV. Time Requirements for a Technician I

Minimum of 6 months as a Trainee

____________ Date Training Began ________ Date ____________ Supervisor

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V. Comprehensive Examination

I certify that ______________ has successfully passed the comprehensive examination for Health Physics Technician I.

____________ Exam Grade ________ Date ____________ Supervisor

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VI. Final Certification Statement

______________ is qualified to perform all duties of a Health Physics Technician I with the following limitations.

________ Date ____________ Supervisor

FIG. 2. Sample qualification guide for Health Physics Technician I.

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appropriate) on-the-job experience is required before the technician is eligible for promotion to the next qualification level. A comprehensive examination is given when the technician has completed the formal instruction, practical factors, and experience. This comprehensive examination is composed of a written section reviewing all aspects of the formal instruction, and an oral section reviewing the practical factors. Upon completion of these requirements, the technician is promoted to the next higher level of qualification. The Technician II module and the Senior Technician module consist of the same types of training as the Technician I module; however, the material is progressively more advanced and the practical factors reflect greater responsibility.

As stated in the Introduction, an effective training program must provide specific instructions that are divided into discrete elements that can be accomplished on a daily basis. To do this, a qualification guide is given to each technician undergoing training. An abbreviated example of a Technician I qualification guide is shown in Fig. 2. Similar qualification guides exist for the Technician II and Senior Technician levels. Qualification guides are permanent records of training and provide readily available documentation for audits by internal audit teams and by the Nuclear Regulatory Commission. They also demonstrate that companies have adequately trained their technicians.

Spot checks are made for quality control of the lectures and practical factors by the technician's supervisor. This check is conducted by questioning the technician in all of the areas listed on the qualification guide to verify the adequacy of training. If deficiencies are noted, the technician is required to repeat the lecture or practical factor, if necessary, and action should be taken to improve the quality of the instruction.

Concomitant with advancement to each level of qualification, management should incorporate an increa in salary and responsibility. This will give the technician incentive to complete the training program.

The training program as proposed which incorporates a procedure for qualification and a qualification guide in the format previously discussed has inherent within it all of the basic elements that were listed in the Introduction. The program and the levels of qualification for health physics technicians proposed in this paper could easily be adopted throughout the nuclear community. Although specific lectures and practical factors would differ between facilities administering the training, this program introduces an effective, standardized approach to training health physics technicians that clearly defines a technician's title in terms of his training and experience. This uniform approach would provide educational institutions such as vocational schools, technical education centers, and universities a framework around which their health physics technician curriculum could be structured. The graduates of these institutions would be available to industry with directly applicable and creditable training.

CONCLUSION

In this paper, a model has been presented for an effective and efficient health physics technician training program. A qualification guide lists, explicitly, each step a technician must complete in the training program and provides documentation which facilitates audits by internal and external groups. The program permits optimum use of the work force and encourages progress based on individual ability. If adopted by the nuclear industry, this model would provide a uniform approach to training and would give technicians titles which accurately reflect their qualification and experience.

REFERENCES

Ka72 Kathren R. L. and Shipler D. B., 1972, "Profile and Educational Opportunities of Health Physics Technicians", *Health Phys.* **23**, 201.

Le63 Lepak J. W. and Carlson W. D., 1963, Radiological Technicians—A Study of the Needs and Recommended Curricula. University of Nevada Final Report for USPHS Contract No. SAph 78512.

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Si70 Simmons G. H., 1970. A Training Manual for Nuclear Medicine Technologists. BRH/DMRE 70-3.

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If any one of these elements is missing or incompletely applied, the effectiveness of the training program will be significantly reduced.

The remainder of this article describes a health physics technician training program that incorporates the basic elements discussed above and which could be readily adopted as a guide for establishing uniform, documented technician training throughout the nuclear industry. The importance of industry-wide acceptance of such a standardized training technique is also addressed.

METHODS AND MATERIALS

In this training program, health physics technicians are divided into the following four categories based on the level of qualification that they have achieved: Technician Trainee, Technician I, Technician II and Senior Technician. Trainees advance from one level of qualification to the next upon successful completion of a training module. Each module consists of formal instruction demonstrated skills or practical factors, examinations, and experience. The modules are illustrated in Fig. 1.

New employees who are to become health physics technicians are given a basic orientation course in radiation health and safety. The purpose of this course is to orient the employee in emergency procedures and radiation protection so that he can safely enter the facility and continue his training. This basic orientation course qualifies the employee to enter radiation areas and contamination zones without being accompanied by a qualified health physics technician.

New employees designated for further health physics training but without prior health physics experience are given the title Health Physics Technician Trainee and begin training with the Technician I module immediately after he completes the basic orientation course. Employees who have had prior experience may, after their training and experience have been evaluated, be placed in an appropriate higher level of qualification.

Each module includes a series of lectures. Lectures that present practical aspects of health physics are given on the job while those discussing the theory of radiation and radiation protection are more formally presented in a classroom. Although specific lectures may vary from one nuclear facility to another, lectures which this author considers basic for training health physics technicians at reactors, fuel reprocessing plants, laboratories engaged in nuclear research, and other large scale nuclear facilities are listed in Table 1. The length of time (in hours) that is recommended for each lecture is also indicated in Table 1.

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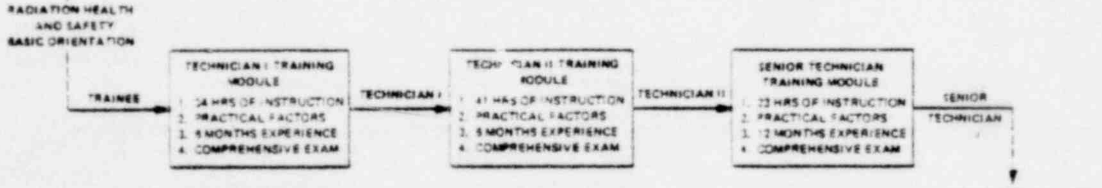

FIG. 1. Health physics technician training modules.

Table 1. Recommended lectures applicable to training health physics technicians throughout the nuclear industry[a]

Radiation Health and Safety Basic Orientation		Health Physics Technician I Module		Health Physics Technician II Module		Senior Health Physics Technician Module	
Basic radiological health	(8)[b]	Administrative procedures for radiation monitors	(1)	Atomic and nuclear physics	(14)	Advanced radiation biology	(2)
Biological effects of radiation	(2)	Advanced instrumentation and instrument maintenance	(6)	Chart of the nuclides	[illegible]	Background radiation	(2)
Emergency procedures	(2)	Building and grounds familiarization	(2)	Fire protection	(3)	Basic counting statistics	(2)
General safety and industrial hygiene	(2)	Chemical safety	(2)	Fractions	(2)	Counting corrections	(2)
Instrument familiarization	(4)	Contamination control	(4)	Fundamentals of mathematics	(4)	Detector theory	(4)
OSHA	(1)	Decontamination procedures	(3)	Graph development and interpretation	(2)	Nuclear safety	(1)
Personnel monitoring	(1)	Health and Safety Policy Manual and procedures manual	(2)	Radiation emergency training	(4)	Radiation attenuation	(2)
Protective clothing	(4)	Laboratory work	(4)	Radioactivity and radioactive decay	(2)	Radiation dosimetry	(2)
Radiation exposure limits	(1)	Nasal monitoring	(1)	Thumb rules for radiation monitoring	(2)	Radiological health handbook	(2)
Radiation monitoring	(1)	Posted area requirements	(2)	Use of calculator	(2)	Waste handling	(4)
Radiation work permits	(1)	Radiation exposure control	(1)				
Respiratory protection	(2)	Shielding	(3)				
		Survey techniques and reports	(3)				

[a]This list recommends lectures needed for a basic understanding and application of health physics.

[b]Numbers in parentheses denote the approximate time required for each lecture in hours.

aspects of health physics related to the particular nuclear facility administering the program. Several training manuals have been published (Mo72; Si70; St66) and are available for developing the information discussed in the lectures and the written material given to technicians in training.

Lectures which must be repeated frequently and which deal with the theory of radiation and radiation protection are shown on videotape. Videotaped lectures cover such subjects as routine administrative procedures, radiation detection theory, mathematics, and atomic and nuclear physics. The use of videotape requires less time for instructors to prepare and formally present classroom lectures and provides an ongoing and consistent training program which can best accommodate employee turnover.

In addition to more efficient use of instructional time and program flexibility, the videotape method also affords the trainee several advantages. He can obtain the written text of the lecture and review the videotape without the necessity of an instructor's presence. However, qualified instructors are always available to answer questions and explain more difficult material. Lessons are divided into 5–10 min segments which trainees can view during normal working hours. Material may be studied as long as the technician feels necessary before he takes a written examination. This flexibility affords optimal use of the work force and encourages progress based on individual ability.

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A minimum of 6 months (or 12 months as

QUALIFICATION GUIDE
HEALTH PHYSICS TECHNICIAN I

Date Training Began ________ Name ________________

	Date Completed	Signature of Supervisor
I. Radiation Health and Safety Basic Orientation	________	________

II. Lectures

Title	Date Completed	Signature of Instructor
1. Administrative procedures for radiation monitors	________	________
2. Advanced instrumentation and instrument maintenance	________	________
3. Building and ground familiarization	________	________

(See Table I for additional lecture requirements)

Lecture quality control check ________ Date ________ Supervisor

III. Practical Factors

	Date Completed	Signature of Qualified Technician
1. Demonstrate a knowledge of emergency alarms, the proper action to take in the event of each alarm, evacuation routes, and emergency shutdown procedures.	________	________
2. Demonstrate the proper use of self-contained and forced air respiratory equipment.	________	________
3. Identify all radiation area and contamination area signs and explain when each is used.	________	________

(Additional practical factors reflecting the responsibilities of a Technician I should be included.)

Practical factor quality control check ________ Date ________ Supervisor

IV. Time Requirements for a Technician I

Minimum of 6 months as a Trainee

________ Date Training Began ________ Date ________ Supervisor

V. Comprehensive Examination

I certify that ________ has successfully passed the comprehensive examination for Health Physics Technician I.

________ Exam Grade ________ Date ________ Supervisor

VI. Final Certification Statement

________ is qualified to perform all duties of a Health Physics Technician I with the following limitations:

________ Date ________ Supervisor

FIG. 2. Sample qualification guide for Health Physics Technician I.

appropriate) on-the-job experience is required before the technician is eligible for promotion to the next qualification level. A comprehensive examination is given when the technician has completed the formal instruction, practical factors, and experience. This comprehensive examination is composed of a written section reviewing all aspects of the formal instruction, and an oral section reviewing the practical factors. Upon completion of these requirements, the technician is promoted to the next higher level of qualification. The Technician II module and the Senior Technician module consist of the same types of training as the Technician I module; however, the material is progressively more advanced and the practical factors reflect greater responsibility.

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CONCLUSION

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