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American Board Of Health Physics

DOCKETED
USNRC
JUN 6 1979
Office of the Secretary
Docketing & Service
Section

MAY 2[illegible] 1979

[illegible] - Misc. Notice
Reg. Guide

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Re: Proposed Revision 2 to Regulatory Guide 1.8 Personnel Selection
and Training

Dear Sir:

The following comments are submitted by the American Board of Health Physics:

The proposed revision to Regulatory Guide 1.8 is a complement to the present ABHP program; however, to specify where the Radiation Protection Manager should be located seems to be unnecessarily limiting. The ABHP recognizes and appreciates the importance of having the best available individuals on the "applied" end, but the Board feels that should be encouraged in more general ways.

Otherwise the American Board of Health Physics would like to support the Proposed Revision 2 to Regulatory Guide 1.8 Personnel Selection and Training.

After thorough deliberations over several years, the American Board of Health Physics has decided to offer specialty certification in power reactor health physics in addition to the presently offered comprehensive health physics certification.

A summary of the Board's deliberations was presented in the April 1978 Newsletter to certified health physicists (Enclosure 1). The responses from certified health physicists regarding the proposal to offer specialty certification in power reactor health physics were almost exclusively favorable.

The Board does not intend to offer specialty certification in other areas of health physics at present. The Board feels that specialty certification will only be considered when there is a genuine need in a given specialty area which cannot be adequately met by the present comprehensive health physics certification program. It is also the Board's intent not to take any action in the specialty certification area that would have an adverse effect on the present comprehensive health physics certification program.

It is the Board's position that comprehensive health physics certification signifies professional competence in the areas in which an individual is experienced; thus, in the power reactor health physics area and

[illegible] c/c

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POOR ORIGINAL 7907260249

Notes on Application for Course Approval for Credit Towards ABHP Continuing Certification

1. Organization or institution sponsoring and/or organizing this training.

2. Address of the above institution.

3. Individual knowledgeable in the details of the makeup of this education (i.e., the information asked for on this form) and who can be contacted for further information.

4. Full title, including subtitles.

5. Starting and ending dates. Repetitions over a two (2) year time span may be specified.

6. Individual(s) presenting the training. The resume should emphasize his qualifications to present this course as well as any relevant health physics background. The instructor's involvement in the design and preparation of the course should also be detailed.

7. Total time (hrs) and time presentation scheme (e.g., 8 hrs. per day, 3 hours per day). Identify separately the number of hours of laboratory or field exercises and outside preparation expected to be performed by the student.

8. As detailed as possible with emphasis on relevance to health physics. As a minimum include major subject areas and the relative portion of the course or training devoted to each area.

9. Also identify areas of required supplemental reading.

10. Both with regard to entry to the course and with regard to the student background assumed in the design of the course. Specifically, is the course designed for experienced health physicists?

11. Show how this course relates to health physics if it is not obvious based on the course description or how it is of particular value to this applicant where specific approval is being requested.

12. Please indicate if a personalized certificate or some other notice of course completion or level of performance shall be given to the student or attendees. This is strongly encouraged as means of assisting the ABHP in its continuing certification review process.

13. By representative of organization identified in 1 if request is other than from an individual C.H.P.

14. This is the individual to whom the approval will be sent unless otherwise indicated. Please indicate the reason for submitting this application.

15. Please allow at least six (6) weeks for ABHP-CEP review.

Send application to: Lester A. Slaback, Jr.
Armed Forces Radiobiology Research Institute
NNMC - Building 42
Bethesda, MD 20014

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For Official Use
Appl. No. ______
Date Rec'd ______

APPLICATION FOR ABHP-CEP COURSE APPROVAL

1. Institution:

2. Address:

3. Person Responsible: Phone ( ) ______________

4. Course Title: 5. Course Date:

6. Instructor(s) (Attach resume(s)):

7. Course duration (lecture and lab time), schedule and outside prep requirements:

8. Course description or outline:

9. Texts/Suppl. Info:

10. Prerequistites:

11. Relationship to Health Physics

12. Certificate of course completion to be awarded: Yes No (Circle)

13. Certification: This is an accurate description of the above named course or program.

Signature
Name
Title

14. Requestor:

Name Phone ( ) ______________

Address

Purpose:
___ For approval for only my attendance
___ For inclusion with publicity for this training
___ Other specify:

15. Date by which approval is required ______________

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AMERICAN BOARD OF HEALTH PHYSICS

Application For Renewal of Certification

INSTRUCTIONS

1. Type or print in block capitals.
2. Submit only one copy.
3. If space is inadequate for any answer, use extra sheet of paper and number items to correspond with items as listed.

Application for:
Initial Renewal ____
Later (specify 2nd, 3rd) _____
Emeritus Status ____

1. Name ______________________________ 2. Date of Birth ____________________
(last) (first) (middle)

3. Home Address ____

4. Business Address ____

5. Send mail to: home address ☐ Home Telephone Number ______________
business address ☐ (incl. area code)
Bus. Telephone Number ______________

6. Year of original certification by ABHP ______

7. ABHP/CEP-approved continuing education courses attended during current renewal period.

	Sponsor	Course Title	Where Offered	Dates From To	CEP Approval Certificate No.	Cont. Ed. Credits
a.						
b.						
c.						
d.						
e.						

8. Other ABHP-approved continuing education activities during current renewal period.

	Description of Activity	Where Offered	Dates From To	Cont. Ed. Credits
a.				
b.				
c.				
d.				
e.				

Note: Do not submit application until a minimum of 16 continuing education credits have been earned within your current renewal period.

9. Academic Degrees Attained:

	Institution	Major	Minor	Years of Full Attend.	Degree	Year
a.						
b.						
c.						

10. Additional education and training related to health physics (except as listed in 7 and 9) since you were certified or since last renewal.

	Institution	Title of Course	Length of Course	Dates From	To
a.					
b.					
c.					

11. Present position. Describe in your own words. Do not use official job descriptions. We are particularly interested in your health physics activities. Describe any previous positions with present employer in item 12.

Date Assigned to Position:	Name of Employer:	Place of Employment:	Name and Title of Immediate Supervisor:
Exact Title of Present Position:			
Description of work. Include major responsibility and specific fields Percent of time in health physics work ________.			

12. Previous positions held since you were certified or since last renewal. Start with most recent position and work back. Emphasize those portions of work that are health physics or closely related. Employer may or may not be same as in item 11.

Date of Employment: From: To:	Name of Employer:	Place of Employment:

Exact title of position:

Description of work. Include major responsibility and specific fields

Percent of time in health physics work _________.

Date of Employment: From: To:	Name of Employer:	Place of Employment:

Exact title of position:

Description of work. Include major responsibility and specific fields

Percent of time in health physics work _____ __.

13. Describe any other professional health physics activities, such as consulting, in which you have engaged in the past five years, or since your last renewal.

14. Current Professional and Technical Society Membership:

Name of Organization	Year Joined	Type of Membership	Office Held

15. Special Achievements:

a. Citations or other awards:

b. Committee Activities (past five years or since last renewal):

16. Communication (within past five years or since last renewal):

a. Books and journal articles published

b. Technical papers read at meetings

c. Technical reports, memoranda or similar documents (include a small but representative sample if possible).

d. Other speeches and lectures related to health physics

17. Categories of Competence:

Select the categories in the list below in which you feel you are competent at this time to function as a Certified Health Physicist. Rank these in the order of your proficiency. (1 for your first choice, 2 for your second, etc.).

___ Industrial Radiographic Installations
___ Medical Radiographic and Fluoroscopic Installations
___ Radiotherapy Installations
___ Radionuclide Laboratories
___ Enviornmental Monitoring
___ Other (specify)______________________________

___ Nuclear Power Reactors
___ Nuclear Fuel Cycle Facilities
___ Accelerators
___ Radiological Engineering
___ Regulatory Programs
___ Other (specify)____________

18. Professional References: name and address of at least two persons other than your supervisor who are qualified to evaluate your health physics competence. If possible, at least one reference should be a Certified Health Physicist; do not use a Board or Panel member as a reference. References will be consulted only in exceptional cases where the Board needs additional information.

____

____

____

I certify that the statements above (including any attachments I have submitted hereto) are, to the best of my knowledge, accurate, and I understand that any falsification of information in this application will be cause for rejection of the application or withdrawal of a certification already made.

____

Signature (in ink)

19. Statement Concerning Professional Responsibilities of Certified Health Physicists

In order to maintain his technical competence, the Certified Health Physicist has a commitment to remain active in the field of health physics and acquainted with the scientific, technical and regulatory developments in his field.

In order to uphold the professional integrity of health physics implied in this certification, his relations with others, including clients, colleagues, governmental agencies, and the general public shall always be based upon and reflect the highest standards of professional ethics and integrity. The Certified Health Physicist shall represent himself as an authority only in those areas in which he has extensive experience and in which he is considered expert by his peers.

By my signature, I verify that I am fulfilling the Professional Responsibilities of a Certified Health Physicist.

Date: ____________________ Signature (in ink): ____________________

Note: This application is not complete unless you have signed your name twice above and have included a check, for the renewal of certification, made out to the American Board of Health Physics, in the amount of $20.00. Send to C. J. Roberts, EIS-Bldg 10, Argonne Natl. Lab., Argonne, IL 60439

GUIDELINES FOR THE
AMERICAN BOARD OF HEALTH PHYSICS
CONTINUING CERTIFICATION PROGRAM

I. Renewal Period

In the five-year period beginning on January 1, 1977, and during each four-year period thereafter, each Certified Health Physicist shall renew his* certification. Individuals certified after January 1, 1977, shall renew their certification within each four-year period starting on January 1 in the year after certification is awarded.

Explanatory Note: Present Certified Health Physicists would be required to renew their certification before January 1, 1982. The next renewal deadline would be January 1, 1986. For example, an individual may choose to have his certification renewed in 1978 and he may wait until 1985 before the next renewal.

II. Extension of Renewal Period

The ABHP may extend the renewal interval, upon request, when an individual cannot meet the requirements because of sickness, foreign residence or other unusual circumstances.

Explanatory Note: This flexibility is provided to allow the Board to grant extensions when necessary. These cases should be infrequent.

III. Requirements for Continuing Certification

To renew his certification a diplomate shall remain active in the profession of health physics and keep abreast of new developments in the profession. Demonstration of these requirements shall be provided through the following steps that shall be accomplished during the renewal period:

a. Submission of an Application for Renewal of Certification.

b. Attendance at ABHP-approved continuing education courses, or other approved activities.

c. Submission of additional information to describe and verify his continuing professional responsibilities and activities if requested by the Board.

Explanatory Notes:

a. The Application for Renewal of Certification will provide the Board with information about the diplomate's professional activities since his previous application was submitted. The form will be similar to the original application for certification. The application will also include a reaffirmation that the individual is fulfilling the Professional Responsibilities of a Certified Health Physicist.

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* Throughout this document the conventional masculine pronoun is used when collective members of both sexes are referred to: thus, his = his/her.

b. In his renewal application, the diplomate will demonstrate the extent to which he remains active in health physics. His efforts may include teaching, conducting and reporting the results of research, participating in scientific reviews and standards setting, and other activities which have a significant educational component. While these activities are relevant to the first requirement for continuing certification, they do not satisfy the requirement for continuing education.

c. The continuing education requirement may be met by attending professional-level courses on advanced health physics topics approved by the ABHP. During the renewal period, each diplomate shall attend courses or other activities providing a total of at least 16 continuing education credits (CEC's).

d. In order for the diplomate to receive credit, each course he attends must be approved by the Board's Continuing Education Panel (CEP). At the time the course is approved the Panel will determine the number of continuing education credits to be awarded to participants. In no case will the number of CEC's exceed the number of contact hours of lecture or demonstration, and it may be less. Course examinations will not be required. Lecturers at an ABHP/CEP-approved course will receive appropriate credit depending on the extent to which their participation constitutes an educational experience for them.

e. Applications for accrediting of advanced health physics courses for continuing education may be submitted to the Panel by the course organizers or by an individual Certified Health Physicist. Courses may be sponsored by any organization. If possible, approval by the Panel should be obtained before the course is held; however, within defined limits, applications may be submitted after the course has been completed.

f. The primary responsibility of the Panel on Continuing Education is to accredit courses. It will not organize and conduct courses itself, although it may offer assistance to other organizations. Whenever practical, the ABHP/CEP will announce approved courses in advance through selected publications or other means; however, the sponsoring organization will have the primary responsibility for announcements as well as all other aspects of the course. Educational activities other than participation in formal courses also may be approved by the Board for credit toward satisfying the requirements for continuing certification.

g. If the Board cannot determine through a review of the Application for Renewal of Certification that the applicant is actively engaged in the profession of health physics at least 25% of his working time and fulfilling the Professional Responsibilities of a Certified Health Physicist, the Board may require the applicant to submit reports or other documentation and letters of reference to assist the Board in its review. These cases should be infrequent.

IV. Classification of Certified Health Physicists

There shall be three classes of Certified Health Physicists:

Certified Health Physicist: This class shall consist of all diplomates who, in the judgment of the Board, meet the requirements for recertification. These individuals shall be included in published listings of Certified Health Physicists.

Certified Health Physicist - Emeritus: This class shall include Certified Health Physicists who have retired from active professional practice. These individuals shall be included in published listings of Certified Health Physicists with the Emeritus designation.

Certified Health Physicist - Inactive: This class shall consist of all individuals who, in the judgment of the Board, do not meet the requirements for continuing certification. These individuals shall not be included in the published listings of Certified Health Physicists. At any future time, an individual in this class may regain active status upon completion of the requirements for renewal of certification. The necessary 16 CEC's must have been earned within the span of four consecutive calendar years including the year in which application is made.

Explanatory Notes:

a. The Emeritus status will be awarded, upon request, to Certified Health Physicists who retire from active participation in professional activities because of age or health requirements.

b. The Inactive status will, in most cases, result from individuals changing disciplines. For several reasons, the Board chooses to place these individuals in an Inactive status rather than revoke certification. The most compelling reason is that legal action may be initiated to prevent revocation of certification. Although the Board is confident that its judgment would be upheld, the Board prefers to use its limited resources to further the certification program rather than expend them in legal procedures.

V. Renewal Fee

The renewal fee shall be $20.

Explanatory Note: The fee for renewal of certification will be paid at the time the Application for Renewal of Certification is submitted. In addition, organizations that sponsor continuing education courses may charge a registration fee for the courses. The Board will encourage these organizations to establish the registration fees at a reasonable level. Preferably, these fees should only reimburse the sponsoring organization for the expenses incurred in the administration of the course.

VI. Appeals

Individuals shall have the right to meet with the Board and appeal any decision made by the Board that affects their certification status.

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American Board Of Health Physics

CONTINUING EDUCATION PANEL

General policies and procedures.

A. In order to qualify for credit toward meeting the continuing education requirements of the American Board of Health Physics (ABHP) all courses and other activities must be approved by the Continuing Education Panel (CEP). Application for approval may be made directly to the Chairman of the CEP by the course sponsor or a participating Certified Health Physicist (CHP). Applicants are urged to submit their requests far enough in advance that a decision can be made by the Panel and announced before the course begins; however, the Panel will accept without prejudice (applying their usual approval criteria) all applications received within ninety (90) days after an event has concluded.[1] Applications must be in the form specified by the Panel and be complete in all respects.

B. In the context of this document, a "continuing education course" is a program that is formally organized, is offered within a specific time period, covers preselected topics and is given by specified individuals. Only that portion of a program which relates rather directly to health physics and contributes to the technical competence of the CHP will be approved. Related subjects are those that are used directly in health physics but are not usually designated as health physics courses. Examples of these might be statistics, meteorology as applied to environmental dose assessment, reactor coolant chemistry and radiation genetics. The Panel will evaluate each course on the basis of content, instructors' qualifications, degree of student involvement and schedule. After weighting these factors according to an established formula, it will assign each course a number of continuing educations credits which may be less than the number of contact hours.

C. The following activities have been reviewed by the CEP and approved for continuing education credit without specific application by individual CHP's. These approvals are exclusive of any additional education credits that might be earned by attending specific events at these meetings.

(1) Attendance and participation at the annual Health Physics Society meeting shall receive one continuing education credit per day with a limit of three (3) credits per meeting.[2]

(2) Attendance and participation at the HPS Midyear Topical Symposium shall receive one continuing education credit per day with a limit of three (3) credits per meeting.[2]

D. Course sponsors or organizers are strongly encouraged to provide certificates of attendance or other forms of recognition to the attendees.

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[1] As an exception, applications for approval of continuing education activities concluded any time during 1977 will be accepted through April 1, 1978.

[2] The ABHP will accept a maximum of 8 CEC's acquired through attendance at these meetings toward the required total of 16 credits.

American Board Of Health Physics

Memo to: Certified Health Physicists

From: C. J. Roberts, Vice Chairman, ABHP

Subject: Continuing Certification Program

This is a status report on the Continuing Certification (or recertification) Program of the American Board of Health Physics.

The program had a lengthy gestation period which included an open discussion of continuing certification at the Annual Health Physics Society meeting in 1975 and invitations* to all CHP's for comments concerning the Board's evolving proposals. As a result of this extended dialogue the Board diplomates did reach a consensus on guidelines for a continuing certification program. These guidelines, formally adopted by the American Board of Health Physics at its meeting on June 27, 1976, are enclosed (see Attachment I).

At its San Francisco meeting last June, the Board also appointed the Continuing Education Panel called for by the guidelines. The panel is chaired by Roger J. Cloutier (see Attachment II for complete membership list). The responsibilities of the Panel include establishing standards for approval of courses to meet ABHP continuing education requirements.

Although the Panel is not ready to publish a general set of standards for use by potential sponsors in organizing acceptable courses, it is in the process of approving certain refresher courses to be given at the 22nd Annual HPS meeting in Atlanta, July 3-8, 1977. As soon as these arrangements are completed the details will be announced in the HPS Newsletter, and in the program for the Atlanta meeting. As many as 6 hours of lecture may be approved for credit. Since the refresher courses have been scheduled in pairs, anyone at the Atlanta meeting will be able to attend up to three hours of approved lectures. A total of 16 contact hours of lectures and demonstrations in advanced health physics topics is required during each renewal period, including the initial one which ends on December 31, 1981.

The Board expects to publish general standards for approval of continuing education courses soon after the Annual HPS meeting. Applications for renewal of certification also will be available at that time, although it will not be possible for CHP's to apply until they have accumulated the required credits for attendance of approved courses.

Please let me know if you have questions or comments concerning the continuing certification program.

C. J. Roberts
CEA-15
Argonne National Laboratory

Phone:
312-739-7711
Ext. 2211

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*From W. C. Reinig, Chairman of the ABHP at that time, dated October 10, 1975, and March 15, 976.

AMERICAN BOARD OF HEALTH PHYSICS
CONTINUING CERTIFICATION PROGRAM

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Explanatory Note: Present Certified Health Physicists would be required to renew their certification before January 1, 1982. The next renewal deadline would be January 1, 1986. For example, an individual may choose to be recertified in 1977 and he may wait until 1983 before the next renewal.

II. Extension of Renewal Period

The ABHP may extend the renewal interval, upon request, when an individual cannot meet the requirements because of sickness, foreign residence or other unusual circumstances.

Explanatory Note: This flexibility is provided to allow the Board to grant extensions when necessary. These cases should be infrequent.

III. Requirements for Continuing Certification

To renew his certification a diplomate shall remain active in the profession of health physics and keep abreast of new developments in the profession. Demonstration of these requirements shall be provided through the following steps that shall be accomplished during the renewal period:

a. Submission of an Application for Renewal of Certification.

b. Attendance at ABHP-approved continuing education courses.

c. Submission of further documentation to verify professional responsibilities and activities may be required by the Board.

Explanatory Notes:

a. The Application for Renewal of Certification will provide the Board with information about the diplomate's professional activities during the past four years. The form will be similar to the original application for certification. The application will also include a reaffirmation that the individual is fulfilling the Professional Responsibilities of a Certified Health Physicist.

b. The continuing education requirement will be met by attending professional-level courses approved by the ABHP. During the renewal period, each diplomate shall attend a course or courses providing a total of at least 16 contact hours of lectures and demonstrations on advanced health physics topics. No course examinations will be required. Courses may be sponsored by any organization. Each course must be approved by the ABHP prior to attendance. Approval may be requested by sponsors of courses or by individual Certified Health Physicists. The Board will establish a Panel on Continuing Education to arrange and accredit courses. Lecturers at an ABHP-approved course will receive appropriate credit depending on the extent of their participation. Whenever practical, the ABHP will announce the approved courses in advance through selected publications; however, the sponsoring organization will have the primary responsibility for course announcements.

c. If the Board cannot determine through a review of the Application for Renewal of Certification that the applicant is actively engaged in the profession of health physics at least 25% of his/her working time and fulfilling the Professional Responsibilities of a Certified Health Physicist, the Board may require the applicant to submit reports or other documentation and letters of reference to assist the Board in its review. These cases should be infrequent.

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Certified Health Physicist - Inactive: This class shall consist of all individuals who, in the judgment of the Board, do not meet the requirements for continuing certification. These individuals shall not be included in the published listings of Certified Health Physicists. At any future time, an individual in this class may regain active status upon completion of the requirements for renewal of certification.

Explanatory Notes:

a. The Emeritus status will be awarded, upon request, to Certified Health Physicists who retire from full-time active participation in professional activities because of age or health requirements.

b. The Inactive status will, in most cases, result from individuals changing disciplines. For several reasons, the Board chooses to place these individuals in an Inactive status rather than revoke certification. The most compelling reason is that legal action may be initiated to prevent revocation of certification. Although the Board is confident that its judgment would be upheld, the Board prefers to use its limited resources to further the certification program rather than expend them in legal procedures.

V. Renewal Fee

The renewal fee shall be $20.

Explanatory Note: The fee for renewal of certification will be paid at the time the Application for Renewal of Certification is submitted. In addition, organizations that sponsor continuing education courses may charge a registration fee for the courses. The Board will encourage these organizations to establish the registration fees at a reasonable level. Preferably, these fees should only reimburse the sponsoring organization for the expenses incurred in the administration of the course.

VI. Appeals

Individuals shall have the right to meet with the Board and appeal any decision made by the Board that affects their certification status.

CONTINUING EDUCATION PANEL

Chairman: Roger J. Cloutier
Vice-Chairman: Robert L. Junkins

Term Expires 1977

Donald E. Barber
815 22nd Avenue, NW
New Brighton, MN 55112
(612)373-8080

T. Jordan Powell
Mail Code L-518
Lawrence Livermore Laboratory
Livermore, CA 94550
(415)447-1100 X 3822
FTS: 457-3822

Term Expires 1978

Roger J. Cloutier
Oak Ridge Associated Universities
P. O. Box 117
Oak Ridge, TN 37830
(615)483-8411 X 263
FTS: 850-4642

Jean St. Germain
Department of Medical Physics
Memorial Sloan-Kettering Cancer Center
1275 York Avenue
New York, NY 10021
(212)794-7390

Term Expires 1979

Frazier Bronson
2647 North Prindle
Arlington Heights, IL 60006
(312)266-8566 (work)
(312)259-7076 (home)

Francis J. Haughey
Radiation Science
Busch Campus
Rutgers University
New Brunswick, NJ 08903
(201)932-2551 or 2582

Term Expires 1980

Robert L. Junkins
Radiation Management Corporation
Suite 400, Science Center Bldg. #2
3508 Market Street
Philadelphia, PA 19104
(215)243-2964

Lester A. Slaback, Jr.
Armed Forces Radiobiology Research Institute
Defense Nuclear Agency
Bethesda, MD 20014
(202)295-1285

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American Board Of Health Physics

March 1978

Dear Colleague:

Enclosed for your information is material concerning the Continuing Certification Program. The following information is enclosed:

(1) General Policies and Procedures

(2) Guidelines for the ABHP Continuing Certification Program

(3) Application for Renewal of Certification

(4) Application for ABHP-CEP Course Approval

Inquiries concerning the Continuing Education Program should be made to the following individuals:

(1) Inquiries concerning education credits for courses and related activities should be directed to:

Lester Slaback
AFRRI NNMC
Bethesda, Maryland 20014

(2) Inquiries concerning continuing certification of individuals and applications should be directed to:

Carlyle J. Roberts
Division of Environmental Impact Studies
Building 10
Argonne National Laboratory
Argonne, Illinois 60439

In addition, information dealing with courses and supporting documentation submitted to L. Slaback should be summarized in concise language not to exceed 5 pages. If more than 5 pages are required, then the individual and/or organization should provide 8 additional copies.

A formal newsletter summarizing the previous year's activities will be transmitted in April.

Thank you for your continued support of ABHP activities.

Mike
Michael S. Terpilak
Secretary-Treasurer

568 060

DRAFT

FINAL ACTION OF THE BOARD

The final action of the Board is based on its evaluation of the applicant's total professional record, i.e., his training and experience, the achievements he has obtained in health physics and related fields, the maturity of his judgement, the ethical nature of his professional conduct as indicated by his associates and peers, and often the results of oral interviews as well as the written examination. Anyone meeting the education and experience requirements and who is practicing health physics in a competent and ethical manner is strongly urged to apply to the Board for admission to the written examination. Although satisfactory performance on the written examination is a necessary but not sufficient requirement, persons who are admitted to and who perform well on the examination usually recieve certification by the Board.

REVOCATION OF CERTIFICATE

Certificates may be revoked for actions considered by the Board to be in violation of the statement "Professional Responsibilities of Certified Health Physicists." Any person for whom such action is contemplated shall have the right of appearance before the Board.

CHANGE IN REQUIREMENT

Current requirements, procedures, and fees of the American Board of Health Physics are described in this brochure. These are subject to change without notice; however, changes will be published before their effective date whenever practical. No changes will be retroactive.

CORRESPONDENCE

All correspondence to the American Board of Health Physics should be sent to:

POOR ORIGINAL

568 061

AMERICAN BOARD OF HEALTH PHYSICS HISTORY

Shortly after its organization, the Health Physics Society established a Committee to study the need for certification of health physicists and to develop plans for certification if this appeared to be desirable. After an intensive study, the Committee recommended that an American Board of Health Physics be established to develop standards and procedures, to examine candidates, and to issue written proof of certification to individuals who have satisfied the requirements established by the Board. The Board of Directors of the Society decided that these recommendations had merit and appointed a temporary American Board of Health Physics on November 8, 1958.

The temporary ABHP developed a set of minimum requirements for certification after carefully reviewing the professional background of 100 selected individuals believed to be representative of those recognized as competent health physicists. These minimum requirements were submitted to the membership of the Society for comment. At the Society's Annual Meeting in June 1959, the matter was discussed in an open meeting and there was general support for the plan. The Board of Directors of the Society formally established the American Board of Health Physics by approving an amendment to the By-Laws of the Society on October 29, 1959.

The ABHP was incorporated in the State of New York on December 1960. Provision was made for organizations other than the Health Physics Society to be represented on the Board.

The American Board of Health Physics has seven members. Five are sponsored by the Health Physics Society, one by the American Association of Physicists in Medicine, and one by the American Public Health Association. Each member serves a five-year term.

An Examination Panel consisting of Certified Health Physicists appointed by the Board prepares, administers, and grades the written certification examination under the guidance and approval of the Board.

In September 1978, after consideration for over three years, the ABHP decided to offer a Specialty Certification in Power Reactor Health Physics in addition to the Comprehensive Certification. The Board appointed a Power Specialty Examination Panel to prepare, administer and grade the Power Reactor Specialty Examiniation under the guidance and approval of the Board.

APPLICATION AND FEE

Application for examination must be made on the prescribed form which is available from the Chairman. Applications should be filed with the Chairman at least two months before the date of the examination. Certification fees are as follows:

Certification Step	Fee*
Application to take Part I of written examination	$75
Application to take Part II of Comprehensive or Power Reactor Specialty written examination only	$75
Application to take Parts I and II of the written Comprehensive or Power Reactor Specialty examinations together	$150
Charge for oral examination (if required)	$75
Charge for certification plaque	$25

Re-examination fees following failure of the exam are the same as original application fee schedule above.

*Effective January 1, 1979.

EXAMINATIONS

Examinations are usually given once a year - at the time of the Annual Meeting of the Health Physics Society. They are conducted at the location of the Society's meeting and may also be given at other selected locations if demand warrants.

Permits are required for entry into the examination room. No reference material may be brought into the room.

RE-EXAMINATIONS

A candidate who fails his first examination may be admitted to a second examination after one year. A candidate who fails to appear for re-examination within two years must submit a new application.

After a second failure, a new application must be filed. The candidate must also submit evidence of substantial additional study before being allowed to take the examination for a third time.

POOR ORIGINAL

EARLY ADMISSION TO WRITTEN EXAMINATION

Applicants are permitted to take Part I of the written examination if they have fulfilled the academic requirements for the MS degree in Radiation Safety or a closely related field, have recieved a Bachelor's Degree in Radiation Safety and have one year of practical (professional level) experience, or have a general Bachelor's Degree and two years of professional experience at the time of the examination. Applicants must meet all the requirements listed in the preceding section before being admitted to Part II.

The purpose of early admission to Part I of the examination is two-fold: (1) to allow the recent graduate an opportunity to demonstrate competence in the fundamentals of health physics at the beginning of his career, and (2) to encourage younger health physicists to proceed toward certification. Applicants who successfully complete this step in the examination procedure will be required to take only Part II of the written examination when they apply later for regular certification.

SPECIALTY CERTIFICATION IN POWER REACTOR HEALTH PHYSICS

A diplomate with comprehensive certification can apply for Power Reactor Specialty Certification with examination if that that person meets the following additional experience requirements:

a. Within the past six years of the date of the application, the diplomate has spent at least two years in a position which has as a responsibility a major portion of the health physics program for an operating nuclear power plant.

b. The diplomate is presently spending at least 50% of his time in power plant reactor health physics.

(In questionable cases, the Board may give the candidate the option of taking Part II of the specialty exam or an oral exam for the purpose of evaluating the candidate's knowledge of power reactor health physics.)

If a diplomate with Comprehensive Certification does not meet the above additional experience requirements, but does have at least three years of professional experience in applied radiation protection work with nuclear facilities dealing with radiological problems similar to those encountered in nuclear power stations, the candidate may apply to take Part II of the Power Reactor Specialty Certification Examination.

A diplomate with Power Reactor Specialty Certification can apply to take Part II of the comprehensive certification examination and obtain Comprehensive Certification upon successful completion of the examination.

PURPOSES OF THE BOARD

First: To elevate the standards and advance the profession of health physics by encouraging its study and improving its practice.

Second: To encourage and insist on the highest standards of professional ethics and integrity in the practice of health physics.

Third: To determine the competence of the specialists in health physics and to arrange, control, and conduct investigations and examinations to test the qualifications of voluntary candidates for certificates to be issued by the Board.

Fourth: To grant and issue certificates in the field of health physics to voluntary applicants and to maintain a registry of holders of such certificates.

MEANING OF CERTIFICATION

The certificate indicates that its holder has completed certain requirements of study and professional experience, which the Board considers to constitute an adequate foundation in health physics and has passed an examination designed to test his competence in this field.

It should be recognized that the certificate awarded by the Board is not a license and, therefore, does not confer a legal qualification to practice health physics.

PROFESSIONAL RESPONSIBILITIES OF CERTIFIED HEALTH PHYSICISTS

In achieving certification, the Certified Health Physicist recognizes and assumes the responsibilities due the profession of health physics.

To maintain his technical competence, the Certified Health Physicist has a commitment to remain active in the field of health physics and is acquainted with the scientific, technical and regulatory developments in his field.

To uphold the professional integrity of health physics implied in this certification, the relations of the Certified Health Physicist with other individuals and groups including clients, colleagues, governmental agencies, and the general public shall always be based upon and reflect the highest standards of professional ethics and integrity.

The Certified Health Physicist shall represent himself as an authority only in those areas in which he is considered expert by his peers.

CONTINUING CERTIFICATION

•

In January 1977, a Continuing Certification program was initiated by the American Board of Health Physics in an effort to ensure that Certified Health Physicists are fulfilling their professional responsibilities and to encourage continued professional development. To remain on the list of active Certified Health Physicists, individuals must be re-certified every four years. The requirements for continued certification are: (1) to be engaged substantially and currently in professional health physics practice; and, (2) to have earned during the four-year period at least 16 Continuing Education Credits by participation in ABHP approved courses, meetings and other activities. The Board established a Continuing Education Panel which reviews courses in advanced health physics and related subjects that are submitted to it by the course organizers, and determines the number of Continuing Education Credits to be awarded to participants.

GENERAL REQUIREMENTS

Requirements for candidates for certification are as follows:

1. ACADEMIC - The applicant must have a Bachelor's Degree in physical science or in a biological science with a minor in physical science. In exceptional cases, persons who have demonstrated adequate knowledge of health physics, but who are deficient in these academic requirements may, at the discretion of the Board, be permitted to substitute experience for academic requirements.

2. EXPERIENCE - An applicant must have at least 6 years of full-time equivalent professional experience in health physics. At least 3 years of the experience must have been in applied radiation protection work. Additional education may be substituted for up to a maximum of 2 ½ years of experience as follows:

Type of Study	Years of study or degree	Equivalent credit for experience
General - related to HP	1	½
General - related to HP	2 or MS	1
General - related to HP	Ph.D.	2
Health Physics	1	1
Health Physics	2 or MS	1-½
Health Physics	Ph.D. or Sc.D.	2-½

An applicant may not claim professional experience for an advanced degree and work experience for the same period. For example, if an applicant attends night school for four years and earns an MS degree, and during the same period he is employed as a health physicist, he may claim four years professional experience, but not claim an additional year of experience for his MS.

For Power Reactor Specialty Certification, at least 3 years of the professional experience must be in applied radiation protection work with nuclear facilities dealing with radiological problems similar to those encountered in nuclear power stations, preferable in an actual nuclear power station.

3. PROFESSIONAL - Each applicant must be engaged in the professional practice of health physics a substantial portion of his time. Reference statements are required from the applicant's supervisor (if appropriate) and from at least two other individuals who are professionally qualified to evaluate the applicant's ability in health physics. It is recommended (but not required) that at least one reference be a health physicist already certified by the ABHP.

4. WRITTEN REPORT - The Board, after examination of the application for certification, may request reports on radiation protection evaluations made personally by or under the supervision of the applicant. Each applicant must be capable of making a satisfactory evaluation on several installations or operations involving possible radiation hazards of which those listed below are examples:

   a. Radiographic installation - industrial or medical
   b. Fluoroscopic installation
   c. Therapy installation
   d. Radionuclide laboratory
   e. Air and water sampling and environmental survey
   f. Nuclear fuel processing plant
   g. Nuclear reactor
   h. Major decontamination operation
   i. Particle accelerator

5. EXAMINATION - Written examinations will be mandatory; oral examinations will be at the discretion of the Board. The written examination has 2 parts: Part I determines the competence of the applicant in fundamental aspects of health physics and Part II determines his competence in practical health physics topics. The examination must be taken within 2 years of notification of eligibility, or a new application must be submitted.

LAWRENCE LIVERMORE LABORATORY
Hazards Control Department

April 6, 1979

TO: AMERICAN BOARD OF HEALTH PHYSICS
BOARD AND PANEL MEMBERS

Enclosed is a directory of all ABHP board and panel members. Please let me know if any of the information is incorrect.

Sincerely,

Dave Myers

David S. Myers

DSM:gw

Enclosure

University of California / P.O. Box 5505 / Livermore, California 94550 / Telephone (415) 422-1100 / FTS 532-1100 / TWX 910-386-8339 / DOE LLL LVMR

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EXAMINATION PREPARATION GUIDE

American Board
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Health Physics

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EXAMINATION PREPARATION GUIDE

American Board of Health Physics

1979

EXAMINATION PREPARATION GUIDE

American Board of Health Physics

TABLE OF CONTENTS

Section 1

Message to Candidates

This guide will help you prepare for the ABHP certification examination. However, use of the Guide by itself will not be adequate preparation for the exam. Successful candidates usually start their preparation months before the test. Preparation should include a careful review of health physics fundamentals and then review of applied aspects of health physics in several of the specialty areas. The suggested study references in Section 7 will help guide you to some of the pertinent information. Joining either a formal or informal study group (particularly those that continue over a period of months) can assist you by forcing a systematic review of various topics and by exposing you to the knowledge of people expert in subjects which you are not familiar with.

The Board warns against approaching the exam in a casual fashion. We find that most unsuccessful candidates did not prepare adequately. In contrast, the successful candidates have usually planned and followed a comprehensive study program.

Because candidates credentials are reviewed carefully, the Board feels that all applicants declared eligible to take the examination have a good probability of passing. You can avoid the disappointment of poor performance by recognizing from the start that the exam will be a rigorous test of your professional knowledge. Your grade will represent, for the most part, the thoroughness of your preparation.

Now that you know the key to good performance on the examination, the Board wishes you success in achieving certification.

Content of the Examination

The examination has two parts.

Part I is made up of 150 multiple choice questions, divided into three general categories: Fundamentals, measurements, and operational health physics. (A more detailed breakdown by subject matter is given in Section 3 of this Guide.) Each question has five answers, and each of the answers is a plausible answer. Selecting the proper answer requires thorough knowledge of the subject matter. For example, in questions that require calculations, answers other than the correct one are obtained by making some of the common calculational errors. Three hours are allowed to answer Part I (given in the morning of the examination day). Not all of the questions in Part I are replaced each year. As a consequence, this part of the examination is held in strict confidence and copies of past exams are not distributed. Section 4 of this Guide gives some typical Part I questions.

Part II is an essay type exam which is made up of sixteen questions. The candidate may select any seven of the questions to answer, and has four hours in which to complete Part II (given in the afternoon of the examination day). Part II contains four general questions which cover topics such as dosimetry, shielding, emergency response, instrumentation, effluent monitoring, waste disposal, air sampling, meteorology, radiation biology, standards and regulations, and topical subjects. The exam also includes two questions on the health physics aspects of each of the following specialty areas:

Accelerators

Environmental

Fuel Cycle (mining, milling, fuel fabrication and fuel reporcessing)

Medical

Power Reactors

University

Under each specialty area, one of the two questions is specific to the specialty area to allow the specialist to demonstrate his experience and ability; while the other question is kept more general so a person without detailed experience in that specialty, but who has studied in the specialty, should be able to answer it.

Part II questions and problems are designed to test judgment, the ability to analyze and organize complex problems, and the use of practical skills at a high professional level.

Constants needed for the solution of numerical problems are provided. Logarithm and exponential tables are also made available to examinees. Standard slide rules and non-programable calculators may be used during the exam, but so-called "health physics" slide rules are not permitted.

Part II of the exam is made up of new questions each year, so copies of old exams are available. (Copies of the six most recent exams are included in Section 5 of this Guide.)

Further information about the certification program may be obtained from the chairman of the American Board of Health Physics. Please write to:

Mr. Bryce L. Rich
Allied Chemical Corp.
550 2nd Street
Idaho Falls, Idaho 83401

Section 3

Part I - Topics Covered

Part I of the exam is broken down into three general categories. The number of questions in each category and the subjects covered in each category are:

1. Fundamentals - 50 questions

   a. Sources
   b. Units
   c. Atomic Structure
   d. Decay
   e. Interaction of Radiation with Matter
   f. Radiobiology

2. Measurements - 30 questions

   a. Personnel Dosimetry
   b. Bio-assay and Whole Body Counting
   c. Instruments
   d. Calibration
   e. Measurement of Radiation
   f. Statistics
   g. Radiochemistry and Sample Preparation
   h. Dose Estimates

3. Operational Health Physics - 70 questions

   a. Laboratory Design
   b. Shielding and Equipment Design
   c. Contamination Control
   d. Surveys and Inspection
   e. Waste Processing
   f. Emergency Response
   g. Criticality Controls
   h. Accelerator Safety
   i. Reactor Health Physics
   j. Environmental Surveillance
   k. Waste Disposal
   l. Hazards Analysis
   m. Medical Health Physics
   n. Standards, Guides and Regulations
   o. Medical-Legal Aspects

p. Data Evaluation
q. Emergency Planning
r. Public Relations
s. Procedures
t. Non-ionizing Radiation

Section 4

Part I - Typical Questions

Fundamentals

1. The Roentgen is equal to:

   1. 1.0 Coulomb/kg.
   2. 1.00×10^{-3} Coulomb/kg.
   3. 5.28×10^{-3} Coulomb/kg.
   4. 2.58×10^{-4} Coulomb/kg.
   5. 5.28×10^{-4} Coulomb/kg.

2. The term solubility or transportability, when applied to the metabolism or radionuclides, refers to the:

   1. Metabolic breakdown of a radionuclide - containing compound which allows its incorporation into body tissues.
   2. Solubilization of a radionuclide - containing compound by means of hydration, ion exchange, or esterification reactions.
   3. Translocative dissimilation of a radionuclide - containing compound by means of biological-chemical action such as enzymatic attachment and catabolism.
   4. Property of a radionuclide - containing compound which results in its transfer across body membranes.
   5. Translocation of a radionuclide - containing compound from one point to another under conditions of physiological dysfunction.

3. The collection of ions produced as a result of X or gamma ray interactions in a given small volume of air under electronic equilibrium conditions is a measure of the:

   1. Dose equivalent
   2. Linear energy transfer
   3. Absorbed dose
   4. Specific ionization
   5. Exposure

4. Which one of the following statements concerning radioactive decay is correct?

   1. Secular equilibrium exists when the decay constant of the daughter is slightly greater than that of the parent.
   2. In secular equilibrium the activity of the daughter is inversely proportional to that of the parent.
   3. In transient equilibrium the activity of the daughter is less than that of the parent.
   4. Equilibrium exists if the half-life of the daughter is shorter than that of the parent.
   5. Transient equilibrium exists if the half-life of the parent is very much longer than that of the daughter.

5. In tissue, fast neutrons lose from 80% to 95% of their energy in interactions with:

   1. Sodium
   2. Nitrogen
   3. Oxygen
   4. Hydrogen
   5. Carbon

6. An investigator has received some Zirconium-95 ($T_{\frac{1}{2}}$ = 65 days) for use in a long-term study. He finds the Zirconium to be contaminated with Cobalt-60 ($T_{\frac{1}{2}}$ = 5.24 years) such that the ratio of μCi ^{60}Co/μCi ^{95}Zr is 0.012. After the initial assay, the activities of the two emitters will become equal in:

   1. 280 days
   2. 290 days
   3. 340 days
   4. 360 days
   5. 430 days

7. The International Commission on Radiation Units and Measurements has considered it necessary in radiation protection to provide a factor that denotes the modification of the effectiveness of a given absorbed dose by linear energy transfer. This factor is:

   1. Dose equivalent
   2. Relative distribution function
   3. Quality factor
   4. Relative biological effectiveness
   5. Distribution factor

Measurements

1. Which one of the following solid-state materials has the most constant response per roentgen over the energy range of 0.01 to 1 MeV when used as a dosimeter without special shields to correct for energy dependence?

   1. Calcium Sulfate
   2. Calcium Fluoride ($CaF_2:Mn$)
   3. Lithium Drifted Germanium
   4. Low-Z Glass Rods
   5. Lithium Fluoride (TLD-100)

2. The response time of an ionization chamber-type survey meter used to measure an X-ray beam is not influenced by the:

   1. Inertia of the meter movement
   2. Range selector resistance
   3. Circuit capacitance
   4. RC time constant
   5. Incident X-ray photon energy

3. In a satisfactory 'air-walled' ionization chamber the ionization per cubic centimeter would be:

   1. Inversely proportional to the density of the gas in the chamber.
   2. Inversely proportional to the gamms ray energy absorbed per cubic centimeter of wall material.
   3. Directly proportional to the stopping power of the walls for electrons.
   4. Independent of the density of the gas in the chamber.
   5. Independent of the volume of the chamber.

4. Unless some type of internal or external quenching is used, a geiger detector will retrigger because of the:

   1. Breakdown of the detector gas caused by interaction with the negative ion sheath.
   2. Bremsstrahlung produced by the negative ion sheath during the avalanche.
   3. Decrease in the density of the positive ion sheath caused by recombination of the ion pairs.
   4. Electrons released while the positive ion sheath is being neutralized at the outer cathode wall.
   5. Extraneous noise produced by the high-voltage power supply in the circuit.

Operational Health Physics

1. The half-value thickness for 1 MeV photons in lead approximates 1 cm. A 100- millicurie essentially massless source of Zinc-65 (gamma-ray energy = 1.12 MeV) produces a dose rate of 30 milliroentgens/hour at 1 meter without shielding. What would the dose rate be at about 10 cm from this source with the addition of a 5-cm thick lead shield if the build-up factor is 2.1?

   1. 0.02 milliroentgen/hour
   2. 0.9 milliroentgen/hour
   3. 2 milliroentgens/hour
   4. 20 milliroentgens/hour
   5. 200 milliroentgens/hour

2. In routine environmental surveillance, certain samples are collected and analyzed for specific reasons. In this regard, which one of the following statements is incorrect?

   1. Foodstuffs are analyzed because they are generally the main route of radionuclide intake by the general population.
   2. Air and water are analyzed because they are always the most sensitive indicators of environmental releases.
   3. Muds are analyzed because they are often good indicators of the history of radionuclide wastes in an aquatic environment.
   4. Aquatic organisms are analyzed because they concentrate certain radionuclides and aid in the assessment of radionuclide contamination.
   5. Milk and milk products are analyzed because these are generally the major avenue of intake of Strontium-90, particularly among younger population groups.

3. The method most commonly used today for removing noble gases from effluent waste streams from nuclear reactors and chemical processing plants is:

   1. Cryogenic distillation
   2. Chelation with EDTA
   3. Adsorption on activated carbon
   4. Countercurrent ion exchange
   5. Absorption in freon

4. The medical radiation exposure of a patient <u>cannot</u> be reduced by using:

1. High KVP techniques
2. Short time, high MA techniques
3. A 3-mm aluminum filter placed in the X-ray beam
4. A high speed intensifying screen
5. A larger target to film distance

5. Photoneutron sources are generally made by surrounding a gamma-ray emitting nuclide with:

1. Tantalum
2. Carbon
3. Beryllium
4. Aluminum
5. Iron

6. According to 10CFR20, personnel monitoring is required when an individual:

1. Enters an area such that he is likely to receive 1.25 rems to the whole body in a quarter.
2. Performs an operation such that he may receive 18.75 rems to his hands in a quarter.
3. Under 18 years of age may receive any amount of radiation regardless of how little the exposure may be.
4. Enters an area such that he is likely to receive an exposure in excess of 10% of legal exposure values.
5. Enters an area such that he is likely to receive an exposure in excess of 25% of legal exposure values.

7. When air is sampled by being pulled through a filter paper, the radioactivity at equilibrium on the filter paper due to naturally occurring radon daughters is:

1. Proportional to the flow rate of the sampler.
2. Dependent only on the total volume of air sampled.
3. Dependent on the period of time required for radioactive equilibrium on the filter paper to be established.
4. Dependent on the volume of air sampled after radioactive equilibrium on the filter paper has been established.
5. Independent of the flow rate of the sampler.

8. A radiation survey outside the shield at an 8 MeV electron linear accelerator beaming into a copper target requires the exercise of care in choosing appropriate instruments and conducting the survey because:

1. Neutron activation of NaI scintillation counters may cause erroneous dose rate measurements.
2. Pulse pile-up in G-M counters may cause erroneous dose rate measurements.
3. Pulse pile-up in BF_3 counters may cause erroneous neutron measurements.
4. Induced radioactivity may pose a contamination problem.
5. High radiation fields may saturate ionization chambers, causing erroneous dose rate measurements.

9. In performing a maximum credible reactor accident analysis, which of the following assumptions is not generally applied?

1. Complete loss of containment has occurred.
2. 100% of the noble gases, 50% of the halogens, and 1% of the solids are released to the primary system.
3. 50% of the halogens released to the containment building plate out and are not released to the atmosphere.
4. Class F weather conditions exist at the time of the accident.
5. A double ended primary system pipe failure has occurred.

Answers

Fundamentals

Question #1	4
Question #2	1
Question #3	5
Question #4	4
Question #5	4
Question #6	5
Question #7	3

Measurements

Question #1	5
Question #2	5
Question #3	5
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Operational Health Physics

Question #1	5
Question #2	2
Question #3	3
Question #4	2
Question #5	3
Question #6	5
Question #7	1
Question #8	2
Question #9	1

Section 5

Part II - Copies of Past Six Exams

June 12, 1972

PART II - ANSWER ANY SEVEN

TOTAL TIME: 3 HOURS

Question #1

You are asked to measure absorbed dose from gamma radiation in various materials under various conditions. For each case shown below list the quantities you need to know to make the measurement to an accuracy of a few percent. Show also the formula you would use to calculate the dose from the measurement you made.

a) You have a small air-filled, air-equivalent wall ion chamber calibrated in roentgens for 1 MeV gamma rays.

You are asked to measure absorbed dose in water from 0.5 MeV gamma rays.

b) You have a small capsule of thermo-luminescent dosimeter (TLD) material. The capsule walls are tissue equivalent. The TLD is calibrated in roentgen for 0.662 MeV gamma rays.

You are asked to measure absorbed dose in tissue from 0.662 MeV gamma rays.

c) You have a small air-filled ion chamber with aluminum walls calibrated in roentgen for 250 kVp x-rays.

You are asked to measure absorbed dose in lead from ^{60}Co gamma rays.

Question #2

In assessing the radiological environmental impact of a power reactor located on a fresh water lake, many possible pathways or modes of off-site human exposure must be considered.

a) List 10 such possible pathways.

b) Assume a boiling water reactor with once-through secondary cooling water released to the lake, and a gaseous effluent system equipped with a standard 30 minute delay line for gases and no charcoal absorbers. Which pathway would you expect to contribute the most dose to the populations within a 50-mile radius?

c) Discuss (briefly) some of the information you should have to do a more complete evaluation of the relative importance of each pathway.

POOR ORIGINAL

Question #3

A technician in a pharmaceutical company will handle 500 mCi ^{131}I, 1000 mCi ^{198}Au and 25 mCi ^{42}K. She was employed at the age of 18 and will work under conditions such that she will be exposed to radiation from these sources for one hour per day, five days per week, over an extended period of time. During the exposure period her body position is 60 cm from the radioactive materials located in a laboratory hood. What is the minimum amount of lead shielding (or equivalent) you would prescribe for a barrier at the front of the hood? Manipulators will be provided so that hand exposure within the barrier is not necessary. Assume source strength maintained at levels given, i.e. you may neglect decay of isotopes.

Given:

	^{131}I	^{198}Au	^{42}K
HVL in lead, cm	0.3	0.3	1.2
R/mCi-hr at 1 cm	2.18	2.35	1.50

Question #4

You are to survey a new diagnostic x-ray tube unit and collimator for compliance with NCRP recommendations for tube housing and collimator leakage and for total filtration. The tube unit is rated for and operated from a 150 kVp three-phase twelve-pulse generator capable of operation from 0.1 mA tube current for fluoroscopy to 1000 mA for diagnostic radiography. The generator is connected to the tube unit by 35 feet long high-voltage cables.

a) Describe the instrumentation and procedure you would use, including x-ray equipment operating factors, to determine the maximum tube housing and collimator leakage (mR in 1 hour at 1 meter from the focal spot).

b) What, if any, is the effect of high-voltage cables on tube housing leakage measurements?

c) How does half-value layer and the corresponding total filtration determination vary with tube current and high voltage cable length at a constant kVp?

d) What is meant by the "narrow beam", or "unique" half-value layer and how can this determination be made?

e) What is the minimum total filtration recommended for a 150 kVp diagnostic x-ray machine and what is the rationale behind this recommendation?

Question #5

Assume you have been asked as a consultant to audit the radiation safety program of one of the following nuclear facilities. Prepare a check list of the items you should consider, and discuss the reasons why each is important.

State your choice:

1. Nuclear Fuel Reprocessing Plant
2. Radiopharmaceutical Manufacturing and Supply
3. Industrial Radiography Involving X-Rays and Isotopes
4. Power Reactor Facility

Question #6

An employee at a facility where you are the health physicist has been involved in an incident wherein he is suspected of having inhaled plutonium oxide (insoluble).

a) Compare the advantages and disadvantages of attempting to determine his lung burden due to Pu-239 by direct counting techniques.

b) Compare the advantages and disadvantages of using the 60 KeV photon from the Am-241 present to determine the Pu-239 lung burden.

c) Compare the techniques of (a) and (b) with urine and fecal sampling.

Question #7

You are asked to consult in the design and installation of a 15 MeV electron accelerator to be used for cancer therapy. The electron beam will strike a thick tungsten target in the accelerator to produce x-rays.

a) There is a choice of material for collimators and target shielding, U-238 or Pb. Which would you recommend and why?

b) The accelerator is to be installed in a room which previously housed a Co-60 teletherapy unit. The room has 2 ft thick concrete walls and one wooden door with a 1/4 in layer of Pb affixed to the inside surface. Discuss what you would consider in evaluating the adequacy of the accelerator and room shielding.

Question #8

Some tritium water vapor was released in a laboratory. An air sample was taken using a freeze out technique (100% freeze out). Ten cubic feet of air were drawn through a trap, the collected moisture was diluted to 50 ml, one ml of the dilution was counted for ^3H beta using a liquid scintillation counter.

Given:
(1) The instrument background is 12 c/m.
(2) The counting efficiency is 31%.
(3) 3200 counts per minute were found in the 1 ml.
(4) 2.832×10^4 cc = ft^3.
(5) Principal intake by inhalation.
(6) Biological half-life is 10 days.
(7) Breathing rate is 10^7 cc/8 hrs.
(8) 70% of inhaled ^3H assimilated by body water.
(9) Effective absorbed energy is 0.01 MeV/disintegration.
(10) Mass of critical organ is 4.3×10^4 grams.

a) Determine the uCi/cc of tritium in air.

b) A technician, working for eight hours in this atmosphere, left for a vacation without submitting a urine sample. Estimate his dose in rems based on the air sample data.

c) If the technician submits a urine sample for tritium analysis when he returns from vacation 20 days after his exposure, what concentration of tritium would you expect to find in this urine sample?

Question #9

A transient burst of 1×10^{15} fissions in an unshielded accumulation of fissile material causes a total dose equivalent of 25 rem at 6 feet.

a) Assuming a neutron-to-gamma dose equivalent ratio of 9, what is the gamma absorbed dose?

b) Your criticality detector is a gamma response instrument with an alarm point of 50 mR/hr. If the detector responds to 1/2500 of the actual gamma dose rate during a short transient, what is the maximum distance over which this device will be effective in signalling an unshielded, one millisecond transient of 1×10^{16} fissions? Neglect absorption by the air.

c) Should sufficient shielding materials be present between the source of the burst and the detector to result in attenuation by a factor of three, what will the maximum distance of (b) be reduced to for a 1×10^{15} fission burst?

POOR ORIGINAL

Question #10

A radiochemist is planning to analyze lunar samples by activation analysis. In developing his analysis procedures he activates a number of knowns including antimony.

a) Based on the information provided, how much ^{122}Sb activity would he have at the time he initiated his work?

b) What would be the dose rate at 1 foot from the unshielded sample? State all assumptions. Use "rules of thumb" if you wish.

c) What precautions would you recommend for handling this sample assuming it is to be pulverized?

d) In working up the Sb sample he has a spill which results in inhalation of ^{122}Sb. His initial body burden is determined to be 4×10^{-2} μCi. If the $(MPC)_a$ for ^{122}Sb is 2×10^{-7} μCi/ml, would this incident require reporting to the AEC (or State) Authorities? (Assume a breathing rate of 10^7 ml per 8 hours.)

Data for Antimony Sample

Sample Mass:	1 mg antimony
Isotopic Abundance of ^{121}Sb:	57.25%
Cross Section for ^{121}Sb (n,γ) ^{122}Sb	
Reaction:	6 barns
Half-life of ^{122}Sb:	2.8 days
Principal Gamma Ray:	0.564 MeV (70% abundance)
β Particles	1.97 MeV (70% abundance)
	1.40 MeV (30% abundance)

E_β (MeV)	Tissue (Range g/cm^2)
0.5	0.2
0.7	0.3
1.5	0.7
2.0	1.0

Irradiation Conditions

Irradiation Time:	6 days
Flux Density:	5×10^{13} n/cm^2-sec
Elapsed time between end of irradiation and start of work:	2 days

ABHP EXAMINATION #17 PART II

June 18, 1973

PART II - ANSWER ANY SEVEN

TOTAL TIME: 3 HOURS

Question #1

Describe in detail the advantages and disadvantages, energy dependence and sensitivity of 2 of the following personnel neutron dosimetry systems.

1. NTA film
2. ^{6}LiF-^{7}LiF TLD
3. Albedo
4. Fission Track

Question #2

The health physicist's evaluation of radiological exposures to man and his environment from man-made sources is complicated by the existence of natural sources.

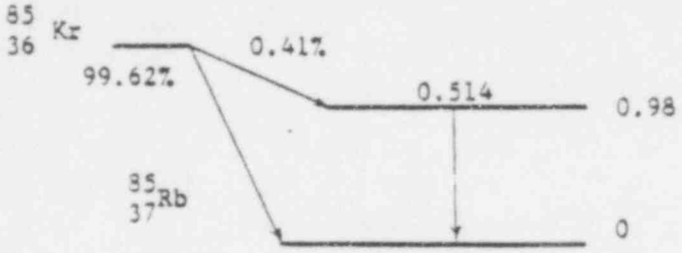
Consider the following natural contributors; ^{40}K, cosmic radiation, uranium series and thorium series. For each category below, briefly state how they might affect a health physicist's measurements.

1. Air monitoring,
2. Sample counting,
3. In vivo counting,
4. Radiation background measurements,
5. Calibration of low-level instruments,
6. Materials for construction and shielding of low-level counting facilities,
7. Radiochemical analyses including materials and equipment used.

Question #3

^{85}Kr is continuously released from operating nuclear reactors to the environment.

(1) Briefly describe how you could monitor for ^{85}Kr in the stack effluent when it is masked by other short-life noble gases.



(2) Briefly describe how you could monitor the environment near a reactor boundary for ^{85}Kr.

(3) Would you expect any significant uptake of ^{85}Kr by biota? Why?

(4) Describe how you would calculate a maximum estimated radiation dose-rate (skin and whole-body) to nearby residents (e.g., a few miles away) based on the measured release rate at the point of release.

Question #4

NBS Handbook 97 lists neutron attenuation coefficients for various shield materials. In particular, for 4 MeV neutrons, the attenuation coefficient for iron is 0.31 cm^{-1} while the attenuation coefficient for ordinary concrete is 0.157 cm^{-1}.

a) Ignoring cost factors, why is iron alone not satisfactory for neutron shielding?

b) Design a combined iron and concrete shield for a 4 MeV neutron source emitting 5×10^{10} neutrons per second isotropically such that the fast neutron flux outside the shield at 2 ft from the source is less than 5 neutrons-cm^{-2}-sec^{-1}.

c) What would be the flux density if only 2 ft of concrete were used for shielding.

Question #5

One of the important health physics problems arising from the generation of electrical energy by the use of nuclear reactors is the safe disposal of

Question #5 (Continued)

the various radioactive wastes resulting from the reprocessing of irradiated fuel.

a) Briefly discuss in general terms the quantities and hazards of the gaseous, liquid and solid waste materials generated in the reprocessing.

b) Describe the treatment and disposal methods appropriate to the various radioactive wastes identified above.

c) Identify the radionuclides which will continue to represent a hazard over the first several hundred years, and those which represent the hazard over thousands to millions of years; describe some of the proposed solutions to the problem of "ultimate disposal" of these materials.

Question #6

A release of airborne, particulate, alpha-emitting activity has occurred in a large room in which there are glove box operations with various heavy metal alpha emitters. The release was detected by an alpha air monitor which alarmed. The four men who were in the room left following the alarm. You were notified within a few minutes and reported immediately to the scene and find that the exact source of the release is unknown, the four men are contaminated and none was wearing respiratory protection.

You are the lead health physicist, have adequate staff assistance, and your facility has a medical staff, in vivo gamma/x-ray counter, bioassay lab and radioanalytical labs.

List, in a rough chronological order, the actions you would take, the recommendations you would make and the reason for each.

Question #7

Radiation effects are influenced by the density of energy deposition of the impinging radiation. Some radiation delivers energy to a relatively large volume of the cell (e.g., gamma rays) and has a low relative biological effectiveness (RBE). Other radiation delivers energy to a highly localized part of the cell (e.g., alpha particles) and has a high RBE. Several closely spaced ionization events are referred to as an "ion cluster."

Tumor cells having critical structures with 10^{-7} cm diameter are being irradiated. Assume that one ion cluster has an energy density of 100 eV/ion cluster and that one ion cluster will destroy or inactivate one cell.

Question #7 (Continued)

a) Which of three radiations having linear energy transfer's (LET's) of 10 keV/μ, 100 keV/μ and 500 keV/μ would you expect to be the most efficient for tumor destruction where the tumor is given the same total dose for each of the three radiations? Why? ($1\mu = 10^{-4}$ cm)

b) If the tumor were irradiated, using the most effective radiation, with 1000 rads, how much would the average temperature increase in each cell? (4.18×10^7 ergs/cal; assume tumor tissue = water).

c) Many tumors are poorly vascularized, particularly near the center, and hence are far from oxygen-saturation. Discuss the "oxygen-effect" for low LET radiations.

Question #8

The liquid contents of a beaker containing 10 millicuries of ^{126}I accidentally boils to dryness in a laboratory measuring 4 meters x 4 meters x 3 meters high. A person working in the room breathes the vapor for 30 minutes before discovering the accident. Assuming a breathing rate of $1.25 m^3$ per hour, and the fraction of the inhaled iodine reaching the critical organ was 0.23:

1) Calculate the maximum uptake by the critical organ

2) Calculate the maximum dose commitment to the critical organ (rems)

Whole body weight = 70 kg
Thyroid weight = 20 g
T_r = 13.3 days T_b = 138 days
$\Sigma EF\ (RBE)n$ = 0.16 MeV

3) Why does this probably represent a maximum dose estimate?

4) Would you expect this dose to produce any observable biological effects? Why?

Question #9

Shown below is the plan view of a proposed 125 kVp radiographic x-ray installation to be used for general radiography. The useful beam can strike all barriers except A - B. For a workload of 400 mA-min/week, specify the lead thickness required at 5 of the 7 points. State all assumptions on which your calculations are based.

See the following page for tabular data.

Question #9 (Continued)

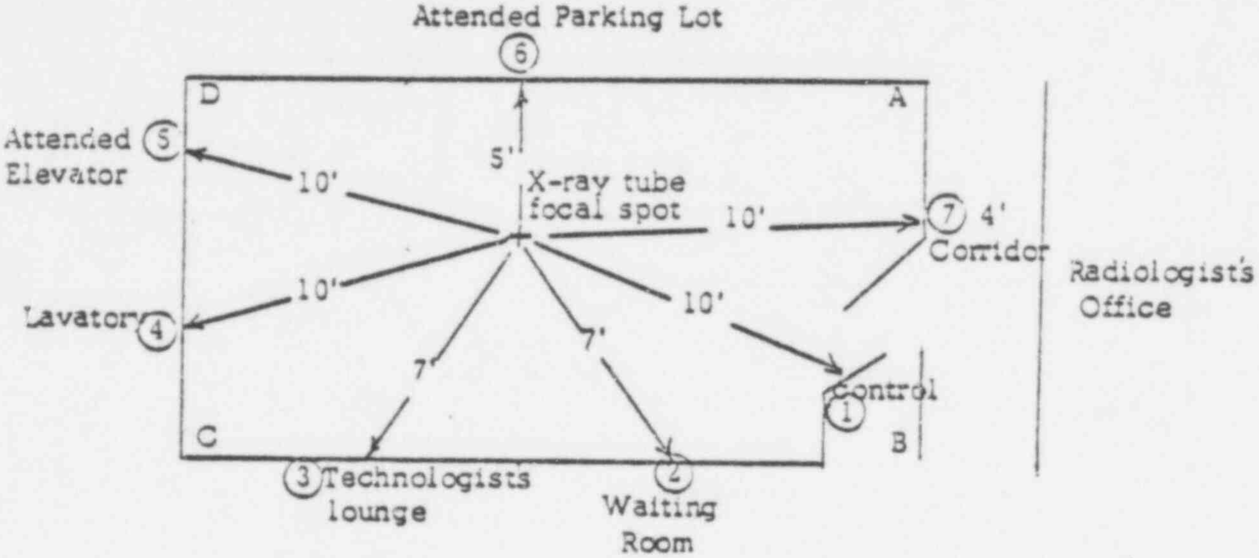


TABLE 5—*Shielding requirements for radiographic installations*

WUT[a] in mA min/week			Distance in Feet from Source (X-Ray Tube Target) to Occupied Area									
100 kVp	125 kVp	150 kVp										
1,000	400	200	5	7	10	14	20	28	40			
500	200	100		5	7	10	14	20	28	40		
250	100	50			5	7	10	14	20	28	40	
125	50	25				5	7	10	14	20	28	40
62.5	25	12.5					5	7	10	14	20	28
Type of Area	Material		Primary Protective Barrier Thickness									
Controlled	Lead, mm[b]		1.9	1.65	1.4	1.2	1.0	0.75	0.5	0.3	0	0
Noncontrolled	Lead, mm[b]		2.65	2.4	2.2	1.95	1.7	1.5	1.25	1.0	0.8	0.5
Controlled	Concrete, in[c]		5.9	5.2	4.6	4.0	3.3	2.7	2.1	1.6	1.0	0.4
Noncontrolled	Concrete, in[c]		8.0	7.3	6.7	6.0	5.4	4.8	4.1	3.5	2.9	2.2
			Secondary Protective Barrier Thickness									
Controlled	Lead, mm[b]		0.55	0.4	0.2	0.1	0	0	0	0	0	0
Noncontrolled	Lead, mm[b]		1.2	1.0	0.8	0.6	0.45	0.25	0.1	0	0	0
Controlled	Concrete, in[c]		1.9	1.4	0.8	0.2	0	0	0	0	0	0
Noncontrolled	Concrete, in[c]		3.8	3.2	2.6	2.1	1.5	1.0	0.4	0	0	0

[a] *W*—workload in mA min/week, U—use factor, T—occupancy factor.

[b] See Table 25 for conversion of thickness in millimeters to inches or to surface density.

[c] Thickness based on concrete density of 2.35 g/cm³ (147 lb/ft³).

568 095

POOR ORIGINAL

Question #10

A quantity of tritium was accidentally released. Bioassay data indicated assimilation of tritium by exposed individuals.

a) An initial tritium activity measurement in urine for one case was 3.4×10^{-3} μCi/ml and 5 days later was 2.4×10^{-3} μCi/ml. Estimate the retention half-period of tritium for this individual.

b) Identify one treatment that might be instituted to reduce the total integrated dose.

c) One urine sample measured 23.4 c/m, including counter background, compared to a background count rate of 19.1 c/m. If both rates were determined by 100 minute count times, estimate whether or not the observed count rates are statistically different.

d) Some of the accidentally released tritium is ultimately discharged to the environment. Mechanisms which have been found to be important in the reconcentration and redistribution of environmental radionuclides include bioconcentration and transpiration. State in one or two sentences the importance of these mechanisms in determining the environmental behavior of tritium.

July 8, 1974

PART II - ANSWER ANY SEVEN

TOTAL TIME: 3 HOURS

Question #1

A solvent vapor explosion has taken place in a source encapsulation facility at the U. S. Radionics Company site. The most recent isotope inventory for the facility indicates a total content of 10 μg of ^{252}Cf as the oxide. Continuous air monitors with audible alarms indicate significant amounts of alpha activity. Three of the facility occupants have evacuated to a pre-assigned hold-point just outside the facility entrance. As director of the health physics emergency response team discuss the following:

Point Value

2 1. Your priorities in the initial response.

3 2. The steps you would take for proper total response.

3 3. Personnel protection for team members.

2 4. Monitoring and surveillance for cleanup operations.

Data on ^{252}Cf:

a) Specific neutron dose rate: 2.4×10^3 rem/hr.gm. at 1 m.

b) Specific gamma dose rate: 1.4×10^2 rem/hr.gm. at 1 m

c) Specific activity (alpha): 5.37×10^2 Ci/gm

d) MPC_a (40-hr week): 3×10^{-11} $\mu Ci/cm^3$

Question #2

An employee working in a glove box containing $^{239}PuO_2$ discovers that he has a heavily contaminated hand. It was determined that the contamination was the result of a hole in one of the glove box gloves. It was estimated from a recording air monitor (with a defective alarm) that the employee was exposed to an airborne $^{239}PuO_2$ concentration of 4×10^{-8} $\mu Ci/cc$ for one hour. From cascade impactor results the mass median aerodynamic particle size (MMAD) was estimated to be 0.5 μ.

Point Value

7 a. Given the revised lung model data on the attached page and assuming uniform energy deposition in the lungs, calculate the total integrated dose in rem to the pulmonary region of the lungs.

3 b. Briefly discuss the current controversy surrounding the assumption of uniform energy deposition in the lungs for an inhalation exposure of this type.

568 009

DATA for PROBLEM #2

Mass of pulmonary region of the lungs = 6×10^2 grams

^{239}Pu $\epsilon E(RBE)n$ = 53 MeV

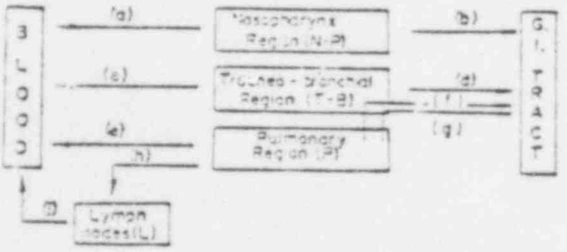
1 MeV = 1.6×10^{-6} ergs

Breathing Rate = 20 liters/minute

$^{239}PuO_2$ is a Class Y compound

[illegible]ED CONSTANTS FOR USE WITH TGLM CLEARANCE MODEL†

Region	Pathway	Compound class (D)	(W)	(Y)
N-P	(a)	0.01 d/0.5	0.01 d/0.1	0.01 d/0.01
	(b)	0.01 d/0.5	0.4 d/0.9	0.4 d/0.99
T-B	(c)	0.01 d/0.95	0.01 d/0.5	0.01 d/0.01
	(d)	0.2 d/0.05	0.2 d/0.5	0.2 d/0.99
P	(e)	0.5 d/0.8	50 d/0.15	500 d/0.05
	(f)	—	1 d/0.4	1 d/0.4
	(g)	—	50 d/0.4	500 d/0.4
	(h)	0.5 d/0.2	50 d/0.05	500 d/0.15
L	(i)	0.5 d/1.0	50 d/1.0	1000 d/0.9



† The first value listed is the biological half-life; the second is the regional fraction.

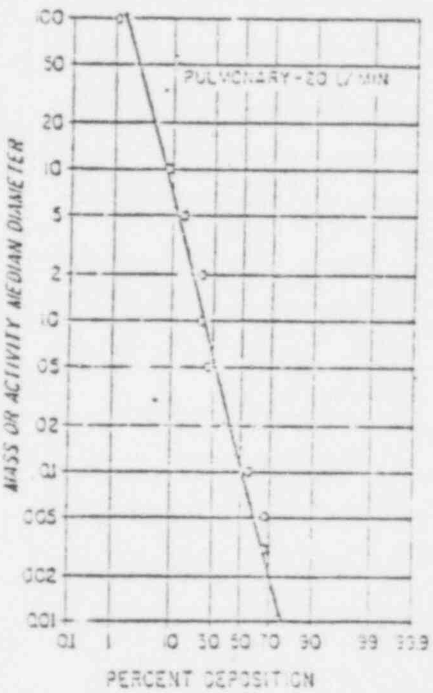


FIG. 14. The deposition estimate for the pulmonary compartment while breathing at a moderate work rate. Different aerosol distributions are represented by the mass or activity median aerodynamic diameters (0.01 to ~100).

Point Value Question #3

10 A radiation dosimeter is made from a cubical plastic scintillator (5 cm on a side). The light output is detected with a photomultiplier tube and the resulting current is measured with an electrometer. The dosimeter is calibrated with a ^{137}Cs source with an activity of 4.5 mCi. The electrometer reads 6.0×10^{-7} amperes (background subtracted) when the source is placed 1 meter from the center of the detector.

An Iodine-125 source gives a reading of 2.3×10^{-6} amperes at the same distance (background subtracted).

What is the exposure rate at 1 meter from the Iodine-125 source? Neglect the effect of scattered radiation or the inverse-square law distance variation through the detector. Assume the energy flux density falls off in the crystal as $e^{-\mu_{en}x}$ and the radiation is incident normally on the crystal face.

Data	^{137}Cs 0.66 MeV	^{125}I 0.027 MeV
Mass energy absorption coefficient, cm^2/g, for crystal	0.031	0.097
Gamma photons emitted per disintegration	0.935	.07
Mass energy absorption coefficient, cm^2/g, for air	0.029	0.26

Density of air at 0°C, 760 mm	0.001293 g/cm^3
Density of crystal	1.0 g/cm^3
Mean electron volts to produce 1 ion pair	34
Charge on electron	1.6×10^{-19} Coulomb
Ion pairs/cc - Roentgen	2.08×10^{9}
Coulomb/gram - Roentgen	2.58×10^{-7}

Question #4

Give the physiological effects to be expected from the following acute exposures:

Point Value

2 a) 300 rad to the whole-body from ^{60}Co gamma rays;

2 b) 25 rad to the whole-body from ^{60}Co gamma rays;

2 c) 1000 rad to the hands from ^{32}P beta rays;

2 d) 500 rad to the whole-body from fast neutrons.

2 How would you modify your answer if the exposures were uniformly spread over a period of one year?

568 100

Point Value **Question #5**

10 Differentiate the merits of NaI(Tl), Ge(Li), and Si(Li) for gamma spectroscopy of environmental samples from uncontrolled areas.

Question #6

As a health physicist in a fuel reprocessing plant, how would you handle each of the following?

Point Value

5 a) You are required to analyze the stack effluent for radioiodine in particulate, elemental, organic and other forms. Briefly describe how you would sample this effluent, analyze the sample, and interpret the results.

2-1/2 b) You are asked to show that your stack sample probe is isokinetic. How would you do it?

2-1/2 c) List the factors which determine the rate at which liquid waste can be discharged to a stream. List at least four of them.

Question #7

A cubical room, 3 meters on a side, contains a 14 MeV neutron source at the center emitting 10^{15} n/sec. It is desired to shield the room so that the dose equivalent rate in adjacent rooms is less than 2.5 mrem/h. Ten-foot thick walls of ordinary concrete are planned. The roof will have two feet of concrete.

Point Value

4 a) Calculate the dose equivalent rate "coming through" the walls, and the percentage due to gamma radiation.

2 b) Discuss the adequacy of the overall shielding design. Do you foresee any problems?

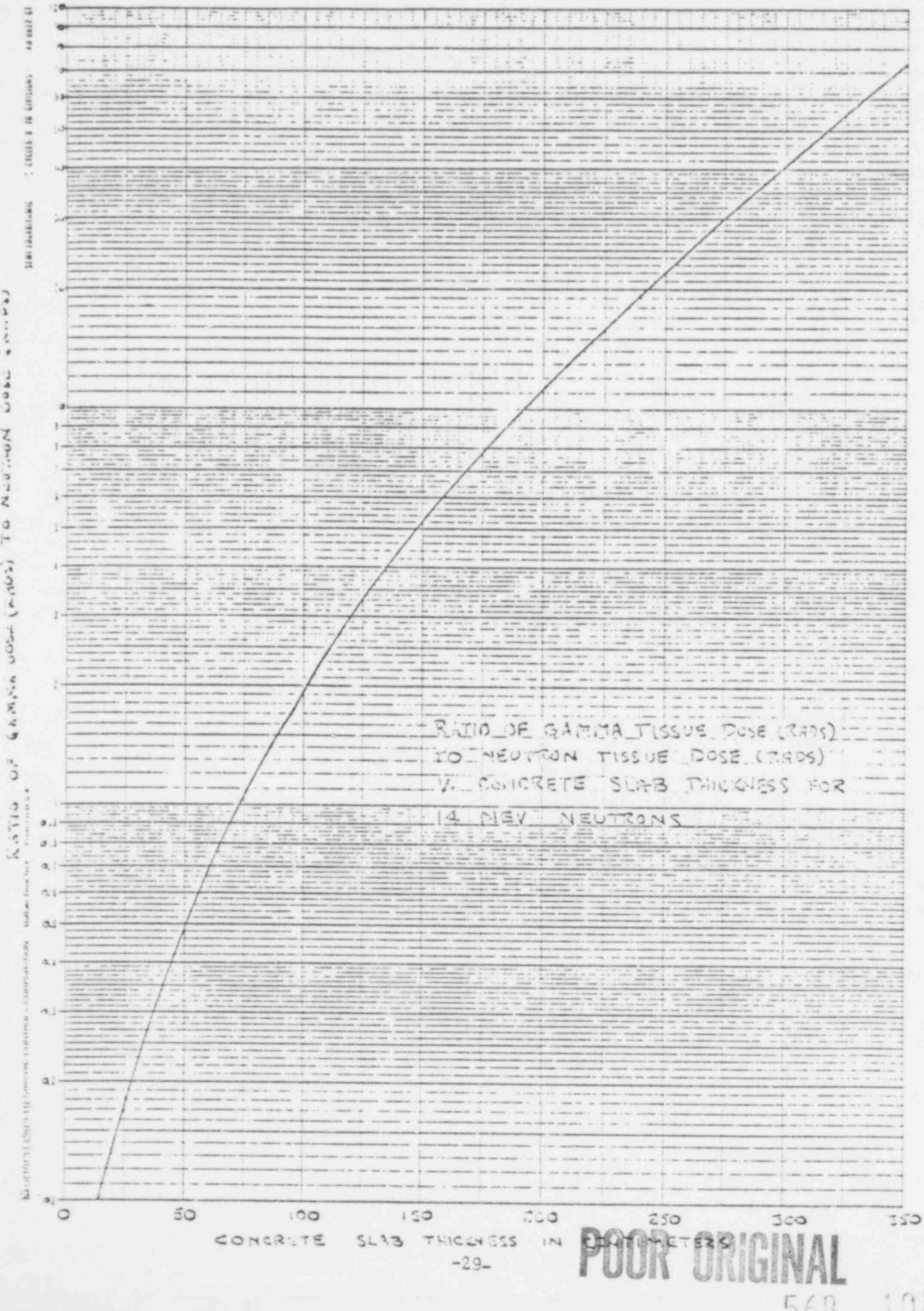
4 c) What additional radiation problems would be associated with the operation of this facility.

State any assumptions you make that affect your answers, and support your discussion with calculations where appropriate.

Given: Figure (attached)

for 14 MeV neutrons:
QF = 7.5
12 n/cm^2-sec = 2.5 mrem/h
neutron DE absorption coefficient in ordinary concrete = 0.07 cm^{-1} (includes neutron buildup)

DATA FOR PROBLEM #7



POOR ORIGINAL

568 101

Question #8

You are a health physicist at an accelerator facility and are asked to participate in the design of shielding required for a new experimental beam. The information you are given is:

Accelerator - electron LINAC for industrial radiography

Beam energy - 25 MeV

Peak current - 1 amp

Beam pulse width - 2 μsec

Pulse repetition rate - 360 pulses/sec

The electron beam is to be bent 90° with a radius of curvature of 10 cm.

Point Value

4 1. Where would one expect to find significant radiation sources within the machine? What types of radiation will you consider under:

a) normal operating conditions,

b) a failure in some portion of the beam transport system at the bend?

2 2. Qualitatively, what would your shield design be at the bend and why?

3. You are told that the continuous beam loss in the bend will be less than 0.1% and that the interlock systems will reliably turn off the beam within 2 pulses if any failure occurs in the beam transport system.

3 a) Would you consider the continuous beam loss or the failure situation to be the limiting case for determining shielding? State any assumptions and all considerations.

1 b) Is it necessary to consider activation of machine parts when designing the shield? Why or why not?

Question #9

A radiochemistry laboratory in a facility consists of a high level lab, a low level lab, and a counting room all in one complex.

Point Value

4 a. Discuss the design of the air supply and exhaust system for this complex. Include such things as air flow paths, flow rates, filtration, air treatment, placement of exhaust fans, etc. Give reasons to justify each of your design recommendations.

4 b. Discuss your recommendations for the drain system in this complex. Include such things as appropriateness of segregated drains recommended materials of construction, routing, traps, etc. Give reasons to justify each of your design recommendations. (Assume the facility of which this lab complex is a part also has a radwaste treatment complex.)

2 c. Discuss your recommendations for floor and wall coatings.

Question #10

Give an explanation of why the following are examples of situations in which charged particle equilibrium (CPE) conditions do not exist:

Point Value

3-1/3 a. an air-tissue boundary,

3-1/3 b. near a point source of radiation,

3-1/3 c. a 10 MeV photon beam in air incident upon an air-equivalent dosimeter.

ABHP EXAMINATION #19

July 14, 1975

Part II - Answer any seven

Total Time: 4 hours

Question #1

A serious accident has resulted in the dispersal of reactor-grade plutonium dioxide on a busy interstate highway. You have survey instruments from which you can estimate the average plutonium activity per unit area of contaminated surface. As the health physicist on the emergency response team, you are asked to establish an exclusion zone to limit public access during cleanup operations.

Point Value

5 a) Briefly discuss the health physics considerations which you would use in establishing a maximum contamination level at the exclusion zone barricades immediately post-accident, and during cleanup.

5 b) What health physics considerations would bear on the establishment of an acceptable residual contamination level for long-term public access after cleanup?

Question #2

Maximum Permissible Concentrations in air of many insoluble radioactive isotopes as recommended by the ICRP, NCRP, and codified in 10 CFR Part 20 of the Code of Federal Regulations, are based on the assumption that the material is uniformly deposited in the lung, and that there is a uniform distribution of energy per gram of lung tissue.

3 a) Is this a reasonable assumption with regard to large numbers of beta and gamma emitting particles? Why?

3 b) Is this a reasonable assumption with regard to alpha emitting particulates such as ^{239}Pu? Why?

4 c) Would you expect the assumption of uniform distribution of particulates and energy in the lung to result in an underestimate or overestimate of the <u>risk</u> of cancer from inhalation of ^{239}Pu? Why?

Question #3

You have just been hired as a health physicist by Acme Rad Services, Inc., which is planning to install an 11 kCi ^{60}Co source for industrial purposes. The source pig is to be located in an existing room shown in Figure 1 below. It has been previously determined that with the planned workload of 10 h/week, the exposure rates just outside of walls A and B are 0.17 R/yr and 5 R/yr, respectively. Wall D is a very thick concrete wall because of an accelerator on the far side. Wall C is a thin wallboard wall to be rebuilt of ordinary concrete.

Point Value

5 a) Using the data below and Figures 1 and 2, calculate the minimum shielding for Wall C required to reduce the exposure rate on the far side to 5 R/yr. Neglect any build-up factors and consider only radiation scattered at 90° from the object.

5 b) Comment on the entire installation from a health physics point of view.

Given:

Density of ordinary concrete: 2.35 g/cc

Ratio of 90° scattered radiation at 1 meter from radiographed object to incident exposure: 10^{-3}

For ^{60}Co: 1.3 RHM per Curie.

Energy of scattered photon $E' = \dfrac{E}{1 + (E/m_0c^2)(1 - \cos\theta)}$

m_0c^2 = rest mass energy equivalent of electron = 0.51 MeV

E = initial photon energy

Mass attenuation coefficients for ordinary concrete (See Figure 2)

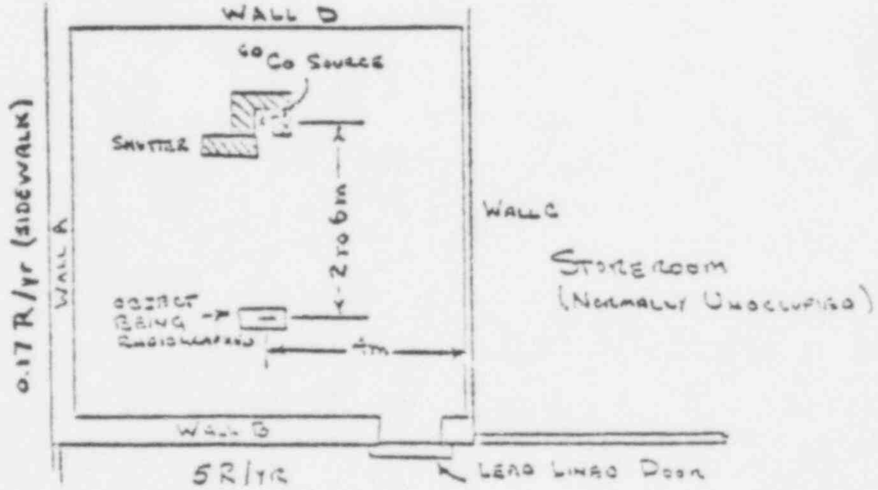


FIGURE 1

DATA FOR QUESTION #3

MASS ATTENUATION COEFFICIENTS FOR ORDINARY CONCRETE

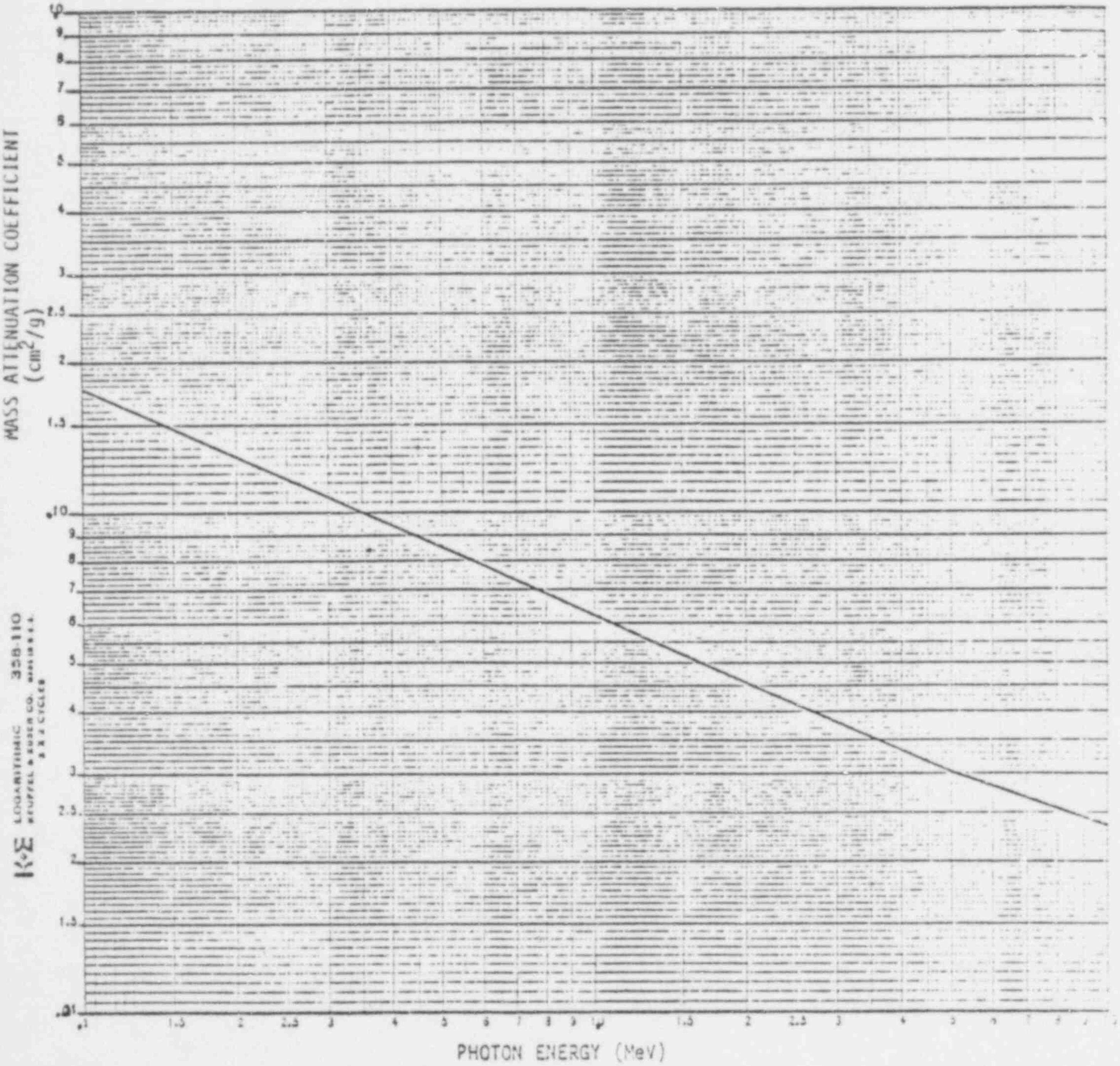


FIGURE 2

568 108

POOR ORIGINAL

Question #4

Two important reactions for thermal neutrons in tissue are $^{14}N\ (n,p)\ ^{14}C$ and $^{1}H\ (n,\gamma)^{2}H$. Calculate:

Point Value

6 a) The absorbed dose and dose equivalent for each reaction in tissue per unit thermal neutron fluence (n_{th}/cm^2).

4 b) The maximum permissible thermal neutron flux density based on the sum of these two reactions.

State any assumptions necessary in making calculations.

Given:

$N_{^1H} = 6.02 \times 10^{22}$ atoms/g tissue

$N_{^{14}N} = 0.11 \times 10^{22}$ atoms/g tissue

$\sigma_{th}(^1H) = 0.33$ barns $E_\gamma = 2.2$ MeV

$\sigma_{th}(^{14}N) = 1.3$ barns $E_p = 0.6$ MeV

1 rad = 10^{-2} J/kg

1 MeV = 1.6×10^{-13} J

Fraction of γ energy absorbed in body = .28

1 barn = 10^{-24} cm^2

tissue density = 1 g/cc

Point Value

Question #5

10 You are hired as a Health Physics Consultant by a utility planning to build a nuclear power reactor. Discuss in general terms the basic elements of the environmental surveillance program (including rationale) for radiation and radioactivity you would recommend.

Question #6

It is recognized that ^{137}Cs ($T_{1/2}$ = 30 y) comprises a significant fraction of fallout radioactivity. Given an initial background exposure rate of 1.5 uR/hr from ^{137}Cs in the soil:

Point Value

1 a) Calculate its initial annual exposure rate contribution.

3 b) Calculate the integrated 30-year exposure to each individual in the population at risk, assuming no additional fallout.

3 c) Compare the 30-year exposure value with the I.C.R.P. population gonadal dose limit and briefly discuss its significance.

3 d) Discuss the other factors (in addition to external exposure) which should be considered in evaluating the radiological significance of ^{137}Cs fallout to the general population.

Question #7

Radwaste handling and processing is an important part of a power reactor health physics program.

Point Value

2.5 a) In a power reactor, list three (3) sources of each of the following types of radioactive waste.

1. Liquid waste
2. Gaseous waste
3. Solid waste

2.5 b) Briefly discuss at least three (3) methods for processing liquid waste.

2.5 c) Briefly discuss at least three (3) methods for processing gaseous waste.

2.5 d) Briefly discuss at least three (3) methods for processing solid waste.

Question #8

The radiation doses received during the annual outages at power reactors contribute significantly to the total personnel dose in these facilities. Select either a PWR or BWR and discuss.

Point Value

3 a) Which outage jobs are the major sources of exposure?

7 b) As the health physicist, what specific recommendations would you make to reduce the exposure received on the jobs listed in (a) above?

Question #9

A graduate student was working with 10 Ci of tritium gas in a hood. As the result of a small explosion in the tritium gas container, the container was ruptured and the front of the hood was blown out. The considerably shaken, but otherwise uninjured student, suspected that he might have received some tritium uptake. He collected a urine sample approximately 15 minutes following the incident and submitted it to the Radiation Safety Officer (RSO). The RSO requested that the student submit another urine sample in 2 hours. The analysis of this second urine sample indicated a tritium concentration of 2 mCi/ℓ.

Point Value	
1	a) In your judgment was the RSO correct in requesting the second urine sample to evaluate the uptake? Why?
3	b) Calculate the students integrated dose equivalent assuming an effective elimination half-life of 10 days.
4	c) What would the student's average daily liquid intake have to be to reduce the integrated dose equivalent to 2.5 rem.
2	d) If you were the RSO would you recommend to the student the increased fluid intake necessary to reduce his dose equivalent to 2.5 rem.

Given:
Critical Organ for Tritium is Body Water (43 litres)
QF for tritium = 1
Energy of tritium beta: $E_{max.} = 18$ keV, $E_{ave.} = 5.6$ keV
1 eV = 1.6×10^{-19} joules
1 rad = 10^{-2} J/kg

Question #10

University research operations often utilize a variety of radiation sources, such as large fixed gamma sources, X-ray machines, nuclear reactors, particle accelerators, neutron sources, and unsealed radioisotope sources. Each of these radiation sources must be installed and used so as to minimize the radiation dose to individuals. Considering the basic principles for reducing personnel dose, discuss which method(s) you would emphasize in each of the following cases. Explain your reasons in each case.

Point Value	
3-1/3	a) 50 mCi of ^{32}P used in a biochemical labeling experiment.
3-1/3	b) 5000 Ci of ^{60}Co as a sealed source used for radiation damage studies.
3-1/3	c) A one time transfer of 1 mg of ^{252}Cf as a sealed source from its shipping container to a large experimental water tank.

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Question #11

Neutron radiation is often a major contributor to the radiation environment around particle accelerators.

Point Value

2 a) List four (4) important processes by which neutrons interact with matter.

8 b) For each interaction process listed in part (a), describe a neutron detector based on that interaction process. Briefly discuss the application of each detector in measuring neutrons around an accelerator.

Question #12

You are hired as a consultant by an industrial firm who proposes to use an electron accelerator for the unique application of excavating rock. Two alternative designs are proposed, one producing an energy of 2 MeV with an average beam current of 5 amps, the other using a beam energy of 10 MeV with the same average beam power. There is no difference in the efficiency of either accelerator in excavation; they may be manufactured at the same cost.

a) Which accelerator would you recommend be produced? Why?

b) Calculate the maximum radiation level at the surface of the ground when a 2 MeV, 10 MW accelerator is operating 2 meters underground.

Given:

The forward Bremsstrahlung intensity, I, produced by an electron beam impinging on a thick target is given by:

I (watts cm $^{-2}$ per amp at 1 meter) $= 5.0\times10^{-2}\, T(T+0.51)^2 \ln(960\, R/x_o)$

T = Electron energy in MeV

(Rock may be assumed identical to aluminum in its atomic properties.)

R = range of 2 MeV electrons in Al = 0.95 gm cm $^{-2}$

x_o = radiation length of Al = 26.3 gm cm $^{-2}$

Assume 10^6 photons cm $^{-2}$ sec $^{-1}$ $\equiv$ 1 rem h $^{-1}$.

1 MeV = 1.6×10^{-13} joules

1 joule/sec = 1 watt

Attenuation coefficient of photons in rock = 0.15 cm $^{-1}$

Assume a buildup factor of 2.

Question #13

Point Value

10

A patient is to be given a 200 mCi ^{131}I oral therapeutic dose (as iodide) for an inoperable thyroid metastasis. The thyroid has been surgically removed during a previous hospitalization. Briefly discuss the health physics aspects of the dose administration and the following hospitalization of the patient.

Question #14

The plan below (Figure 3) shows a proposed ^{60}Co teletherapy installation. The useful beam can be directed only at the floor and at wall BC.

Point Value

10

a) Using the attached table, specify the concrete shielding required for Point 2 and any three (3) of the others shown for a workload, W, of 120,000 R/week at one meter. List and explain all assumptions used in arriving at the shielding specified.

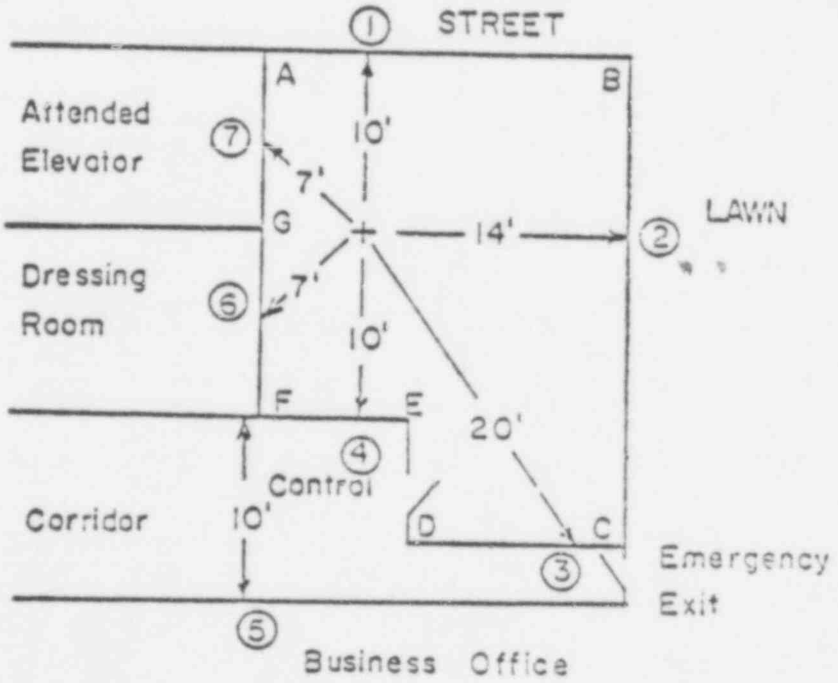

FIGURE 3

DATA FOR PROBLEM #14

TABLE 21—*Cobalt-60 shielding requirements for controlled areas*[a]

WUT[b] in R/ week at 1 meter			Distance in Feet from Source to Occupied Area										
120,000			5	7	10	14	20	25	40				
60,000				5	7	10	14	20	25	40			
30,000					5	7	10	14	20	25	40		
15,000						5	7	10	14	20	25	40	
7,500							5	7	10	14	20	25	40
3,750								5	7	10	14	20	25
1,875									5	7	10	14	20
950										5	7	10	14
475											5	7	10
240												5	7
120													5
Type of Protective Barrier	**Approx. *HVL* Inches of Concrete**	**Approx. *TVL* Inches of Concrete**	**Thickness of Concrete in Inches**[c]										
Primary	2.45	8.15	49.0	46.5	44.1	41.7	39.2	36.8	34.3	31.9	29.4	27.0	24.6
Secondary													
Leakage[d]													
0.1%	2.45	8.15	24.6	22.1	19.7	17.3	14.8	12.4	9.90	7.5	5.0	2.6	0.2
0.05% -	2.45	8.15	22.1	19.7	17.3	14.8	12.4	9.9	7.5	5.0	2.6	0.2	0
Scatter[e]													
30°	2.4	8.0	32.7	30.3	27.9	25.5	23.1	20.7	18.3	15.9	13.5	11.1	8.7
45°	2.35	7.8	30.6	28.2	25.9	23.6	21.2	18.8	16.5	14.2	11.8	9.4	7.1
60°	2.27	7.55	27.8	25.5	23.3	21.0	18.7	16.4	14.2	11.9	9.6	7.4	5.1
90°	1.82	6.05	21.3	19.4	17.7	15.8	14.0	12.2	10.4	8.6	6.7	4.9	3.1
120°	1.72	5.7	18.0	16.3	14.6	12.9	11.1	9.4	7.7	6.0	4.2	2.5	0.8

---

[a] For a weekly design level of 100 mR; add one tenth-value layer (*TVL*) for regions in the environs to reduce radiation to 10 mR/week.

[b] *W* —workload in R/week at 1 m, U—use factor, T—occupancy factor.

[c] Thickness based on concrete density of 2.35 g/cm³ (147 lb/ft³).

[d] Refers to leakage radiation from source housing when source in "ON" condition; may be ignored if less than 2.5 mR/h at 1 m.

[e] For large field (20 cm) and a source to skin distance of 40 to 60 cm. This includes scattering from the collimator and from the phantom [3].

POOR ORIGINAL

Question #15

In a fuel reprocessing plant, irradiated fuel is dissolved so that it is chemically separated into three main streams:

Point Value

3-1/3 a) uranium

3-1/3 b) plutonium

3-1/3 c) fission products

Assume that maintenance work must be done on a pump in each of these streams. Briefly discuss the health physics precautions which must be taken for the work on each stream.

Question #16

One area of a fuel reprocessing plant is made up of the five rooms shown on the attached sketch (Figure 4). You are being consulted by the facility engineer to assist him in properly designing the ventilation system. He gives you the attached sketch and the following information:

a) The ventilation supply and exhaust for this area will service only the five rooms shown.

b) Each room will have its own supply and exhaust duct and any volume of air can be supplied to and exhausted from any room. (The facility engineer will design the pressure drop between areas so the proper air flow patterns will exist when doors are opened.)

c) It is felt that the NRC will agree to waive the Reg. Guide 3.12 requirement for roughing filters on the exhaust of each room if their absence will permit a single alpha constant air monitor to service the entire area and detect 1 x MPC within 4 hours if it occurs in any one of the five rooms.

d) Pu-239 is the limiting radionuclide (MPC_a for ^{239}Pu is 2×10^{-12} $\mu Ci/cc$)

e) The design criteria states that each of the five rooms must have at least 5 air changes per hour.

f) Ceiling heights:

Crane and Equipment Maintenance Area = 20'
Product Container Storage Area and the Plutonium Loadout Operating Station = 14'
Air Lock and Corridor = 12'

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POOR ORIGINAL

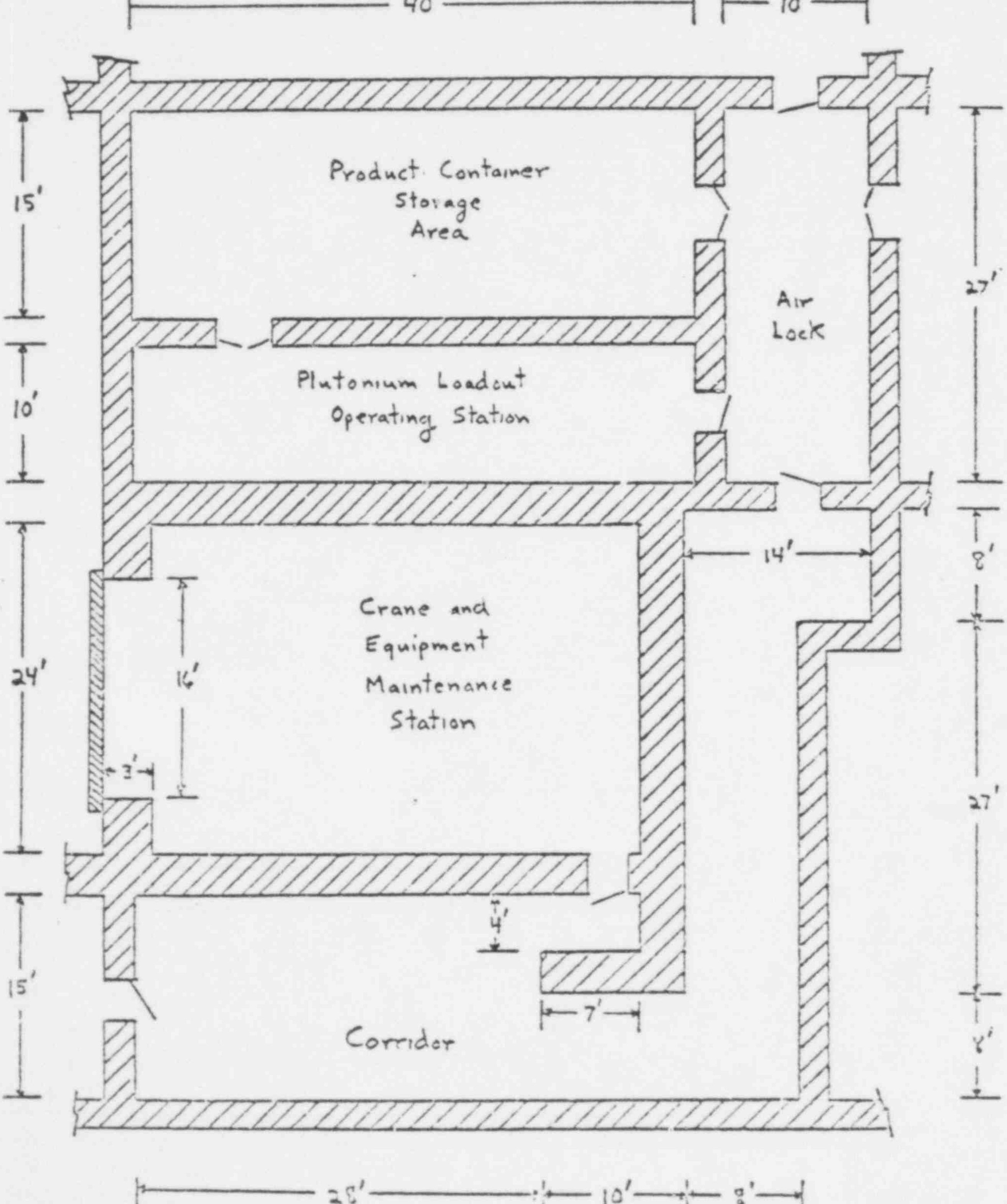
In checking various alpha constant air monitors, the one you have decided to recommend uses a kinetic impactor system with a step advance tape. This monitor has the following specifications:

a. Nominal flow rate = 20 cfm
b. Detector efficiency = 30%
c. The tape advance frequency is adjustable so that a 4 hour sample time is possible.
d. Normal background on the monitor is 10 cpm.
e. The meter scale and time constant of the monitor are such that 20 cpm above background is easily recognized as a positive reading.

Point Value

10 Calculate the minimum airflow which must be used for each of the five rooms so that you meet all the design criteria and can detect 1 x MPC in any room within 4 hours by sampling the common exhaust header. (Neglect the volume of air that is in any personnel door opening.) (1 cu. ft. = 28,300 cc)

DATA FOR QUESTION 16
FIGURE 4



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ABHP EXAMINATION #20

June 28, 1976

Part II - Answer any seven

Total Time: 4 hours

Question #1

The transportation and disposal of radioactive waste have received considerable attention in recent years.

Point Value

5 a) Discuss the environmental impact of accidents involving the transportation of radioactive waste. Include in the discussion the relation of transportation regulations to the environmental effects of accidents.

5 b) Discuss the environmental aspects of the present disposal of 1) activation products and 2) transuranic wastes. Include in the discussion packaging requirements and environmental considerations of disposal site selection and operation.

Question #2

Electron capture detectors for gas chromatographs use tritium or ^{63}Ni foils in the cells. Release rates for each, at their normal operating temperatures, are 10 μCi/min and 10 nCi/min, respectively. One of each type is located in a room 8m x 6m x 3m in a laboratory building fairly accessible to the general public. Assume that the tritium is released as the oxide whereas only 50% of the nickel released is soluble.

A fan in the room provides reasonably complete mixing. The ventilation system, which exhausts the room air directly to the outdoors, provides three air changes per hour.

Point Value

4 a) What are the average room concentrations of tritium and ^{63}Ni at equilibrium when the gas chromatographs are operating?

6 b) Discuss the health physics program that you would recommend for this operation.

Data:

	MPC (air) (μCi/ml)	
	Controlled Area	Uncontrolled Area
Tritium (as HTO or T_2O)	5×10^{-6}	2×10^{-7}
^{63}Ni (S)	6×10^{-8}	2×10^{-9}
(I)	3×10^{-7}	1×10^{-8}

Question #3

A radiographer installed x-ray film around a pipe weld prior to inserting a sealed source of gamma radiation into the pipe as part of the inspection procedure. After completion of the film installation, it was discovered that he had been exposed from the back to the source which had not been fully retracted into its shield.

The radiographer's dosimeter was processed and he described and re-enacted (the source having been removed) the installation of the film. It was found that he wore his dosimeter near the midline of his chest about 20 cm above his belt; the source was at the level of his belt, in line with the midline of his back, and at a distance of 10 cm from the surface of his back; and the dose equivalent at the location of his dosimeter was 0.1 rem for the duration of this exposure.

Point Value

7 a) Calculate the maximum dose equivalent at the surface of his back given the following: the HVL for the radiation in any tissue in this case is 5 cm; neglect any other effect of scattering or buildup and any attenuation by air or clothing; the radiation at any point considered is in equilibrium with soft tissue; the radiographer's torso is assumed to be a slab of soft tissue, 25 cm thick and 35 cm wide; and the source is a point source.

3 b) List the corrective measures which you would institute to prevent a recurrence of this incident.

Question #4

The following average life span data on a large group of young adult rats that survived early mortality (more than 30 days) was collected using cobalt-60 gamma radiation delivered in single acute doses.

Dose (rads)	Life Span (days)
15	997
70	980
150	939
300	832
425	827
550	780
650	739

The control (unirradiated) rat lifespan was 1000 days. The dose leading to 50% mortality (LD_{50-30}) in a third group of previously unirradiated rats is 700 rads.

(Continued on next page)

Point Value

4 a) Estimate the average life-span shortening due to acute ^{60}Co irradiation for rats in days per rad.

3 b) Determine an equation for the life-span as a function of gamma dose. Express the life-span as percent of control lifespan. Make the equation as simple as possible that fits the data approximately.

3 c) Assuming that equal fractions of the LD_{50-30} for the different species of mammals produce the same percentage lifespan loss, estimate the life-shortening effect in years in man from a single acute dose of 100 rads. The LD_{50-30} for man in this case is 300 rads at the midline. The life expectancy is 70 years for unirradiated humans.

Question #5

As the Health Physicist at a large university you have been asked to set up an in-house bioassay program to monitor biology and chemistry research workers who at various times work with up to the following quantities of radioisotopes.

Quantity and Isotope	Half-Life for Critical Organ
2 Ci of ^{3}H	T_e = 10 days
200 mCi of ^{32}P	T_e = 14 days
100 mCi of ^{14}C	T_e = 12 days
50 mCi of ^{125}I	T_e = 42 days

Your previous experience at this university indicates that 99% of the bioassay results are less than 1 investigation level (as defined by the ICRP).

Point Value Discuss your recommendations and reasons for the following points.

4 a) What type of bioassay would you recommend for each radioisotope? (Bioassay includes any method used to evaluate internal deposition of radionuclides) Assume you have access to any type of counter desired.

3 b) Discuss the rationale for the routine bioassay frequency you would recommend for each radioisotope.

3 c) What calibration methods would you recommend for each type of bioassay analysis you choose?

Question #6

A biologist wearing a labcoat but no gloves was homogenizing a cell culture containing 50 mCi of ^{32}P-phosphate. The tube shattered and uniformly contaminated both of his hands. After three scrubbings with detergent, you measured the non-removable activity with a 5 cm diameter detector at contact to be 1.6×10^6 cpm anywhere on either hand. The worker is now on his way to your medical facility and you stop by your office to get the following data before conferring with the Institute physician.

1) From Radiological Health Handbook

$\overline{E}_\beta$ for ^{32}P = 0.69 MeV, T 1/2 = 14.3 day, maximum range of β in tissue = 320 mg.

Standard man:	epidermis	500 gm
	dermis	4400 gm
	skin area	18000 cm^2

Assume that the thickness of the epidermis and dermis is uniform over the body.

2) From your files

Total detector efficiency (including geometry) = 3.0%

Effective removal half-life for 3 previous ^{32}P-phosphate hand contamination incidents was 2.7 days.

3) From Radiation Dosimetry (Hine and Brownell)

For a β^- source on an infinite thin plane inside a uniform absorbing material the dose at point (x) is:

$$D(x) = 2.66 \times 10^{-9} \; \overline{E}_\beta \sigma \left\{ C\left[\left(1 + \ln\frac{C}{\nu x}\right) - \exp\left(1 - \frac{\nu x}{C}\right) \right] + \exp(1 - \nu x) \right\}$$

expression in brackets [] $\equiv 0$ if $x \geq C/\nu$

$D(x)$ = dose rate in rad/min. at depth x in gram/cm^2

$\overline{E}_\beta$ = avg. β energy in MeV

σ = dpm/cm^2

ν = 9.2 cm^2/gm tissue

C = 1

Point Value

6 a) Calculate the maximum dose to the dermis and the subcutaneous tissue.

2 b) How do these calculated doses compare to maximum permissible doses for these tissues?

2 c) What recommendations would you make to the physician regarding initial and follow-up treatment procedures?

Question #7

In a power reactor, failed fuel cladding results in significant gaseous activity being released from the fuel and possibly from the plant. Since this gaseous activity can produce health physics problems both in the plant and in the environs around the plant, it is important to recognize that a cladding failure exists and to identify the suspect assembly or assemblies so that they can be removed from the reactor.

Point Value

2 a) What is usually the first indication that a fuel cladding failure has occurred in a PWR? In a BWR?

1 b) If this first indication is questionable, what can be done to verify or refute the indication?

1 c) What actions can be taken while operating to approximately locate the suspect fuel?

6 d) Once the reactor is shut down, the fuel can be "sipped" to determine the condition of each assembly. There are three general "sipping" techniques used. Describe each of these techniques, describe the activities measured to evaluate the fuel, and give the advantages and disadvantages of each method.

Question #8

A demineralizer on the primary system of a power reactor is processing a flow of 600 l/min. The long-lived isotopes removed by the demineralizer are analyzed to be:

	µCi/ml
^{60}Co	4.3×10^{-4}
^{54}Mn	3.8×10^{-4}
^{137}Cs	3.2×10^{-2}

Point Value

5 a) If the demineralizer has been on-line for 180 days, what is the total activity of these radionuclides which is built up on the demineralizer?

5 b) Assuming that the demineralizer approximates a point source at three meters, what radiation level would you expect to measure at three meters from the demineralizer after it has been isolated for four weeks?

Data:

Radionuclide	Halflife	Beta Radiation (Mev)	Gamma Radiation (Mev)
^{60}Co	5.26y	1.48(0.12%), 0.314(99%)	1.17(100%), 1.33(100%)
^{54}Mn	313d		0.835(100%)
^{137}Cs	30.2y	1.176(7%)	0.66(85%)

Question #9

Fuel fabrication facilities may be required to manufacture plutonium as well as uranium based fuels.

Point Value

Discuss:

7 a) The specific changes in the routine and emergency environmental monitoring programs, and

3 b) The specific changes in facility design philosophy as it relates to the off-site environment

required at a nuclear fuels fabrication facility in order to fabricate plutonium fuel in addition to uranium fuel.

Question #10

The concentration of ^{226}Ra in the atmosphere at a particular location has been measured to be 10^{-16} μCi/cc on the average. The average concentration of ^{226}Ra in the soil at this location is 2.2 dpm/g and it is approximately uniformly distributed in the soil. The density of the soil is 2 g/cc.

Point Value

2 a) Assuming a resuspension factor of 5×10^{-7} m^{-1}, what is the resuspendable ^{226}Ra activity per m^2?

2 b) What is the effective thickness of the resuspendable layer of soil?

6 c) Assuming an adult inhales ^{226}Ra at the concentration measured at this location for 30 years, what would be the total integrated dose equivalent to the bone at the end of the 30 year period?

Given: Breathing rate = 2×10^7 cc/day

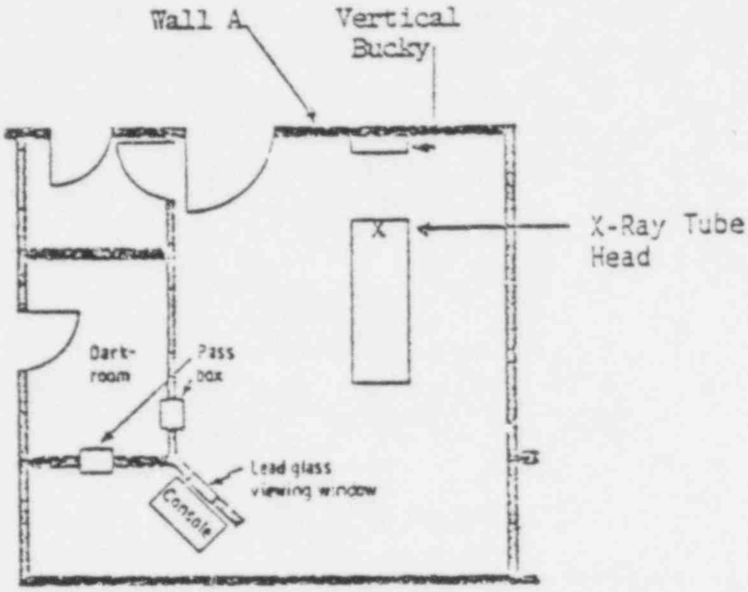
Fraction of ^{226}Ra inhaled reaching the bone is 0.2

T_E for removal of ^{226}Ra from bone = 1.6×10^4 days

Dose equivalent rate to bone from ^{226}Ra = 0.8 rem/day-μCi

Question #11

You are hired as a consultant to specify the required protective shielding for a general purpose radiographic/fluoroscopic examination room that has the following lay-out:



A 100 kVp x-ray generator equipped for image intensified fluoroscopy is to be installed in this facility. The patient load will be approximately 20 per day, 5 days per week. The average number of films per patient is 4 with an average of 100 mAsec per film. The normal tube head to wall distance is 2 meters. The hall on the other side of Wall A is considered a controlled area.

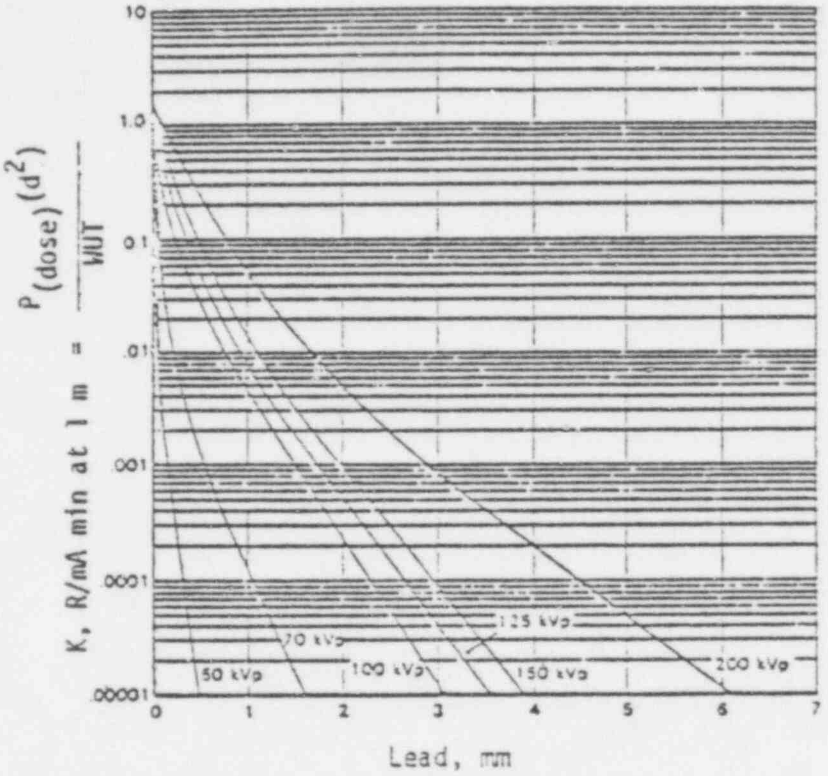
Point Value

5 a) Calculate the required primary protective barrier thickness for wall A using the shielding information given in the accompanying figure.

4 b) Following completion of this facility a radiation protection survey shows the exposure rate in the hall opposite the vertical Bucky to be 200 mR/hr during a typical chest radiographic examination with the x-ray machine operating at 100 kVp and 200 mA. Is this excessive? Explain your answer.

(Continued on next page)

Figure for Question 11



Question #12

A three room nuclear medicine department in a community hospital is conducting routine diagnostic studies with a rectilinear scanner and a gamma camera. It receives a 300 mCi Mo-99 generator each week. Other radiopharmaceuticals are obtained in individual patient doses. Radiotherapy is limited to I-131 for hyperthyroidism and thyroid cancer.

Point Value	Design a continuing radiation control program for this facility. Be sure to discuss:
2	a) Records required
2	b) Instrumentation needed
2	c) Nursing instructions, if any
2	d) Routine radiation and contamination surveillance
2	e) Personnel monitoring

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Question #13

You are a health physicist at an institute that intends to install a 200 MeV proton synchrocyclotron that will produce a beam intensity of 10 μA of protons in the experimental areas.

The accelerator's experimental areas are to be built underground, but the roof shielding design is your responsibility.

Point Value

10

A cosmic ray experiment that is measuring fluctuations in the neutron intensity produced by cosmic radiation is located 500 meters from the synchrocyclotron on a hill directly overlooking the synchrocyclotron. What thickness of concrete roof shielding for the synchrocyclotron would you recommend?

Given:

A 200-MeV proton produces an average of 0.5 neutrons when it interacts in a thick copper target.

Cosmic ray produced neutron flux density at the cosmic ray laboratory $= 10^2$ n/cm^{-2} sec^{-1} with fluctuations of ± 10%.

The transverse attenuation length for the neutrons in concrete is 85 gm cm^{-2}.

Density of concrete = 2.4 gm cm^{-3}.

Charge on the electron = 1.602×10^{-19} coulomb.

Question #14

A physicist working on an experiment calls you to report that he believes he has accidentally placed his right arm in the beam of a 6 GeV proton synchrotron for approximately 1 minute. The accelerator produces 10 pulses per minute at an intensity of 10^{12} protons per pulse.

Point Value

6

a) You have available a 3-in. x 3-in. NaI scintillation counter. Calculate the counting rate you would observe from ^{11}C in activated body tissue with such a counter if the exposure had occurred.

Given: Beam size = 1 cm^2.

Production cross section for ^{11}C for protons in oxygen = 20 mb.

Halflife of ^{11}C = 20.4 min.

Efficiency of detector including geometry = 10%.

Time of measurement = 1 hr after suspected exposure.

The thickness of the arm is 10 cm and its composition is H_2O.

(Continued on next page)

Point Value

2 b) If the measurement of activity induced in tissue were to be taken in the radioactive environment of the accelerator where the γ-background is $\sim$ 1 mR/hr could the induced activity be detected? (The NaI detector gives 400 cps in an exposure rate of 10 μR hr^{-1} due to ^{226}Ra γ's).

2 c) What other steps would you take in investigating this incident?

Question #15

A line containing 95% enriched uranium in solution as uranyl nitrate is being cut in order to install equipment to dislodge a plug in the line. As a health physicist you happen on the scene as maintenance people are cutting the line. They are dressed in coveralls, latex gloves, plastic boots, and are wearing respirators, hard hats, and goggles. The field of radiation is 350 mrem/hr and all personnel are standing around the equipment watching progress of the work. The area has been ribboned off and a plastic bag has been taped to the line around the cut area in order to prevent contaminants from splashing to the floor and adjoining equipment.

Point Value

4 a) What is the major item of concern here?

6 b) What, if any, changes would you recommend in the procedure?

Question #16

You are the health physics member of a design review team responsible for evaluating the design of a fuel reprocessing plant. As means of reducing doses to personnel from radioactive material and releases of radioactive materials to off-site locations, briefly discuss the design of each of the following:

Point Value

3 a) containment and confinement barriers

3 b) shielding

1 c) physical layout

2 d) ventilation

1 e) equipment design

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ABHP EXAMINATION 21, PART II

July 8, 1977

Answer any seven

Total Time: 4 hours

Question #1

Point Value
2
for each
reason

List and briefly discuss five reasons why radiation protection standards for occupationally exposed persons are greater than for members of the public.

Question #2

You are the health physicist for a university hospital which is licensed to perform implants of radionuclide powered pacemakers. Patients receiving such implants are to carry identification cards and a bracelet or other approved jewelry identifying the wearer as a bearer of a radionuclide powered pacemaker. In case of emergency or death, your hospital is to be contacted and the pacemaker is to be removed.

The physician in charge of the program has just learned that, inspite of these precautions, two patients who had implants have died and were buried without notification of the hospital and without removal of the pacemakers. In one case, the pacemaker was powered by 80 Ci of Pm-247 (2.62 year half-life) implanted a year ago. The other was powered by 250 mgms of Pu-238 (~4.3 Ci) (87.8 year half-life). Neither patient was cremated and disinterment of the bodies for removal of the pacemakers is possible. However, the legal problems and the potential mental anguish which may be suffered by the survivors are also factors to be considered.

Point Value
10

You are asked what your recommendations would be from a health physics point of view.

Question #3

An analyst inhaled about ten nanograms of ^{35}S when he entered a laboratory module after a vial containing one milligram of ^{35}S exploded. Floor surfaces in the laboratory were contaminated to 70 mCi/m^2. His body surfaces were decontaminated with soap and water; contaminated body hair was removed by shaving. All urine and fecal samples were collected for ^{35}S determinations until the concentration in the samples decreased to the limits of detection, 0.1 nCi/liter of urine or 0.1 nCi/100 grams feces.

Sample	Period Monitored (days)	Total ^{35}S Activity (μCi)	Fraction Eliminated %	Biological Halftime (days)
Urine	65	610	0.75	0.3
			0.25	7
Fecal	8	380	1.0	1

Point Value

4 a) Determine the dose equivalent from one millicurie of ^{35}S in the body for one day assuming the whole body to be the critical organ.

6 b) Calculate the analyst's integrated whole body equivalent.

Given: ^{35}S data half-life = 87 days; beta energy = 0.167 MeV (max);
= 0.05 MeV (ave)
Quality Factor = 1.0 (total body)
Organ Weight, total body = 70 kg; lung = 1 kg
Curie = 3.7×10^{10} dis/s
eV = 1.602×10^{-12} ergs
day = 8.64×10^{4} s
Fraction of Systemic burden excreted in urine (Fu) = 0.9

$$\int_0^\infty e^{-az}\,dz = \frac{1}{a}$$

Question #4

You are requested, by a large experimental facility, to suggest methods for them to evaluate their stack for tritium releases. The facility conducts many experiments which involve releases of small quantities of gaseous beta/gamma emitters.

Point Value

5 a) List and describe four methods for evaluating tritium released in their stack gases.

5 b) Discuss the problems associated with each method.

Question #5

Point Value

a) Discuss the major method of neutron production and intercompare the relative neutron production for:

2 1) 3 MeV electron constant voltage accelerator
2 2) 50 MeV proton cyclotron
2 3) 30 GeV protron synchrotron

4 b) List the most common means of personnel dosimetry for neutrons at accelerators and discuss the advantages and limitations of each method.

Question #6

Point Value

10 Calculate the flux density of high-energy muons that will produce a dose equivalent rate of 1 millirem per hour in soft tissue. Take $\frac{dE}{dx}$ as 2 MeV g^{-1} cm^2. State your other assumptions.

Question #7

The continuation of atmospheric testing of nuclear devices by the People's Republic in China adds to the inventory of radiocontaminants in the northern hemisphere. This situation tends to complicate periodically the interpretation of routine radiological environmental surveillance data. This is particularly so for facilities which have been operating for some time. For the following situations discuss the methods by which you would estimate the origin of the contamination or the facility's contribution to sample activity. Assume the facility to be a pressurized light water reactor which has operated for two years and has been through two partial refuelings. Assume the weapon to be a pure fission device. Assume the time lapse between the test and sample collection to be 7 days. Assume heavy rains with the arrival of the fallout.

Point Value

3.3 a) Silt samples collected at several downstream locations in the receiving stream showed the presence of ^{58}Co, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{140}Ba, ^{141}Ce, ^{95}Zr, ^{95}Nb, ^{131}I, and ^{103}Ru.

3.3 b) Milk samples collected at several local farms showed significant concentrations of ^{131}I, ^{132}I, ^{89}Sr, with no significant change in ^{90}Sr and ^{137}Cs.

3.3 c) Composited raw domestic water collected at a downstream intake showed elevated tritium and small quantities of ^{58}Co, ^{60}Co, ^{54}Mn, and ^{140}BaLa.

Question #8

You are a health physics consultant for a uranium mining and milling company. Last night, at 11:00 p.m., at the Victorio Peak uranium mill, a retention dam broke releasing 2 million gallons of tailings water and slimes. About 50 acres of land adjacent to the mill have been flooded. The Shift Supervisor ordered a temporary berm thrown up which has confined the flow to land controlled by the mill. The flow stopped about 1/2 mile short of the small community of Black Sands (about 50 residents). The mill has been shut down.

The mill is located in a dry part of the country subject to frequent periods of high winds. Drinking, farm, and mill process waters are obtained from shallow aquifers.

Point Value

4 a) What program would you initiate to assess the potential radiological impact of the tailings spill upon the environment?

4 b) What actions would you recommend to the mill operators to minimize and to control the impact of the spill?

3 c) What radioisotopes are of major concern?

Question #9

You are asked to determine the gaseous releases from a laboratory operation. An isokinetic stack sampler (flow rate 10^3 cm^3/min) containing an activated charcoal canister is utilized to sample the gaseous releases. The canisters are changed and analyzed once every 24 hours. The stack discharge rate has averaged 200 m^3/min over the last year and the only radionuclide released has been ^{131}I. The average net ^{131}I activity (background subtracted), as determined by an end window GM counter, for each canister was 43,600 cpm. Assuming a collection efficiency of 90% and a counter efficiency of 30%, and neglecting radioactive decay of ^{131}I, conduct the following calculations.

Point Value

2 a) Calculate the average concentration of ^{131}I (μCi/cm^3) released via the stack for the year.

2 b) Determine the total amount of ^{131}I (μCi) released to the atmosphere by the laboratory over the year.

3 c) Calculate the average thyroid dose to an individual who stands at the facility fence for the entire year. Weather data indicate an average annual dispersion factor for the area at the distance of interest of 7×10^{-6} sec/m^3. The dose to the thyroid of an adult from ^{131}I is approximately 1.49×10^{-3} mrem/pci inhaled.

Breathing Rate = 2.3×10^7 cm^3/day.

3 d) Briefly outline a suggested environmental monitoring program for a followup to the effluent monitoring program at this laboratory.

Question #10

A researcher in the Physics Department wishes to construct a photo neutron source of ^{9}Be and ^{124}Sb. He plans to use a very small sealed capsule of ^{124}Sb surrounded by 30 gm of ^{9}Be.

Point Value

8 a) Calculate the approximate radiation dose rate from this source. Show calculations.

2 b) Discuss the nature of the shielding you would recommend.

Data:

10 Ci of ^{124}Sb

^{9}Be (γ, n) cross section = 1 millibarn
^{9}Be (γ, n) threshold = 1.66 MeV
Be density = 1.8 g/cm^{3}

^{124}Sb decay Scheme:

Energy (MeV)	%
0.603	97
0.644	7
1.692	50
2.088	7

Neutron energy = 24 KeV

400×10^{6} n/cm^{2} = 1 rem

Question #11

An impact wrench used with a chemical separations facility crane has been in storage for three years. Analysis of a swipe from the wrench showed 2 mCi ^{90}Sr, 8 mCi ^{137}Cs, 2 μCi ^{239}Pu, and 7 nCi ^{241}Am. The radiation intensity at 2 meters from the wrench is 10 rad/hr. Direct maintenance will be required to make the wrench serviceable since the lifting bail was bent during storage. A plastic containment hut with a HEPA filtered exhaust is available in the shielded repair cell.

a) Discuss your recommendations regarding:

1. Decontamination of the wrench prior to repair.
2. Protective clothing and equipment.
3. Exposure control.

b) Radioactive waste (cleaning rags, rubberized canvas gloves, and fire retardant paper) from the repair operation was packaged in a 55-gallon galvanized drum. Estimate activity in the drum, assuming all radionuclides are removed equally effectively.

Given: Radiation intensity at 10 meters from the drum is 20 mR/hr.

Nuclide	Half-Life	Alpha Energy	Beta Energy	Gamma Energy
^{90}Sr	27.7 years	-	0.546 MeV (max)	-
^{90}Y	64 hours	-	2.27 MeV (max)	-
^{137}Cs	30 years	-	1.18 MeV (max)	0.662 MeV (85%)
^{239}Pu	24,400 years	5.16 MeV (88%)	-	0.052 MeV (0.02 %)
^{241}Am	458 years	5.49 MeV (85%)	-	0.060 MeV (36%)

Question #12

Possible accidents at power reactors have received considerable attention in the past several years. WASH-1400 (Rasmussen Report) is an in-depth investigation of potential accidents at power plants. Answer 4 of the following 5 sections:

Point Value
2.5
per section

a) Explain the event tree and fault tree technique used in the report. (What is the relationship between them?)
b) What are the three sets of probabilities which are combined to reach the final probability of a specific consequence (death or injury) on the population?
c) This report develops some new values for $LD_{50/60}$. Approximately, what are these values, and what are the reasons for having more than one?
d) What doses are combined to arrive at the total dose used to evaluate mortality rates?
e) Based on this report, what natural phenomenon (or group of natural phenonmena) has an equivalent probability of mortality as do 100 operating nuclear power plants?

Question #13

A stainless steel bolt has come loose from one of a reactor vessel internals. Plans are to pick the bolt up with a remote set of tongs and and bring it up out of the water for local visual inspection and then send it off-site for metalurgical inspection. This bolt has been in the reactor for 910 effective full power days. The thermal neutron flux in this portion of the reactor is calculated to be 2.1 E 12 n/cm^2- sec. The reactor will have been shut down for 17 days at the time the bolt will be removed. From drawings, the bolt is calculated to weigh 215 grams. The composition of the bolt is:

Iron	--	80%
Nickel	--	19%
Manganese	--	0.5%
Carbon	--	0.5%

Point Value
10

Calculate the gamma radiation level expected at 12 inches from the bolt in air. (Use data from that provided on the attached table. ^{59}Co contamination in nickel and iron should be neglected. Avogadro's number = 6.022 E 23.)

Data for Question #13

Radionuclide	Half-Life	E gamma (MeV)	Yield: % per Disintegration	Parent	Isotopic %	Thermal Neutron Activation Cross Section (barns)
Mn-54	313d	0.835	100	Fe-54	5.82	0.011
Fe-55	2.7y	no gamma		Fe-54	5.82	2.3
Mn-56	2.58h	2.98	0.4	Mn-55	100	13.4
		2.13	15			
		2.65	1.8			
		1.87	24			
		0.845	99			
Co-58	71.4d	0.51	30	Ni-58	67.77	0.13
		0.810	99			
		0.865	1.4			
		1.67	0.6			
Fe-59	45.1d	0.191	3	Fe-58	0.31	0.9
		1.29	43			
		1.10	57			
Ni-59	8E4y	no gamma		Ni-58	67.77	4.8
Ni-63	92y	no gamma		Ni-62	3.66	14
Ni-65	2.56h	0.37	4.1	Ni-64	1.16	1.6
		1.49	24.9			
		1.12	18.1			

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Question #14

A 26 year old female was referred to radiology by her internist for the following examinations:

a) Chest, PA and Lat.
b) Barium Enema
c) Intravenous Pyelogram

Subsequently it is discovered that this patient was two weeks pregnant at the time of the examination. As the hospital health physicist, you are consulted.

Point Value

5 a) Estimate the fetal dose from each of these procedures. Describe your method and assumptions.

2.5 b) Discuss your recommendations regarding patient management in light of your estimated fetal dose.

2.5 c) What controls would you recommend be instituted in order to minimize the reoccurance of this type of problem?

Question #15

A graduate student is opening an irradiated quartz ampoule containing 500 Ci of ^{169}Yb oxide powder. He is working behind a 4 inch thick, lead glass shield and is using long tongs to unwrap the aluminium foil covering on the ampoule. He becomes impatient with the tongs, reaches aroung the shield with both hands and unwraps the foil, at which point he discovers that the ampoule is broken and the ^{169}Yb powder spills out. The student recognizing a potential problem immediately stepped back from the area. Within minutes the exhaust air alarm (set for 10 X normal background at the absolute filter) sounds.

Subsequent reconstruction of the incident shows that the student's hands were close to but not less than one centimeter from the ampoule for 30 seconds. Measured dose rates were 1 rem/minute at one foot unshielded and 20 mrem/hr behind the shield. ^{169}Yb decays by electron capture ($T_{\frac{1}{2}}$ = 32 d) emitting primarily Tm X-rays, plus 63 and 198 KeV gammas.

Discuss the following:

Point Value

5 a) Exposure evaluation and management.
3 b) Cleanup of laboratory.
2 c) Steps to prevent recurrence of incident.

Question #16

The Yakima Hospital Radiopharmacy has requested to do radioiodination with ^{125}I. They propose to use up to 10 mCi per day to do the protein iodination work. Discuss the following health physics aspects of the program that you would initiate.

Point Value

4 a) Health physics controls for preparation including monitoring problems.
3 b) Personnel protection.
3 c) Waste disposal of liquids and solids.

The following information is provided:

^{125}I(s) Concentrations, μCi/cc

10CFR20 Values				Occupational Limits	
Table I		Table II		Air	
Air	Water	Air	Water	40 hr	168 hr
5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}	5×10^{-9}	2×10^{-9}

Maximum permissible body burden (C.O. = thyroid) is 625 nCi.

An increase of 52 nCi in the thyroid would indicate an exposure to an air concentration ≥ the 40 hr MPC limit.

Gammas: Te X-rays, 0.035 MeV (7%); T 1/2 = 60 days.

ABHP EXAMINATION 22, PART II

June 19, 1978

Answer any seven

Total Time: 4 hours

Question 1

Point Value

3 a) Beams of protons or electrons which pass through air can produce radioactivity by interacting with air molecules. Identify the most commonly produced radionuclides and show methods of production.

2 b) These radionuclides can produce exposure to several different parts of the body. Identify these parts and indicate which one is the limiting case.

2 c) What are the simplest methods of controlling radiation exposure in an occupied room from this source?

3 d) Given that the production cross-section for one of these radionuclides is 60 mb, calculate the equilibrium concentration in a room of 100 m^3 and no ventilation for a $6.25 \times 10^{13} \frac{p}{s}$ proton beam and a 1 m air gap. Assume a 1 cm^2 beam. Specify which reaction you have chosen.

Data

Density of air at standard conditions = $1.29 \times 10^{-3} \frac{g}{cm^3}$

Molecular weight of air = $\frac{28\ g}{mole}$

Avogadros Number = $6.02 \times 10^{23} \frac{molecules}{mole}$

Question 2

Point Value

5 a) As a consultant to a university, you have been asked to provide recommendations for the shielding requirements of a particle accelerator. What information will be needed to provide these recommendations?

3 b) Identify at least three types of radiation which are normally produced by the interaction of a particle beam and a target and which are significant from a health physics point of view. How is each produced?

2 c) Which type of radiation would you expect for a 3 MeV electron beam interacting in a copper target? For a 30 GeV proton beam interacting in a copper target?

Question 3

A composite whole milk sample collected on April 10 from cows on pasture at a dairy farm revealed the following:

Nuclide	Measured Concentration
^{40}K	1100 pCi/l
^{89}Sr	< 2 pCi/l
^{90}Sr	12 pCi/l
^{131}I	< 0.2 pCi/l
^{137}Cs	1.7 pCi/l
Ca	1030 mg/l

The dairy farm is located 14.7 miles ENE from a 860 MW_e boiling water power reactor. Prevailing winds are from the south, and X/Q values at 15 miles from the plant reveal the maximum X/Q to be in the NNW sector, decreasing radially in a counterclockwise direction. X/Q in the ENE sector is approximately 10% of the maximum X/Q. Measured rainfall in the area during the week of April 3 - 10 was 0.88 inches. Since the start of the year, reactor operations have been normal and 24 kCi of gaseous radioactivity including 26 mCi of ^{131}I have been discharged to the atmosphere; approximately 8% of this amount was discharged the week of April 3 - 10.

Point Value

6 a) Discuss the significance of the radionuclide concentrations given above, and suggest an explanation for any anomalies.

2 b) What sort of radionuclide distributions would you expect in milk from a dairy farm located 6 miles south, in the sector of lowest X/Q? A goat milk dairy farm 3 miles NNW? Why?

2 c) Suppose that a small (100 KT) nuclear weapons test (atmospheric) had been set off in Siberia 2 weeks prior to collection of the sample. Would you expect any change? Why?

Question 4

Assume that you are the health physicist at a nuclear power facility which includes a complex of buildings. The ventilation system from the nuclear processes is exhausted through a vent at a height of 75 meters. The facility is located on generally flat terrain, with no substantial hills and only scattered trees.

Point Value

2 a) Describe the purposes for maintaining a meteorological monitoring program.

2 b) Describe the general design criteria you would prescribe for the meteorological monitoring system.

Assume that you are awakened at 0430 to be told that about 100 curies of gross beta activity had been released from the vent between 0400 and 0415. The wind is reportedly blowing steadily at 2 m/sec toward a small community about 15 km away. The sky is clear on this winter night.

1 c) Describe the general configuration of the plume of activity.

4 d) Estimate the ground level concentrations at the site boundary (1000 meters) and at the community (15 km) and provide your assessment of the potential hazard. (Relative axial concentration curves are attached.)

1 e) If the release occurred between 1300 and 1315 hours, how would your answer differ at the location of the community (15 km)?

Question 5

Point Value

The principal activities which occur at a nuclear fuel storage pool are:

3 a. Fuel unloading

3 b. Fuel storage

4 c. Fuel preparation for reprocessing

Identify the potential health physics problems associated with each activity and the precautions which could be used to minimize these problems.

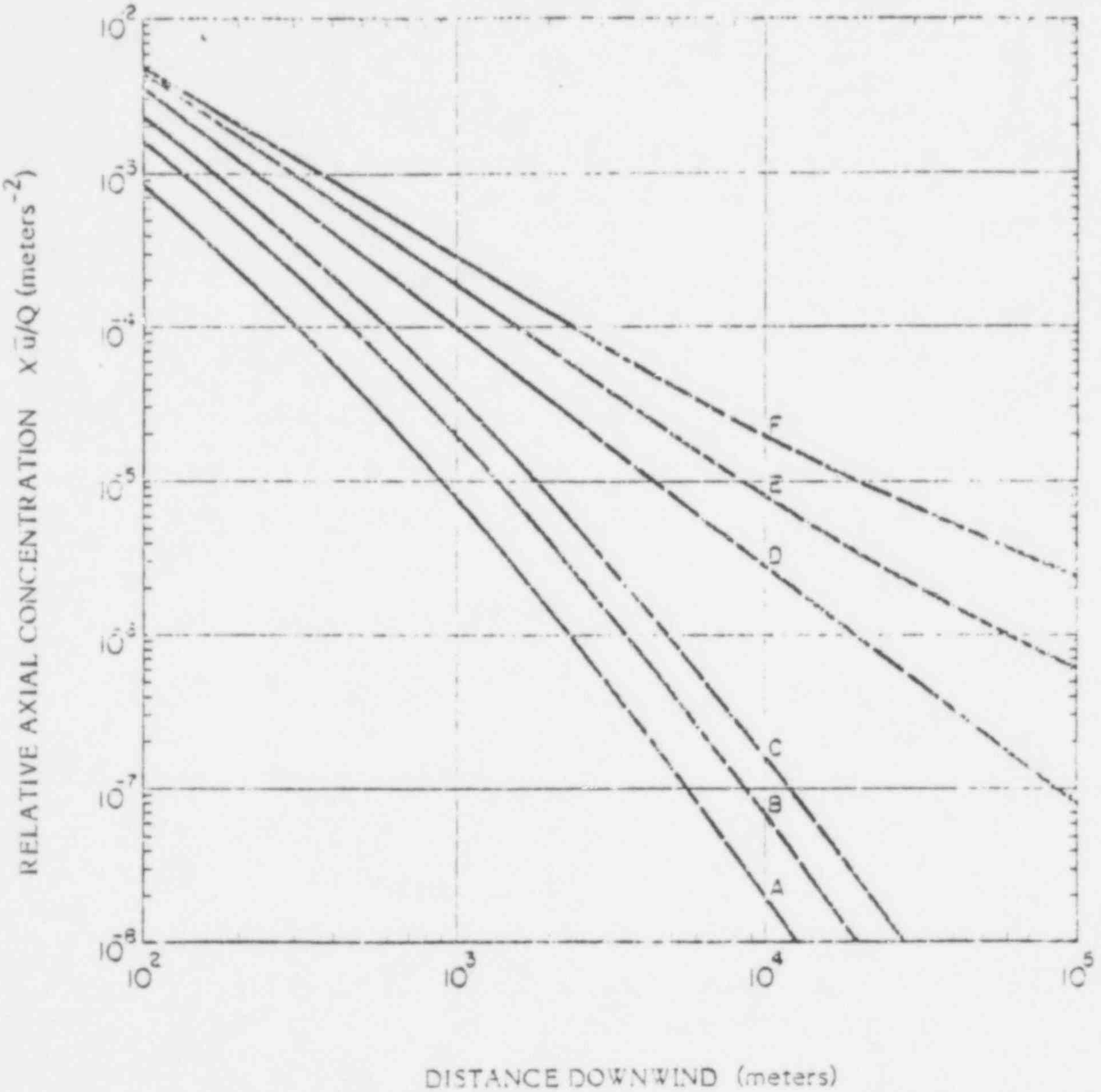
Point Value

Question 6

5 a) Provide a physical and conceptual description of working level (WL), including its relationship to MPC_a, MPC_w, and MPE.

2 b) What is the application of WL?

3 c) Briefly describe a method of determining WL that is commonly used, along with its limitations.



Relative axial concentration versus distance downwind by stability class -- 15 to 60 minute release time (Markee).

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Question 7

As shown in the diagram, a CT (Computer Tomagraphy) machine is to be installed in a room. The 0.1 mR/scan scatter contour is shown, as are meter distance markers. The north room is an existing X-ray suite. The east room is to be a waiting room. The south wall borders a corridor. The west room is to be the control room.

OPERATING PARAMETERS

Potential: 120 kVcp	Current: 30 mA
Time per scan: 30 sec.	Scans per patient: 28
Patients per day: 10	Time open per day: 8 hours
Days open per week: 5	Tube type: diagnostic
Max. tube heat dissipation: 3600 joules/sec	

Point Value

2 a) What status (controlled or uncontrolled), use factor, and occupancy factor would you assign to each of the four areas bordering the room?

3 b) Excluding the shielding of the walls, estimate the exposure expected per week at positions 1 and 2.

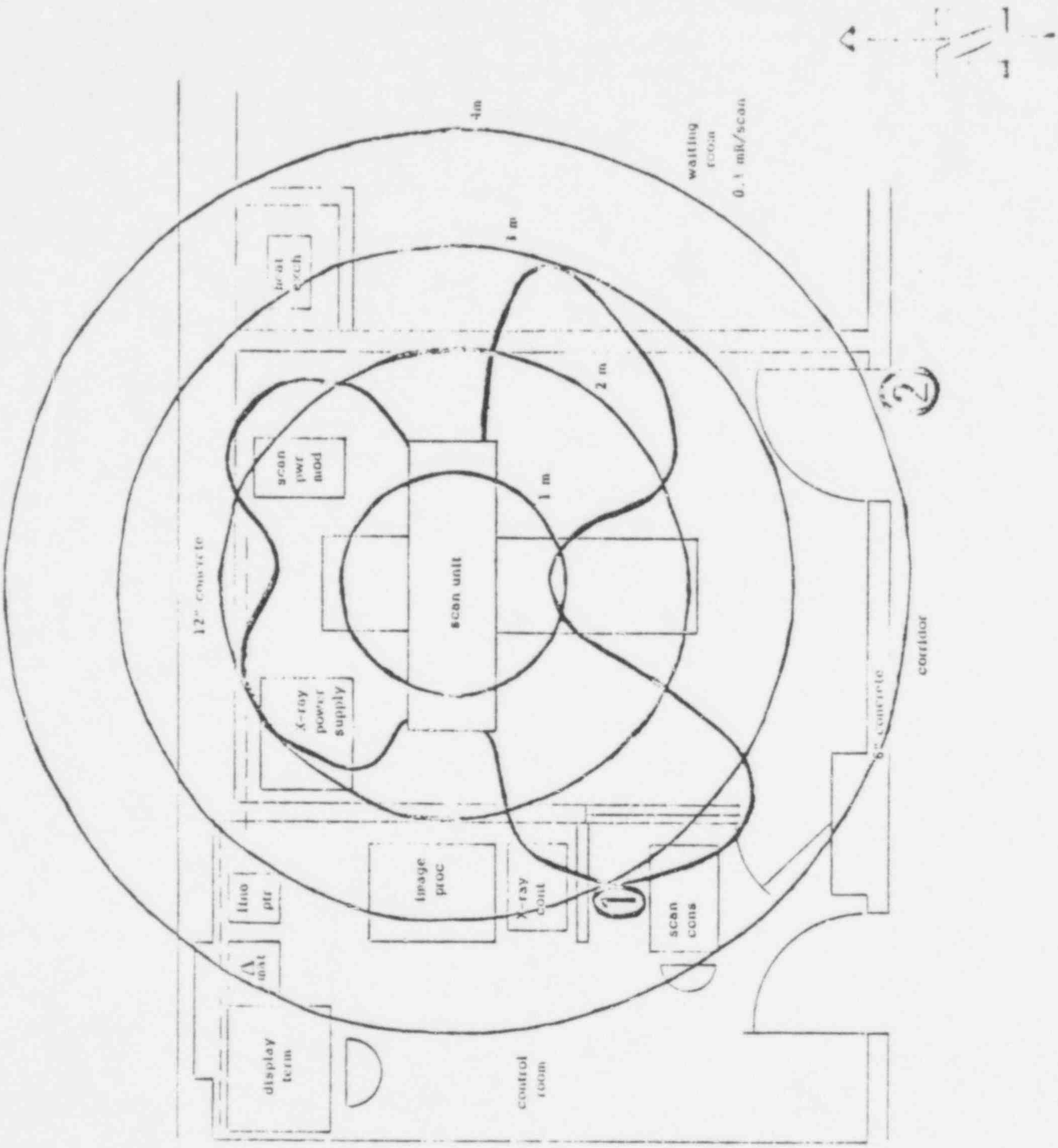
2 c) What shielding (total) is required in the walls, at the two indicated positions (1 and 2), to bring weekly exposure rates down to acceptable limits?

3 d) Describe how you would check the adequacy of the wall shielding after the machine was put into operation?

Half-Value and Tenth-Value Layers

Approximate value obtained at high attenuation for the indicated peak voltage values under broad-beam conditions; with low attenuation these values will be significantly less.

	Attenuating Material					
Peak Voltage (kV)	Lead (mm)		Concrete (cm)		Iron (cm)	
	HVL	*TVL*	*HVL*	*TVL*	*HVL*	*TVL*
50	0.06	0.17	0.43	1.5		
70	0.17	0.52	0.84	2.8		
100	0.27	0.88	1.6	5.3		
125	0.28	0.93	2.0	6.6		
150	0.30	0.99	2.24	7.4		
200	0.52	1.7	2.5	8.4		
250	0.88	2.9	2.8	9.4		
300	1.47	4.8	3.1	10.4		
400	2.5	8.3	3.3	10.9		
500	3.6	11.9	3.6	11.7		
1,000	7.9	26	4.4	14.7		
2,000	12.5	42	6.4	21		
3,000	14.5	48.5	7.4	24.5		
4,000	16	53	8.8	29.2	2.7	9.1
6,000	16.9	56	10.4	34.5	3.0	9.9
8,000	16.9	56	11.4	37.8	3.1	10.3
10,000	16.6	55	11.9	39.6	3.2	10.5
Cesium-137	6.5	21.6	4.8	15.7	1.6	5.3
Cobalt-60	12	40	6.2	20.6	2.1	6.9
Radium	16.6	55	6.9	23.4	2.2	7.4


4m
3 m
2 m
1 m
waiting room
0.1 mR/scan
heat exch
scan pwr mod
12" concrete
scan unit
X-ray power supply
image proc
X-ray cont
line ptr
dist
display term
control room
scan cons
corridor
6" concrete
1
2

Question 8

Point Value
10

There has been much written about the "preferred" use of ^{123}I over ^{131}I for thyroid work. As a consulting health physicist for a major hospital as well as a consultant to outlying community hospitals, discuss the advantages and disadvantages of each for both diagnostic and therapeutic studies.

The following information is provided:

Radiopharmaceutical	Physical Half-Life	Decay Process
^{123}I, Sodium Iodide	13.3 hours	EC (100%)
^{131}I, Sodium Iodide	8.05 days	β^- (100%)

HVL, mmPb	Energy of Principal	γ-ray, KeV
0.05	^{123}I	159 (84%)
2.5	^{131}I	364 (83%), 637 (6.7%)

Absorbed Dose, Rads/mCi (25% Uptake)

	As Manufactured	Pure
^{123}I	30 - 50	2 - 10
^{131}I	1500 - 2000	1500 - 2000

Question 9

As the RSO at a large research oriented University you are responsible for specifying the personnel dosimetry program, as well as equipment and procedures for adequate radiation protection. Describe in general terms the recommendations you would make for working with:

Point Value

2 a) 50 mCi of ^{32}P phosphate solution used in biochemical labeling work.

2 b) 2 Ci of ^{3}H used in making biochemical tracers.

2 c) A 10 MeV Van de Graaff particle accelerator, occasionally used with titanium tritide targets.

2 d) Unsealed sources of radioiodine labeled compounds in quantities exceeding 10 mCi.

2 e) Reactor irradiated geological samples (often powders) producing activities of 10 - 100 mCi/sample.

Question 10

A geology research associate is studying brine solubilization of transuranics as part of a bedded salt waste disposal program proposal. He has in a glovebox, one millicurie each of the following radionuclides: ^{238}Pu, ^{243}Am, ^{244}Cm, ^{249}Cf. You, as University RSO, receive at 4 p.m. a telephone call that there has been a small fire in the glovebox from a solvent extraction process. On arriving at the scene, you observe through the lab door window that the glovebox apppears undamaged except for possible leaks around the gloves where they mate with the box. It is ascertained that the glovebox filters are intact. The lab room exhaust ventilation system is still working because there is air flow under the door into the lab. Previous studies with smoke tubes have shown the mixing factor in the room to be 0.1. From your experience, you estimate that a maximum of 10% of the material has been released from the glovebox. The room is 20 feet by 20 feet by 10 feet high, and the exhaust flow rate is 4000 ft^3/min.

Point Value

7 a) The experimenter is quite concerned and wants to reenter the room immediately (30 minutes after the incident) to shut down a valuable piece of equipment. Calculate the room air concentrations and state the appropriate protective clothing and equipment necessary to do this job.

3 b) Comment on the overall reentry problem from the standpoint of timing and preplanning.

Radionuclide	MPC$_a$ (μCi/cm^3)
Pu-238	2×10^{-12}
Am-243	6×10^{-12}
Cm-244	9×10^{-12}
Cf-240	2×10^{-12}

Ventilation Equation

$$C = C_o \, e^{-\frac{kQt}{V}} \quad \text{where}$$

k = mixing factor
Q = flow rate
V = volume
t = time
C$_o$ = initial concentration

Respiratory protection factors

a)	Half mask	10
b)	Full-face mask	50
c)	Airline respirator	
	half mask	1000
	full-face	2000

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d) Self-contained breathing apparatus

pressure demand 10,000
demand 50

Permissible emergency excursion factor above MPC$_a$ is 5

Question 11

You are responsible for monitoring radioactive shipments at a waste management facility. A large shielded iron cask containing stainless steel scrap from a reactor storage basin was positioned at 50 feet from a high resolution gamma monitor and a 10-minute count showed photopeaks characteristic of ^{60}Co.

1173.2 KeV: 2960 counts (net)

1332.5 KeV: 5150 counts (net)

Point Value

5 a) Determine the apparent thickness of the cask assuming a point source and no significant buildup factor.

5 b) Estimate ^{60}Co activity in the cask.

Nuclide	Energy (KeV)	Photon Yield %	Detector Efficiency*	Linear Absorption Coefficient-iron (cm^{-1})
^{54}Mn	835	100	5.6×10^{-9}	0.5112
^{60}Co	1173	100	4.1×10^{-9}	0.4335
^{60}Co	1332	100	3.5×10^{-9}	0.4058

*Absolute efficiency at 50 feet in air (photons counted/photons emitted)

Point Value

10

Question 12

You have been hired by a large nuclear facility as a consultant to develope a respiratory protection program. Assume that the design of the facility has been reviewed and approved by a panel of certified health physicists and that this panel has assured that engineering controls have been instituted wherever practicable to minimize the inhalation of radioactive material. However, they recommend that the use of respiratory protective devices will be necessary in addition for certain routine, non-routine and emergency operations. Discuss the elements of an acceptable respiratory protection program.

Question 13

A worker was found to have spent an entire 8-hour shift in an area behind a wall adjacent to a radiography operation. The X-ray machine in use was beamed down at the floor and operated at 220 kVp and 22 mA: the worker was about 10 feet from the tube head with only a plaster wall as a shield. The measured exposure rate at the worker's location was obtained by the radiographer with a thin metal (30 mg/cm^2 Fe) wall GM tube used in open window mode and was 27 mR/hr. The worker's TLD (LiF) badge was immediately processed and interpreted as reading 80 mrem; a pocket chamber (200 mR full scale) on the wall behind the worker was off-scale, and a TLD in the same location read 50 mrem.

Point Value

3 a) What dose would you assign to the worker? Explain your basis.

3 b) What additional data would you gather, if any, to establish or verify the dose?

4 c) Explain the discrepancy between the TLD and other readings; would you recommend investigation of the TLD badge processor for accuracy, and if so, how might this be done?

Question 14

An air sampler with a flow rate of 2 cfm, operated for 24 hours sampling the discharge from a stack. The stack gases contain both ^{59}Fe and ^{131}I, and the stack discharge rate is 6000 cfm.

The filter was counted immediately after removal from the sampler and the gross count was 11,280 cpm. Two days later the gross count was 10,666 cpm. The counter background is 100 counts per hour, counting efficiency is 12%, and filter collection efficiency is 85% for ^{59}Fe and 50% for ^{131}I.

Point Value

5 a) Calculate the concentration of ^{59}Fe and ^{131}I in the stack effluent.

1 b) Given that the iodine is in the elemental form and that the iron is attached to particulates, what type of filter media would you use in this air sampler?

2 c) Given the MPC$_a$ for ^{59}Fe $= 5 \times 10^{-9}$ μCi/cm^3 and for ^{131}I $= 1 \times 10^{-10}$ μCi/cm^3, what recommendations would you make concerning this stack effluent?

2 d) Do you think your answer is "statistically significant"? Why?

Data

$T_{1/2}$ for ^{59}Fe = 45 days
$T_{1/2}$ for ^{131}I = 8.05 days
1 cu. ft. = 28,000 cm^3

Question 15

A special maintenance job at a 1230 MWe unit BWR power plant involves rebuilding a reactor water cleanup pump. The procedure calls for removal of the pump from its isolation room to a temporary plastic service tent where most of the work will be performed. Initial surveys indicate no detectable airborne radioactivity, surface contamination levels below the minimum value for a contamination zone, and gamma fields of 200 mR/hr at one meter and 60 mR/hr in the general working area.

Removal from the isolation room can be performed by teams of three men in four hours or six men in two hours.

Point Value

1 a) What is the approximate dose equivalent (individual and integrated) that the men could receive?

1 b) Based on health physics principles which alternative is preferable? Why?

The service tent is located 15 feet from a crud trap (a length of piping 4' long by 10" diameter) three feet above the floor.

4 c) What thickness would a concrete shield wall need to be to reduce the exposure rate at 15 feet from 0.25 R/hr to 5 mR/hr? (Neglect scatter around the wall. Assume that the predominant nuclide in the crud is ^{60}Co. Show all calculations.)

2 d) Approximately how many Curies are contained in the crud assuming it is all ^{60}Co?

2 e) As plant health physicist what would be your recommendation concerning this source of radiation exposure?

Concrete Buildup Factors for a Point Isotopic Source

MeV	μx				
	1	2	4	7	
1.0	1.97	3.18	6.22	12.3	Dose Buildup Factors
2.0	1.75	2.59	4.49	7.74	
1.0	2.09	3.50	7.02	13.9	Energy Absorption Buildup Factors
2.0	1.79	2.69	4.71	8.16	

Broad-Beam ^{60}Co Gamma Dose Transmission	Concrete Shield Thickness (inches)
0.1	11
0.01	19
0.001	27

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Linear Absorption Coefficients Per Inch

MeV	Concrete
1.0	0.354
1.1	0.337
1.2	0.321
1.3	0.306

Half-life of ^{60}Co = 5.26 years

^{60}Co gamma energies 1.17 MeV
1.33 MeV

Question 16

You are the health physicist in a nuclear power station. A certified welder has received an unknown, unplanned exposure. His 200 mR pocket chamber is off-scale and it will take two hours to have his TLD badge read. In addition, he received skin contamination over parts of his body, the most significant of which is 6,700 dpm on his face. The welder is a transient worker and you have not received written confirmation of exposure from previous employers as shown on the worker's NRC-4. However, it is the first week in the quarter and you are certain that he has recived no radition exposure during this period at a facility other than yours. His accumulated pocket chamber readings at your facility for the month are 600 mR prior to this exposure.

Point Value

2 a) This welder is critical to the repair of the system. Consequently, you are being pressed by plant management to permit him to return to work prior to receiving the TLD badge results. Would you allow the welder to return to work in radiation and/or contamination zones? Why?

4 b) Assume that you have made the decision to make an in vivo count of the worker. The results of this count are:

^{131}I - 1.0 μCi ^{60}Co - 1.0 μCi

The activity is to be considered as the total activity in the worker's body.

The data for these radionuclides are:

^{131}I: Critical organ = thyroid
$\epsilon = \Sigma EF\,(RBE)\,n = 0.23$ MeV for thyroid
Maximum permissible burden in total body = 0.7 μCi
Physical $T_{1/2}$ = 8 days
Biological $T_{1/2}$ = 138 days
Thyroid weight = 20 grams
Thyroid size = 3 cm
$f_2 = 0.2$

^{60}Co: Critical organ = whole body
$\epsilon = \Sigma EF\,(RBE)\,n = 1.5$ MeV
Maximum permissible burden in total body = 10 μCi
Physical $T_{1/2} = 1.9 \times 10^3$ days
Biological $T_{1/2}$ = 9.5 days
Body weight = 7×10^4 grams
Body size = 30 cm
$f_2 = 1$

Possibly useful formulas for calculating doses:

$$\text{Dose (rem)} = \frac{51.2\ \epsilon f_2}{m} \int_0^t q(t)\,dt$$

$$\text{Dose (rem)} = \frac{51.2\ \epsilon q f_2}{m\lambda}$$

$$\text{Dose (rem)} = \frac{51.2\ \epsilon q f_2 e^{-\lambda t}}{m}$$

Calculate the dose commitment to the critical organ. How much of this dose would you assign to the first quarter?

Point Value

2 c) What additional things would you recommend concerning this internal exposure?

2 d) The TLD badge for the worker read 2.0 rems. Do you have an overexposure that must be reported to the NRC as specified in 10CFR20?

Section 6

Part II - Answers to Typical Questions

Seven questions have been selected from Part II of recent exams and an acceptable answer for each question is given. It must be recognized that other answers or modified versions of the answers given may be equally acceptable. In grading questions, the Examining Panel is looking for professional attitude, technical approach, organization, justification of assumptions and logical reasoning. Thus, variations on answers are acceptable as long as they are well supported; however, correct numerical answers to calculational problems are expected to obtain a perfect score.

1. Accelerator - Exam 18, Question 8

I. Radiation sources could be any material the beam could strike such as:

Collimators
Magnets
Beam pipe

a. Under normal operating conditions there could be beam loss caused by the spread in the electron momentum causing a portion of the beam to strike material. This would be a small continuous loss generating high energy photons and photoneutrons.

There would also be a continuous radiation of photons because of synchrotron radiation in the bend. These would be low energy.

b. A failure in the beam transport system such as a magnet failure will dump the entire beam into some material (listed above). This would generate a point source of high energy photons and neutrons.

II. The shielding should be high Z material around the beam pipe to reduce the photon and high energy neutron intensity as quickly as possible. This must be followed by low Z material (concrete) to absorb the moderated neutrons.

III. a. Calculate beam power

$$P = 2.5 \times 10^{7}\ (\text{eV}) \times 1\ (\text{amp}) \times 2 \times 10^{-6}\ (\text{sec}) \times 3.6 \times 10^{2}\ (\text{sec}^{-1})$$
$$= 1.8 \times 10^{4}\ \text{watts}$$

Continuous beam loss of 0.1 % gives 18 watts. Thus, the rate of energy lost = 18 joule/sec. At 360 pulses/second, this amounts to 0.05 joule/pulse.

A single failure dumping the entire beam at one point results in 1.8×10^4 watts or 50 joule/pulse. If the beam is turned off within 2 pulses the total energy lost is 100 joules. Thus, if there is less than one failure every 2000 pulses, the continuous beam loss dominates. It is reasonable to expect that a failure every 2000 pulses is intolerable from an operational standpoint.

b. Activation of machine parts is generally not a significant shielding problem in electron accelerators compared with the shielding required for the machine operation. Radiation from activated parts is of much lower energy and more readily shielded than beam-produced radiation. However, local shielding of activated parts may be necessary for personnel access during maintenance periods.

2. Environmental - Exam 17, Question 2

1. Air Monitoring

^{40}K and cosmic radiation are not significant factors in air monitoring. Thoron and radon and their daughters may contribute significantly to the activity observed by an air monitor, and their associated alpha activities make it quite difficult to monitor air at MPC levels or below for more hazardous alpha emitters.

2. Sample Counting

Cosmic radiation contributes significantly to the background counting rate of low-level beta and gamma counting equipment, even though they may be well shielded from effects of terrestial radiation.

3. In Vivo Counting

The human subjects contain significant quantities of ^{40}K and may have in or on their bodies some radon daughters. The equipment in the counting chamber may contain ^{40}K, U and Th. The air in the chamber may contain radon and thoron plus their daughters. Some cosmic radiation will penetrate into the counting chamber.

4. Radiation Background Measurements

All four will contribute to background measurements making it difficult to detect small contributions to background radiation from other activities.

5. Calibration of Low-Level Instruments

Because all four contribute in some degree to background radiation, one cannot obtain "zero" background for calibrating instruments.

6. Materials for Construction and Shielding

Almost all soils and masonry materials contain ^{40}K and U. Some contain Th.

7. Radiochemical Analyses and Materials and Equipment Used

Radon and thoron daughters may be contaminants in low-level laboratories. ^{40}K and isotopes of the U and Th series may derive from materials such as glassware, ceramics, etc., and some of the chemical reagents will likely contain ^{40}K and some of the isotopes of the U and Th series.

3. Fuel Cycle - Exam 19, Question 15

Work on each of the three streams will require work area preparation, wearing of at least a "basic set" of protective clothing including rubber gloves, the use of a Radiation Work Permit, bagging of tools for decontamination at the end of the job and continuous health physics coverage during at least the opening of the pump. Other specific considerations for each stream are:

a. Uranium Stream

The main problems in working on a pump in this stream will be centered around the slight fission product contamination that may still be in the uranium stream. In addition, although the U-235 enrichment will be in the range of just a few percent, there is a chance (under unusual circumstances) such as draining a long length of small diameter piping into a large container) that considerations will have to be given to potential criticality problems. The work area should be papered and absorbent paper placed under the pump to absorb any leakage when the pump is opened. Full-face filter masks should be worn until the pump is opened and air samples are taken. If air samples are $<$ MPC, mask requirements can be removed. When pump is opened, beta and hand exposure rates should be evaluated. Job should require health physics coverage at the start of the job, at the time pump is opened, and after work area cleanup.

b. Plutonium Stream

The main problems in working on a pump in this stream will be centered around potential for rapid spread of contamination, potential for ingestion and criticality considerations. If pump is to be drained into an exterior container, care must be taken that the container is critically safe for the solution to be drained. (Keep in mind that solids may have collected in pump which have the effect of making the solution more concentrated than the normal stream concentration.) A plastic hut or tent should be built around the work area to contain the contamination. The hut or tent should have a separately enclosed exit area for personnel to use for removal of their outermost protective clothing. The work area should be papered and covered with plastic. Absorbant paper or absorbent pads should be used to collect any drips when pump is opened. If pump is not in a cabinet under negative pressure, a filtered exhaust system should exhaust air from the hut or tent in a direction from the pump and away from the workers. Workers should wear at least a double set of clothing and an air-supplied full-face mask with all joints taped. Serious consideration should be given to using an air-supplied plastic suit over one set of basic clothes. Special care should be given to protecting any cuts or breaks in the skin before protective clothing is put on. Air samples should be taken both inside and outside of the hut or tent at several times during the job (or CAM should be used to continuously monitor working zone air within hut). Once pump is opened, exposed surfaces should be decontaminated with absorbent pads to prevent contamination from drying out and becoming airborne. At the end of the job, all exterior surfaces of pump should be decontaminated before hut or tent is taken down. This job will require continuous health physics coverage.

c. Fission Product Stream

The main problems in working on a pump in this stream will be centered around high radiation levels and potential for spread of contamination. Depending on a comparison of man-rem dose estimates for installing and removing shielding with the reduction in exposure afforded the work crew by having shielding in place, temporary shielding should be installed on the pump suction and discharge piping and on other equipment affecting dose rates in the work area. The work area should be papered and covered with plastic. Consideration should be given to using a simple hut or tent if pump is in a large room and dose rates will permit construction of the hut without undue exposure. Absorbent paper should be placed under the pump to collect any leakage when the pump is opened. When the pump is opened, beta and hand exposure rates must be evaluated (exposure rates may well increase by a factor of 3 to 20). Once pump is opened, exposed surfaces should be decontaminated with absorbent pads held with tongs to minimize hand exposures. Personnel should wear an air-supplied full-face mask with at least one set of protective clothing and double rubber gloves with all joints taped. Consideration should be given to wearing a double set of coveralls depending on the actual work to be performed. Air samples should be taken during the pump opening, and at several times during the subsequent work. Job should require health physics coverage at the start, at the time the pump is opened and after the work area cleanup. If contamination levels are very high, continuous coverage might be required once the pump is opened.

4. Medical - Exam 20, Question 11

a. Parameters:

$$K = \frac{P_{(dose)} (d)^2}{WUT}$$

P = 0.1 rem/wk maximum permissible dose

d = 2 m

W = (20 pts/day)(5 d/wk)(4 films/pt)(100 As/film)(1 m/60sec)

= 666 mAmin/wk

U = 1/16 for a radiographic installation

T = 1 for a controlled area

WUT = 41.6

$$K = \frac{(.1)(2)^2}{41.6} = 9.6 \times 10^{-3}$$

from the graph: 0.75 mm Pb

b. 200 mR/hr = 3.33 mR/min

= 0.056 mR/sec

Since the average is 100 **mA** sec per film, the average time at 200 mA is 0.5 sec.

If all 100 pts received 4 chest views, each requiring a 0.5 sec exposure, the beam-on time at wall A will be:

(100 pts)(4 views/pt.)(.5 sec/v.) = 200 sec/wk

(200 sec/wk)(0.056 mR/sec) = 11.2 mR/wk

The MPD for this area is 100 mR/wk; therefore, 200 mR/hr is not excessive.

5. Power Reactors - Exam 20, Question 8

a. Total activity builtup on a demineralizer can be calculated using:

$$\mu Ci = \frac{\mu Ci/min}{\lambda} (1 - e^{-\lambda t})$$

Where: μCi/min is the input activity rate =

μCi/ml x 600 l/min x 1000 ml/l

t = 90 days = 1.30(5) min

Radionuclide	Halflife	λ (min^{-1})	μCi/min	$1-e^{-\lambda t}$	μCi After 90 days
Co-60	5.26y = 2.76(6) min	2.51 (-7)	2.58 (2)	3.21 (-2)	3.30(7)
Mn-54	313d = 4.51(5) min	1.54 (-6)	2.28 (2)	1.81 (-1)	2.68(7)
Cs-137	30.2y = 1.59(7) min	4.36 (-8)	1.92 (4)	5.65 (-3)	2.49(9)
			Total		2.54(9)

b. The radiation level at 3 meters after a four week decay period can be calculated by calculating the activity in Ci after 4 weeks and then using the formula:

$$R = \frac{6\ CE}{d^2}$$

Where: R = radiation level in R/hr

C = Ci

E = MeV/d

d = distance in feet = 9.84

The beta radiation does not enter the picture because of the steel demineralizer vessel and the distance from the source

t = 4 weeks = 4.03(4) min.

Radionuclide	$e^{-\lambda t}$	Activity After 4 Weeks µCi	Ci	Gamma MeV/d	$R/hr = \frac{6\ CE}{96.8}$
Co-60	9.90(-1)	3.27(7)	3.27(1)	2.50	5.07
Mn-54	9.40(-1)	2.52(7)	2.52(1)	8.35(-1)	1.30
Cs-137	9.98(-1)	2.48(9)	2.48(3)	5.61(-1)	8.62(1)
			R/hr at 3 m	=	9.26(1)

6. University - Exam 19, Question 10

a. Shielding and distance

Since the source is a beta emitter, clear plastic (to minimize bremsstrahlung production) shadow shielding can be set up to shield an experimenter's body, and short tongs can be used to reduce the dose to hands and forearms. This quantity of ^{32}P would not require permanent shielding on all sides nor would remote handling tools be required. Reducing exposure time is generally not practical, since such labeling experiments generally require fairly long, complex experimental procedures.

b. Shielding

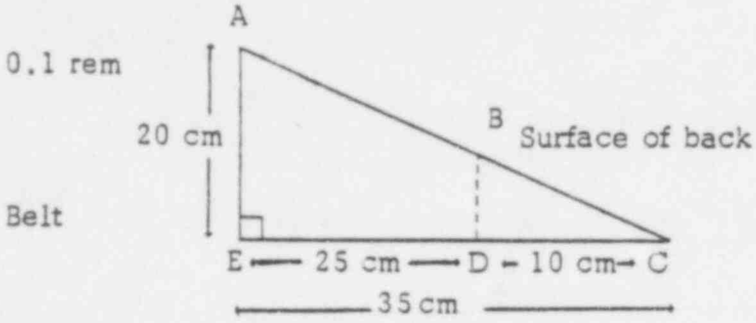
A gamma source of this magnitude would require massive, permanent shielding on all sides. Neither time nor distance would be appropriate for reducing personnel dose. Direct exposure to the source even for very short times could be fatal, and the distance necessary to reduce the dose to a permissible level would preclude any experimental work around the source.

c. Time and distance

This source produces a high neutron dose rate and the particular operation is to be done only once. Due to the neutrons, adequate shielding would be bulky and unwieldy. Such shielding could make the transfer so difficult that personnel dose might actually be increased due to the greatly lengthened time of exposure. Further, since the transfer is to be done only once, adequate shielding would greatly add to the cost of the operation. Therefore, several practice transfers should be done using a simulated source and long handling tools to increase the distance from the source. The practice transfer will serve to uncover any unexpected, particularly difficult steps and, thus help to reduce the time of exposure to the actual source. Thus, time in conjunction with distance (long handling tools) is probably the best solution to this radiation exposure problem.

7. <u>General</u> - Exam 20, Question 3

a. Dosimeter



Given exposure of 0.1 rem at A. Calculate exposure at D

$$AC = \sqrt{20^2 + 35^2} = 40.31 \text{ cm}$$

$$\theta = \text{Arc tan}\left(^{20}/_{35}\right) = \text{arc tan } (0.57) = 29.74^\circ$$

$BC = 10 \text{ cm} \times \sec\theta = 11.5 \text{ cm}, \therefore AB = 40.31 - 11.5 = 28.8 \text{ cm}$

Neglecting attenuation, $\text{Dose (B)} = \frac{(40.31)^2}{(11.5)^2} \times 0.1 \text{ rem}$

$$= 1.23 \text{ rem}$$

$$\mu = \frac{0.693}{\text{HVL}} = \frac{0.693}{5 \text{ cm}} = 0.14 \text{ cm}^{-1}$$

$$\text{Attn} = \frac{I}{Io} = e^{-\mu x} = e^{-0.14 \times 28.8} = 0.018$$

$$\text{Dose (B)} = \frac{1.23 \text{ rem}}{0.018} = 68.26 \text{ rem}$$

$$\text{Dose (D)} = \frac{(11.5)^2}{(10)^2} \times 68.26 = 90.27 \text{ rem}$$

b. 1. Inspect radiographic equipment to rule out malfunction (radiographic "cameras" usually have a positive indication of source retraction to the "safe" position). Set up a regularly scheduled preventive maintenance and monitoring program for the equipment.

2. Have the radiographer wear a "chirper" or "beeper" alarming pocket radiation monitor, and/or monitor the work area before re-entry.

3. Develop standard operating procedures for radiographic equipment usage. Couple this with scheduled periodic refresher courses and equipment checkouts for all users.

4. Use a portable, radiation activated warning light and/or audible alarm in the radiation area during all radiography sessions.

Section 7

Suggested Study References

The following bibliography is intended to provide the candidate with reference material related to the general topics covered in the exam. The Board does not mean to imply that study of these references, only, will ensure successful performance on the examination. This listing is by no means complete, and the candidate may need to consult additional reports, journals, and text books for information not provided in the references below.

At the same time, the Board does not want to infer that study of all of these references is necessary to successfully complete the examination. The list is provided as a guide to the type of material which should be studied.

Selected Health Physics Bibliography

1. National Council on Radiation Protection and Measurements Reports - Particularly the following:

   NCRP Report No. 8 (NBS Handbook 48) Control and Removal of Radioactive Contamination in Laboratories (1951).

   NCRP Report No. 22 (NBS Handbook 69) Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure (1959).

   NCRP Report No. 23 (NBS Handbook 72) Measurement of Neutron Flux and Spectra for Physical and Biological Applications (1960).

   NCRP Report No. 25 (NBS Handbook 75) Measurement of Absorbed Dose of Neutrons and of Mixtures of Neutrons and Gamma Rays (1961).

   NCRP Report No. 28 (NBS Handbook 80) A Manual of Radioactivity Procedures (1961).

   NCRP Report No. 32, Radiation Protection in Educational Institutions (1966).

   NCRP Report No. 33, Medical X-ray and Gamma Ray Protection for Energies Up to 10 MeV - Equipment Design and Use (1968).

   NCRP Report No. 35, Dental X-ray Protection (1970).

   NCRP Report No. 38, Protection Against Neutron Radiation (1971).

   NCRP Report No. 39, Basic Radiation Protection Criteria (1971).

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NCRP Report No. 43, Review of the Current State of Radiation Protection Philosophy (1975).

NCRP Report No. 48, Radiation Protection for Medical and Allied Health Personnel (1976).

NCRP Report No. 49, Structural Shielding Deisgn and Evaluation for Medical Use of X-rays and Gamma Rays of Energies Up to 10 MeV (1976).

NCRP Report No. 50, Environmental Radiation Measurements (1976).

NCRP Report No. 51, Radiation Protection Design Guidelines for 0.1 - 100 MeV Particle Accelerator Facilities (1977).

2. International Commission on Radiation Units and Measurements Reports - Particularly the following:

   ICRU Report 14, Radiation Dosimetry; X-Rays and Gamma Rays with Maximum Photon Energies Between 0.6 and 50 MeV.

   ICRU Report 17, Radiation Dosimetry; X-Rays Generated at Potentials of 5 to 150 kV.

   ICRU Report 19, Radiation Quantities and Units.

   ICRU Report 20, Radiation Protection Instrumentation and its Application.

   ICRU Report 21, Radiation Dosimetry; Electrons with Initial Energies Between 1 and 50 MeV.

   ICRU Report 22, Measurement of Low Level Radioactivity.

   ICRU Report 25, Conceptual Basis for the Determination of Dose Equivalent.

3. International Commission on Radiation Protection Publications - Particularly the following:

   ICRP Publication No. 7, Principles of Environmental Monitoring Related to the Handling of Radioactive Materials.

   ICRP Publication No. 8, The Evaluation of Risks from Radiation.

   ICRP Publication No. 9, Recommendations of the ICRP.

ICRP Publication No. 10, Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure.

ICRP Publication No. 10a., The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes.

ICRP Publication No. 12, General Principles of Monitoring for Radiation Protection of Workers.

ICRP Publication No. 15, Protection Against Ionizing Radiation from External Sources.

ICRP Publication No. 16, Protection of the Patient in X-ray Diagnosis.

ICRU Publication No. 17, Protection of the Patient in Radionuclide Investigations.

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13. Health Physics Journals, Pergamon Press.

14. International Atomic Energy Agency, IAEA Safety Series 1 - 30, UNIPUB, Inc. New York, NY.

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25. Slade, D. (Editor), Meteorology and Atomic Energy, USAEC, TID-24190, 1968.

26. Taylor, L., Radiation Protection Standards, CRC, 1971.

27. Title 10, Chapter 1, Code of Federal Regulations, USNRC, Washington, D.C. 20555.

28. United Nations Scientific Committee on the Effects of Atomic Radiation, Ionizing Radiation: Level and Effects, New York, NY 1972.

29. US NRC Regulatory Guides, Particularily the following: 8.0 Occupational Health series, 1.21, 1.101, 1.109 and 4.2.

30. Wash - 1400, Reactor Safety Study (Rasmussen Report) Particularily: Main Report and Appendix VI (Calculation of Reactor Accident Consequences).

Section 8

Exam Strategy

The Board believes that it is an advantage to develop a strategy for taking the certification examination. We have noted in the past that candidates have, through a number of oversights and errors, penalized themselves heavily, in some cases heavily enough to make a difference between success and failure on the examination.

While we do not believe that our suggestions, given below, are the only possible ones on examination strategy, we do believe that they are sound and that at least they should stimulate the development of a suitable plan of your own.

PART I

Part I is a multiple choice examination, lasting three hours and requiring the answers to 150 questions. Some of the answers require calculation.

1. Budget your time so that you are answering about 1/3 of the questions in each hour.

2. Begin at the beginning and go through the whole examination, answering the questions you are sure of, in order. Pass over the difficult, uncertain questions, saving them until the end. Do not lose time by getting bogged down on a few difficult questions.

3. There is no penalty for a wrong answer, and therefore, it is to your advantage to answer every question.

4. If you are uncertain about an answer, it is probably true that your first choice is the correct answer. Do not change an answer unless you are certain that the first answer is wrong.

PART II

Part II consists of 16 questions, of which you answer any 7 in 4 hours. These questions may call for both numerical answers in which substantial calculation may be involved, and short essay-type answers.

1. When you receive this part of the examination, read through it in its entirety, then begin to work the questions which are easiest for you. Save the difficult questions until the end.

2. As in Part I, make a conscious effort to budget your time.

3. Before beginning to answer a question, read it again carefully so that you can be certain you are answering the question that is asked.

4. Think carefully about numerical constants and assumptions that you use. Try to be sure that they are accurate and reasonable.

5. Do your best to demonstrate a professional approach to the problems.

6. Organize your answer in a logical outline form to use as a check list to assure efficient and complete subject treatment. A concise, well-organized answer is much nore impressive than a rambling ten page discertation.

7. Re-read the question after completing it to be sure you have answered all the portions of the question and have provided all the information requested.

Section 9

Grading Criteria

Effective September 23, 1977, the Board has formalized the following grading criteria for the certification examination.

1. Part I - Taken Alone

Passing Criteria

To pass Part I, the candidate must achieve a score of at least 67 percent on the total exam and on the Fundamentals Section.

2. Part I and II - Taken Together

Passing Criteria

To pass the exam, the candidate must achieve a score of at least 67 percent on both Part I and Part II.

Failure Upgrading Criteria

Any grade less than 67 percent on either part will be considered to be a failure of that part. To provide candidates with the opportunity to raise a failing grade to a passing grade the Board uses the following guides:

a. Give candidates who have scored at least 57 percent on both Part I and Part II and whose average grade (Part I and II given equal weight) is at least 60, the option to take an oral exam or retake the part(s) failed. (If a candidate repeatedly fails one of the parts, the option may be removed and the candidate required to take an oral exam.)

b. The Board considers any grade less than 57 percent to be below the standards for oral upgrading.

3. Availability of Performance Information

Candidates may request their performance information to assist them in preparing for re-examination.

American Board Of Health Physics

Addendum to Examination Preparation Guide for Power Reactor Specialty Examination

Candidates taking the examination for Power Reactor Specialty Certification take the same Part I examination as candidates for the comprehensive certification.

Candidates taking the examination for Power Reactor Specialty Certification take a special Part II examination. The Power Reactor, Part II, examination is made up of two sections. In section 1, there are ten questions which require short answers. These questions may be multiple choice, or fill-in questions or may require one or two sentence answers. The questions are worth two points each, and are designed to require about six minutes each to read and answer. Candidates must answer all ten questions. In section 2, there will be seven essay/calculation problems similar to those on Part II of the comprehensive examination, but specific to power reactor health physics. The questions are worth ten points each and are designed to require about 30 minutes each to read and answer.

Candidates must answer five of the seven questions. Subjects which may be covered in Part II of the Power Reactor specialty examination are:

- Technical Administration
- Professional Judgement
- Design Review
- Plant Systems
- ALARA
- Radioactive Material Control
- Radwaste Management
- Emergency Planning
- Procedures
- Training
- Regulations and Standards
- Medical-Legal Aspects
- Guides and Limits
- Shielding
- Radiation Measurement
- Contamination Control
- Air Sampling
- Protective Clothing and Equipment
- Respiratory Protection
- Instrument Selection, Operation and Calibration (includes survey, effluent monitors and counting room instruments)
- Decontamination
- Personnel Dosimetry
- Bioassay and Uptake Analysis
- In-plant Dose Assessment
- Environmental
- Off-site Dose Projection
- Transportation
- Current Topics

Grading criteria for the Power Reactor Specialty examination are the same as those for the comprehensive examination.

Addendum to Examination Preparation Guide

The subject content of Part I of the examination is changed to eliminate questions in specific areas of expertise. The goal is to have Part I of the examination cover the more fundamental knowledge that all professional health physicists are expected to know. Therefore, in Section 4 (page 4) of the Guide, the following topics should be deleted from Category 3, Operational Health Physics:

h. Accelerator safety

i. Reactor health physics

m. Medical health physics

Inquiries for further information should be directed to:

Mr. Michael Terpilak
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, MD 20857

Telephone: (301) 443-3426

AMERICAN BOARD OF HEALTH PHYSICS
ITEM CLASSIFICATION SCHEME

		No. of ABHP Bank Items
01.	FUNDAMENTALS	
	01. Sources	24
	02. Units	14
	03. Atomic Structure	
	04. Decay	2
	05. Interaction of Radiation with Matter	28
	06. Radiobiology	24
		92
02.	MEASUREMENT	
	01. Personnel Dosimetry	7
	02. Bioassay and Whole Body Counting	6
	03. Instruments	24
	04. Calibration	4
	05. Measurement of Radiation	23
	06. Statistics	
	07. Radiochemistry and Sample Preparation	5
	08. Dose Estimates	7
		76
03.	OPERATIONAL HEALTH PHYSICS	
	01. Laboratory Design	2
	02. Shielding and Equipment Design	23
	03. Contamination Control	4
	04. Surveys and Inspection	3
	05. Waste Processing	
	06. Emergency Response	2
	07. Criticality Controls	2
	08. Accelerator Safety	1
	09. Reactor Health Physics	3
	10. Environmental Surveillance	12
	11. Waste Disposal	6
	12. Hazards Analysis	7
	13. Medical Health Physics	2
		67
04.	HEALTH PHYSICS ADMINISTRATION	
	01. Standards, Guides and Regulations	39
	02. Medico-legal Aspec	
	03. Data Evaluation	1
	04. Emergency Planning	2
	05. Public Relations	
	06. Procedures	
		42
	Total Items	277

5/75

AMERICAN BOARD OF HEALTH PHYSICS

ITEM CLASSIFICATION SCHEME

		No. of Items In Process Ready for Outside Reviewer	No. of Reviewed Items ready for Carding
01.	FUNDAMENTALS		
01.	Sources	2	5
02.	Units	2	4
03.	Atomic Structure	5	2
04.	Decay	3	5
05.	Interaction of Radiation with Matter		10
06.	Radiobiology	2	1
02.	MEASUREMENT		
01.	Personnel Dosimetry		3
02.	Bioassay and Whole Body Counting		1
03.	Instruments		1
04.	Calibration	1	1
05.	Measurement of Radiation		7
06.	Statistics	1	1
07.	Radiochemistry and Sample Preparation		1
08.	Dose Estimates		1
03.	OPERATIONAL HEALTH PHYSICS		
01.	Laboratory Design		2
02.	Shielding and Equipment Design	2	6
03.	Contamination Control		2
04.	Surveys and Inspection		
05.	Waste Processing		
06.	Emergency Response		2
07.	Criticality Controls	1	4
08.	Accelerator Safety		
09.	Reactor Health Physics		1
10.	Environmental Surveillance	1	
11	Waste Disposal		
12.	Hazards Analysis		
13.	Medical Health Physics		
04.	HEALTH PHYSICS ADMINISTRATION		
01.	Standards, Guides and Regulations	3	5
02.	Medico-legal Aspects	1	
03.	Data Evaluation	1	
04.	Emergency Planning		
05.	Public Relations		
06.	Procedures		
		25	65
		Total	90

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May 1975

American Board Of Health Physics

CONFIDENTIAL PROFESSIONAL REFERENCE FORM*

Please return promptly to: Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

Applicant's Name: ______________________ Application No. __________

1. How long have you known the applicant? __________ years.

2. What has been the nature of your association? ______________________

____

____

   a. Do you know him personally? Yes_____ No_____

   b. Are you in a position to evaluate his technical capabilities? Yes_____ No_____

3. Describe briefly your impression of the work the applicant does. _____

____

____

____

   a. Is the work primarily technical in scope? Yes_____ No_____

   b. How and by whom are his decisions used? ______________________

   ____

   c. What type of problems does he have to face? ______________________

   ____

   d. What are his responsibilities in case of emergencies? ____________

   ____

   e. How much supervision does he have and exercise? ______________

   ____

4. How well do you think the applicant does the work assigned to him?

____

____

____

*Note: If you wish to make additional comments, please include them on a separate sheet.

(Please return in duplicate) (over)

5. What specific and noteworthy accomplishments, if any, has he made in the radiation protection field? ______________________

6. What limitations, if any, does the applicant have which might adversely influence his capacity to practice health physics on a responsible professional level? ______________________

   a. How well does he work with others? ______________________

   b. How effectively does (or would) he perform as a consultant? ______________________

7. What is your estimation of:

   a. His honesty? ______________________

   b. His professional ethics? ______________________

8. Do you have any reservations about recommending the applicant for certification? Yes_____ No_____ (If yes, please explain)

Printed Name: ______________________ Title: ______________________

Signature: ______________________ Adress: ______________________

Date: ______________________

American Board Of Health Physics

CONFIDENTIAL PROFESSIONAL REFERENCE FORM*

Please return promptly to:
Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

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2. What has been the nature of your association? ________________________

    ____

    ____

    a. Do you know him personally? Yes_____ No_____

    b. Are you in a position to evaluate his technical capabilities?
    Yes_____ No_____

3. Describe briefly your impression of the work the applicant does. _____

    ____

    ____

    ____

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    b. How and by whom are his decisions used? ______________________

    ____

    c. What type of problems does he have to face? __________________

    ____

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    ____

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    ____

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    ____

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Printed Name:

Title:

Signature:

Adress:

Date:

American Board Of Health Physics

CONFIDENTIAL PROFESSIONAL REFERENCE FORM*

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American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
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   ____

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   ____

   d. What are his responsibilities in case of emergencies? __________

   ____

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Adress:

Date:

American Board Of Health Physics

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American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

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   ____

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(Please return in duplicate) (over)

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____

____

____

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____

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____

____

b. How effectively does (or would) he perform as a consultant?

____

____

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a. His honesty? ______________________

b. His professional ethics? ______________________

____

8. Do you have any reservations about recommending the applicant for certification? Yes_____ No_____ (If yes, please explain)

____

____

Printed Name: ______________________ Title: ______________________

Signature: ______________________ Adress: ______________________

Date: ______________________ ______________________

____

American Board Of Health Physics

IMMEDIATE SUPERVISOR

Reference Data
(All information will be held in strict confidence. If additional space is needed in filling out this form, use the reverse side.)

Return promptly to:

Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

Applicant's Name: ______________________________

1. What are the specific responsibilities of the applicant? ______________________________

____

____

2. What percentage of his time is spent on radiation protection work?

____

3. How much of his previous experience in radiation protection has been in:

   a. Research and development ______________________________

   b. Supervision ______________________________

   c. Practical protection of people ______________________________

   d. Other (specify) ______________________________

4. To what extent are his recommendations reviewed by others before being put into effect? ______________________________

____

5. Is he capable of handling major radiation hazard problems on his own and under emergency conditions? ______________________________

____

6. What limitations, if any, does the applicant have which might adversely influence his capacity to practice health physics at a responsible professional level? ______________________________

____

____

(Please return in duplicate)

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7. Do you have any reservations about recommending the applicant for certification? YES _____ NO _____ (If yes, please explain) ________

____

____

Signed: ______________________ Title: ______________________

Date: ______________________ Address: ______________________

____

____

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American Board Of Health Physics

IMMEDIATE SUPERVISOR

Reference Data
(All information will be held in strict confidence. If additional space is needed in filling out this form, use the reverse side.)

Return promptly to:

Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

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6. What limitations, if any, does the applicant have which might adversely influence his capacity to practice health physics at a responsible professional level? ______________________

(Please return in duplicate)

7. Do you have any reservations about recommending the applicant for certification? YES _____ NO _____ (If yes, please explain) ________

____

____

Signed: ______________________________ Title: __________________________

Date: ________________________________ Address: ________________________

____

____

AMERICAN BOARD OF HEALTH PHYSICS

Application For Certification

INSTRUCTIONS:

1. Type or print in block capitals.
2. Submit in **duplicate.**
3. If space is inadequate for any answer, use extra sheet of paper and number items to correspond with items as listed.

DATE ____________________

☐ Initial Application ☐ Part 1, only

☐ Re-application ☐ Regular Certification

1. Name ____________________ (last) (first) (middle) Citizenship ________ 2. Date of Birth ________

3. Home Address ____________________

4. Business Address ____________________

5. Send mail to: home address ☐ business address ☐

Home Telephone Number: ____________________

Business Telephone Number ____________________

6. Academic Degrees Attained:

	Institution	Major	Minor	Years of Full Attend.	Degree	Year
a.						
b.						
c.						

7. Additional education and training related to Health Physics. (Please do not list courses of less than two weeks duration.)

	Institution	Title of Course	Length of Course	Dates From	Dates To
a.					
b.					
c.					

HAVE YOU TAKEN A CERTIFICATION REFRESHER COURSE? ☐ YES ☐ No. # OF CLASS HRS. ______

8. Professional and Honorary Societies:

Name of Organization	Year Joined	Type of Membership*	Office Held

*TYPE OF MEMBERSHIP – Fellow, Member, Associate Member, Student Member, Other (specify)

9. **Present employment. Describe in your own words. (Do not use official job descriptions.)**

Date Assigned to Position:	Name of Employer:	Place of Employment:	Name and Title of Immediate Supervisor:
Exact Title of Present Position:			
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:			

10. **Previous Employment. (Start with most recent position and work back. Emphasize those portions of work that are Health Physics or closely related.)**

Dates of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:		
Dates of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:		

Date of Employment: From: To:	Name of Employer:	Place of Employment:

Exact title of position:

Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:

Date of Employment: From: To:	Name of Employer:	Place of Employment:

Exact title of position:

Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:

11. **Categories of Competence:**

Select the categories in the list below in which you feel you are competent to function as a Certified Health Physicist. Rank these in the order of your proficiency. (1 for your first choice, 2 for your second, etc.).

_______ Industrial Radiographic Installations
_______ Medical Radiological and Fluoroscopic Installations
_______ Therapy Installations
_______ Isotope Laboratories
_______ Environmental Monitoring
_______ Other (specify) _______________________
_______ Reactor Facilities
_______ Chemical Separations Plants
_______ Particle Accelerators
_______ Complete Hazards Evaluation
_______ Major Decontamination Operation
_______ Other (specify) _______________________

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12. Special Achievements:

a. Medals, Citations, or other awards:

b. Committee Activities:

c. Journal Publications and Books:

d. Speeches and Lectures to outside organizations (last two years)

13. Professional References: name and address of at least two persons other than your supervisor who are qualified to evaluate your Health Physics competence. (If possible, at least one reference should be a Certified Health Physicist; do not use a Board member as a reference.)

I certify that the statements above (including any attachments I have submitted hereto) are, to the best of my knowledge, accurate, and I understand that any falsification of information in this application will be cause for rejection of the application or withdrawal of a certification already made.

Date

(Signature in ink.)

A non-returnable application fee of $100 must accompany the application. An additional fee of $15.00 will be charged when and if certification is approved. In addition, the Board serves notice to all applicants that, if future operations of the Board require it, some system of annual dues from all health physicists previously certified by the Board may become necessary. Make check payable to AMERICAN BOARD OF HEALTH PHYSICS.

Mail Application to:

AMERICAN BOARD OF HEALTH PHYSICS

Application For Certification

INSTRUCTIONS:

1. Type or print in block capitals.
2. Submit in **duplicate.**
3. If space is inadequate for any answer, use extra sheet of paper and number items to correspond with items as listed.

DATE ____________

☐ Initial Application ☐ Part 1, only

☐ Re-application ☐ Regular Certification

1. Name ____________ (last) (first) (middle) Citizenship ____________ 2. Date of Birth ____________

3. Home Address ____________

4. Business Address ____________

Home Telephone Number: ____________

5. Send mail to: home address ☐ business address ☐

Business Telephone Number ____________

6. Academic Degrees Attained:

	Institution	Major	Minor	Years of Full Attend.	Degree	Year
a.						
b.						
c.						

7. Additional education and training related to Health Physics. (Please do not list courses of less than two weeks duration.)

	Institution	Title of Course	Length of Course	Dates From	 To
a.					
b.					
c.					

HAVE YOU TAKEN A CERTIFICATION REFRESHER COURSE? ☐ YES ☐ No. # OF CLASS HRS. ____________

8. Professional and Honorary Societies:

Name of Organization	Year Joined	Type of Membership*	Office Held

*TYPE OF MEMBERSHIP – Fellow, Member, Associate Member, Student Member, Other (specify)

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9. Present employment. Describe in your own words. (Do not use official job descriptions.)

Date Assigned to Position:	Name of Employer:	Place of Employment:	Name and Title of Immediate Supervisor:
Exact Title of Present Position:			
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:			

10. Previous Employment. (Start with most recent position and work back. Emphasize those portions of work that are Health Physics or closely related.)

Dates of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:		

Dates of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
Description of work. Include major responsibility and specific fields and indicate percent of time in Health Physics work:		

Date of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
Description of work: Include major responsibility and specific fields and indicate percent of time in Health Physics work:		

Date of Employment: From: To:	Name of Employer:	Place of Employment:
Exact title of position:		
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_______ Industrial Radiographic Installations
_______ Medical Radiological and Fluoroscopic Installations
_______ Therapy Installations
_______ Isotope Laboratories
_______ Environmental Monitoring
_______ Other (specify) _______________

_______ Reactor Facilities
_______ Chemical Separations Plants
_______ Particle Accelerators
_______ Complete Hazards Evaluation
_______ Major Decontamination Operation
_______ Other (specify) _______________

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12. Special Achievements:

a. Medals, Citations, or other awards:

b. Committee Activities:

c. Journal Publications and Books:

d. Speeches and Lectures to outside organizations (last two years)

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I certify that the statements above (including any attachments I have submitted hereto) are, to the best of my knowledge, accurate, and I understand that any falsification of information in this application will be cause for rejection of the application or withdrawal of a certification already made.

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Mail Application to:

American Board Of Health Physics

REQUIREMENTS FOR ADMISSION TO PART I
OF THE WRITTEN EXAMINATION

The ABHP has announced the formal establishment of a special program to permit younger health physicists to complete an initial step in the certification procedure. Under this arrangement, radiation protection personnel who have:

1. Received a Bachelor's Degree in a physical science or a biological science with a minor in the physical sciences, <u>and</u>

2. completed a minimum of two additional calendar years of professional experience <u>or</u> graduate training in health physics,*

will be permitted to take Part I of the written examination.

In permitting a candidate to take this step, the Board makes no commitment concerning the candidates eligibility to complete additional steps in the certification procedure at a later date. This will depend upon performance on Part I and results of a thorough review of past training, professional experience, and statements contained in references submitted by candidate at time of application for regular certification.

The fee for admission to Part I of the written examination is $75.00 and applications should be submitted on the form required for regular certification. To designate that they are applying for Part I only of the written examination, applicants should write the words, "Part I" in the uppper right hand corner (above the date) on the first page of the form. Such applicants should also note that they are required to submit only one reference statement in support of their application (rather than three as required for candidates applying for regular certification).

Normally, the written examination will be given in June of each year on the Monday of the week of the Annual Meeting of the Health Physics Society. The deadline for submission of applications is April 1.

---

* Applicants are eligible immediately after meeting the requirements for an MS degree in health physics. Also, individuals who have successfully completed a Bachelor of Science program in Health Physics and who have at least one year of practical (professional level) experience.

American Board Of Health Physics

DEFINITION OF HEALTH PHYSICS*

Health Physics is a profession devoted to the protection of man and his environment from unwarranted radiation exposure. A health physicist is a person engaged in the study of the problems and practices of providing radiation protection. He is concerned with an understanding of the mechanism of radiation damage, with the development and implementation of methods and procedures necessary to evaluate radiation hazards and with providing protection to man and his environment from unwarranted radiation exposure.

---

*Officially adopted by the Health Physics Society in 1959.

ANNOUNCEMENT

AMERICAN BOARD OF HEALTH PHYSICS

The continued efforts of the American Board to restrict expenses to a bare minimum have been successful as evidenced by the fact that the amount of money realized through the examination fees has nearly met the expenses of the program during the past year. However, during the last Board meeting, September 26-27, 1978, it was recognized that there are some increased expenses resulting from the need to expand and modify the examination questions in Part I; increased fee assessment from the Professional Examination Service; and additionally, the initiation of a new specialty certification program for power plant reactor health physicists. In any event, it was felt by the Board that it would be necessary to raise the examination and certification plaque fees for new candidates, effective January 1, 1979, in order that the program be self-supporting.

Effective January 1, 1979, the fees will be as follows:

CERTIFICATION STEP	FEE
Application to take Part I of the written examination	$ 75
Application for regular examination to take Parts I and II of the written examination together	$150
Application to take Part II of written examination only	$ 75
Charge for certification plaque	$ 25

Please send application forms to:

Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857

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American Board Of Health Physics

ANNUAL NEWSLETTER

November 1978

Dear Colleague:

The American Board of Health Physics is completing the 20th year of its existence and thanks to the response and support of active Certified Health Physicists, the program continues to be financially stable, active, and is becoming more prestigious with each year.

As indicated in previous annual letters, financial assistance through voluntary subscriptions was initiated as a temporary measure and was dropped in favor of the increased fee program. However, deep appreciation and gratitude are expressed to all those who have contributed. It was clear evidence of the fact that the majority of the Certified Health Physicists recognized the need to support such a program, which contributes to the profession as a whole, as well as to each individual.

The continued efforts of the American Board to restrict expenses to a bare minimum have been successful, as evidenced by the fact that the amount of money realized through the examination fees has nearly met the expenses of the program during the past year. However, during the last Board meeting, it was recognized that there are some increased expenses resulting from: the need to expand and modify the examination questions utilized in Part I; increased fee assessment from the Professional Examination Service; and, additionally, the initiation of a new specialty certification program for power reactor health physicists. In any event, it was felt by the Board that it would be necessary to raise the examination and certification plaque fees for new candidates, effective January 1, 1979, in order that the program be self-supporting. It should be emphasized, however, that employers of the Board and panel members continue to gratuitously support the work of the ABHP in the form of secretarial services, travel expenses, and their own time.

A summary of the highlights of the Board activities is attached for your information.

Thank you for your continued support of ABHP activities.

Sincerely yours,

Michael S. Terpilak
Secretary-Treasurer

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SUMMARY OF ABHP 1978 BOARD MEETING ACTIONS

1. Recertification

The Board approved a Continuing Certification Program and appointed a Continuing Education Panel to initiate and implement the educational aspects of the program. Les Slaback is the present Chairperson and Jean St. Germain is Vice-Chairperson. Carlyle Roberts, as ABHP Vice-Chairperson, coordinates the activities of the Panel with other aspects of the Continuing Certification Program. Information and applications were mailed to all Certified Health Physicists in March 1978. A list of courses approved by the Continuing Education Panel, and a list of frequently asked questions concerning the Program was also mailed to all Certified Health Physicists in April 1978. At present there are 16 who have been recertified through December 1985, and 2 Health Physicists who have been granted Emeritus status.

2. Panel of Examiners

Certification examinations were conducted in July 1978, were graded, and the results approved at the Board meeting in Rockville, Maryland on September 26, 1978. Of the 46 candidates who took the entire exam, Parts I and II, 14 (30%) passed, 13 (28%) failed, and 13 (28%) will be required to take an oral examination, and 6 (13%) will be required to retake the part failed. This year's exam once again was designed to allow specialty groups to demonstrate competence in their area of expertise to a greater extent than in earlier years.

3. Liaison with the National Registry of Radiation Protection Technologists

The second National Registry of Radiation Protection Technologists examination was given as scheduled on November 5, 1977. There were 64 applicants accepted, of which 56 took the examination at 20 locations, and 41 (64%) were successful. The Board does not feel that this higher-than-expected percentage of successful candidates indicates that the exam was too easy. Rather, it is believed that the numerous training programs developed around the country in preparation for the exam were a significant factor.

The NRRPT Board meeting was held on January 15 and 16 at San Diego, at which time the results of the exam were approved by the Board. Those applicants who were accepted, but did not take the exam, are still eligible for the next one to be given on November 4, 1978.

4. Treasurer's Report

The Treasurer's Report indicated total assets of $7,300.84 as of September 10, 1978. It is anticipated that the increases in application fees effective January 1, 1979 for Parts I and II of the examination will provide sufficient funds to support the examination, including the new Specialty Program for Power Reactor Health Physicists.

5. Application Fees

The Board has approved the following increases in the application and certification plaque fees for new candidates. Effective January 1, 1979, the certification fees will be as follows:

Certification Step	Fee
Application to take Part I of the written examination	$ 75
Application to take Part II of written examination only	$ 75
Application to take Parts I and II of the written examination	$150
Charge for oral examination (if required)	$ 75
Charge for certification plaque	$ 25

6. Administrative Services

A meeting was held with R. Burk to arrange a service contract with the Office of the Executive Secretary of the Health Physics Society to assume the day-to-day administrative duties of the American Board of Health Physics. The Executive Secretary would provide the following day-to-day administrative services to the American Board of Health Physics:

1. Set up and administer the ABHP checking account and bookkeeping system.
2. Obtain and administer a bulk mailing permit for future mailings of the ABHP.
3. Provide future printing services for the ABHP.
4. Provide, administer and update a computerized list of certified health physicists for use by the ABHP.

5. Set up and maintain the ABHP records and files at some future date.

6. Service the ABHP mailing and information requests

Mr. Burk submitted a cost estimate for the above services. The Board's proposal is to contract with him on an annual basis for approximately $2,500. This will provide essential facilities and does not commit us to the HPS Executive Secretary for an extended period.

7. Panel Appointments

A. Examination Panel

Panel member replacements were:

Retiring	Replacement
Neil A. Gaeta	Jerrel R. Everett
Walter F. Wegst	Francis J. Haughey
Richard R. Bowers	Robert M. Ryan

Panel officer appointments were:

Joel O. Lubenau - Chairperson
Roscoe M. Hall - Vice-Chairperson

B. Continuing Education Panel

Panel member replacements were:

Retiring	Replacement
Roger J. Cloutier	A. John Ahlquist
Jean St. Germain	Jean St. Germain

Panel officer appointments were:

Lester A. Slaback - Chairperson
Jean St. Germain - Vice-Chairperson

8. ABHP Member Replacements

Retiring	Replacement
Bryce L. Rich	William R. Hendee

In addition, the following ABHP officers were elected:

Michael S. Terpilak - Chairperson
Carlyle J. Roberts - Vice-Chairperson
David Myers - Secretary-Treasurer

At this time, the American Board of Health Physics would like to express its sincere thanks and gratitude to outgoing Board Member Bryce L. Rich for his inspiring leadership, guidance, dedication and support during his term of office. Thanks again, Bryce, for a job well done!

9. Power Reactor HP Certification Program

Enclosed in this newsletter package is recent information to all Certified Health Physicists from Chairperson Bryce Rich, American Board of Health Physics, summarizing the work of a subcommittee composed of Dave Myers and Dick Bowers concerning specialty certification as it relates to the power reactor health physics area.

The Board has now approved the establishment of a Power Reactor Health Physics Examination Panel with the following members:

Richard R. Bowers - Chairperson (NUS Corp.)
William D. Allen - Vice-Chairperson (Pennsylvania Power & Light Co.)

Examination Panel Members:

Edward Scalsky - Jersey Central Power & Light Co.
Harvey F. Story - Florida Power & Light Co.
Raymond G. Carroll - Arkansas Power & Light Co.
Norm L. Millis - Jersey Central Power & Light Co.
Peter J. Knapp - Nuclear Regulatory Commission
John R. Mann - Arizona Public Service Co.

The first certification examination for Power Reactor Health Physics is scheduled to be given on July 9, 1979, at the 24th Annual Meeting of the Health Physics Society, which will be held in Philadelphia, PA.

10. Part I - Eligibility Requirements

At its last meeting the ABHP approved the following change as it relates to Part I eligibility:

> Individuals who have successfully completed a Bachelor of Science program in Health Physics and who have at least one year of practical (professional level) experience can now qualify and be accepted to take Part I of the Certification Examination.

POWER REACTOR HEALTH PHYSICS CERTIFICATION PROGRAM

I. INTRODUCTION

After thorough deliberations over several years, the American Board of Health Physics has decided to offer specialty certification in power reactor health physics in addition to the presently offered comprehensive health physics certification.

A summary of the Board's deliberations was presented in the April 1978 Newsletter to certified health physicists. The responses from certified health physicists regarding the proposal to offer specialty certification in power reactor health physics were almost exclusively favorable. An updated summary of the Board's deliberations in this matter is presented in Section V.

The Board does not intend to offer specialty certification in other areas of health physics at present. The Board feels that specialty certification will only be considered when there is a genuine need in a given specialty area which cannot be adequately met by the present comprehensive health physics certification program. It is also the Board's intent not to take any action in the specialty certification area that would have an adverse effect on the present comprehensive health physics certification program.

It is the Board's position that comprehensive health physics certification signifies professional competence in the areas in which an individual is experienced; thus, in the power reactor health physics area and any possible future specialty areas, an individual with comprehensive health physics certification will automatically be eligible for the specialty certification if the individual has the requisite experience.

II. POWER REACTOR HEALTH PHYSICS CERTIFICATION PROCEDURES

A. Individuals Holding Comprehensive Health Physics Certification

Individuals holding comprehensive health physics certification are eligible for certification in power reactor health physics if:

(1) they have spent two of the last six years in a position in which they were responsible for at

least a major portion of the health physics program for an operating power plant, and

(2) they are presently spending at least 50% of their time in power reactor health physics.

In questionable cases, the Board may give the candidate an option of taking Part II of the specialty examination or taking an oral examination to evaluate the candidate's knowledge of power reactor health physics.

Applications for certification in power reactor health physics will be reviewed by the American Board of Health Physics and the Chairperson of the Power Reactor Health Physics Examination Panel. If the requisite experience requirements are met, certification in power reactor health physics will be issued.

Individuals who hold comprehensive health physics certification and do not have the requisite experience listed above must either:

(1) acquire the requisite experience, or

(2) take Part II of the Power Reactor Certification Examination.

B. Power Reactor Examination Panel

The initial members of the Power Reactor Examination Panel, all of whom hold comprehensive health physics certification, and meet the experience requirements of Section II-A, will receive certification in power reactor health physics.

C. Individuals Not Holding Comprehensive Certification

Individuals not holding comprehensive health physics certification must pass Parts I and II of the Power Reactor Certification Examination. To be eligible for the examination, an applicant must have a bachelor's degree in a physical science or in a biological science with a minor in a physical science. In exceptional cases, and at the discretion of the Board, an applicant may be permitted to substitute experience for the academic degree. In addition, an applicant must have at least six years of responsible professional experience in health physics. At least three years of this professional experience should be in applied radiation protection work with nuclear facilities dealing with radiological problems similar to those encountered in nuclear power stations, preferably in a nuclear power station. Advanced education may be substituted for up to two and one-half of the remaining three years of experience in accordance with normal Board requirements.

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All requirements for early admission to Part I of the examination will be the same as the requirements for comprehensive health physics certification. That is, candidates with a master's degree in health physics are immediately eligible to take Part I, candidates with a bachelor's degree in health physics must have one year of applied experience, and all other candidates must have two years of applied experience.

III. POWER REACTOR CERTIFICATION EXAMINATION

A. Part I of the power reactor health physics examination will be identical to Part I of the comprehensive health physics certification examination, which consists of 150 multiple choice questions which cover fundamentals, radiation measurements, and operational health physics. The time allowed for this part of the examination is three hours.

Part I will be revised so it will contain only questions which are designed to test the applicant's knowledge of fundamental health physics principles, practices, and theory; and questions of general scope which a certified health physicist, regardless of specialty, should be expected to answer.

B. Part II of the examination will consist of two subparts:

(1) Ten short-answer questions. These may be fill-in-the-blank or multiple choice, or may require a one- or two-sentence answer. Candidates will be required to answer all the questions.

(2) Seven essay or problem type questions. The candidate will be required to answer any five.

Time allowed for this part of the examination is four hours.

C. Part II of the Power Reactor Health Physics Examination will cover material selected from the following areas:

Technical Administration
Professional Judgement
Design Review
Plant Systems
Procedures
Training
Regulations and Standards
Medical-Legal Aspects
Guides and Limits
Shielding
Radiation Measurement
ALARA
Radioactive Material Control
Radwaste Management
Emergency Planning
Instrument Selection, Operation and Calibration (includes survey, effluent monitors and counting room instruments)
Decontamination
Personnel Dosimetry

Contamination Control
Air Sampling
Protective Clothing and Equipment
Respiratory Protection
Transportation
Bioassay and Uptake Analysis
Inplant Dose Assessment
Environmental
Off-site Dose Projection
Current Topics

IV. GRADING CRITERIA

The grading criteria for the Power Reactor Health Physics Certification Examination will be identical to the grading criteria for the comprehensive examination.

A. Part I - Taken Alone

To pass Part I, the candidate must achieve a score of at least 67% on the total exam and on the Fundamentals Section.

B. Parts I and II - Taken Together

To pass the exam, the candidate must achieve a score of at least 67% on Part I, the Fundamentals Section of Part I, and Part II.

C. Failure Upgrading Criteria

Any grade less than 67% on either part will be considered to be a failure of that part. To provide candidates with an opportunity to raise a failing grade to a passing grade, the Board will do the following:

(1) Give candidates, who have scored at least 57% on both Part I and Part II and whose average grade (Parts I and II given equal weight) is at least 60, the option to take an oral examination or retake the part(s) failed. (If a candidate repeatedly fails one of the parts, the option may be removed and the candidate required to take an oral examination).

(2) The Board considers any grade less than 57% to be below the standards for oral upgrading.

D. Availability of Performance Information

Candidates may request their examination performance information to assist them in preparing for re-examination.

E. Oral Examinations

In the oral examination for power reactor health physics certification the candidate will appear before two examination panels of three members each. The first panel will examine the candidate in health physics fundamentals for 20 minutes, and the second panel will examine the candidate in power reactor health physics for 40 minutes. The specialty panel will be comprised of Board members or power reactor health physics examination panel members who are certified in power reactor health physics.

To pass the oral examination, the candidate will need at least two passing votes from the power reactor health physics examination panel and four passing votes from the combined panels.

F. Upgrading Power Reactor Health Physics Certification to Comprehensive Health Physics Certification

An individual certified in power reactor health physics can receive comprehensive health physics certification by successfully passing Part II of the comprehensive health physics certification examination.

V. BACKGROUND

As discussed in Section I, the American Board of Health Physics has decided to offer specialty certification in power reactor health physics. The Board made this decision for the following reasons:

A. Power reactor health physics represents a significant number of professionals. Presently, there are about 50 radiation protection managers (RPM) at power plants and about 125 additional health physics professionals within the utility industry. In addition, significant numbers of people in architect/engineering firms, consulting firms, and regulatory groups are involved full time in power reactor health physics.

B. Because the number of nuclear power plants is expected to increase significantly, the number of professionals needed in this area will also increase. Paul Ziemer, in a study of future personnel needs (Health Physics Society Newsletter, March 1976), predicts that 274 health physics professionals will be needed in the power reactor area by 1980 and 734 by 1990.

C. A limited number of individuals have the special qualifications required for these professional positions. As the need increases, it will become more important to insure that these critical positions are filled by persons with demonstrated capability in power reactor health physics. The specialty certification offers one mechanism for providing this assurance.

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D. The importance of power reactors as a source of occupational radiation dose is evidenced by the trend of increasing person-rem per reactor. The need for competent people to minimize exposure from this source is apparent.

E. The public has shown less than complete confidence in the radiation safety of the nuclear power industry. It is important that persons dealing with the public be knowledgeable and be recognized professionals in order to gain the confidence of the public.

F. The Nuclear Regulatory Commission has indicated that it has under consideration a requirement for further documentation of capability for individuals who are designated to radiation protection manager (RPM) positions.

G. While the broad knowledge implied by a comprehensive health physics certification is <u>desirable</u>, it is not <u>required</u> for adequate functioning as a RPM in a nuclear power plant. The specialty certification will be of more obvious and direct relevance.

H. An individual with comprehensive health physics certification does not necessarily have the special qualifications and knowledge required by a nuclear power plant RPM without receiving further training and experience. The specialty certified HP will necessarily have these prerequisites.

I. Requiring that all RPMs hold comprehensive health physics certification and also have training and experience in nuclear power plant health physics is unrealistic in view of the current and expected near-term availability of such personnel.

The Board realizes that offering specialty certification presents some possible problems. In the past it decided against specialty certification for various reasons, some of which are listed as follows:

A. The specialty certification being considered was in a fringe area between health physics and other technical specialties and the Board felt that other credentialing groups were better suited to handle these situations.

B. There is great difficulty and effort in preparing, giving, and grading different examinations for various groups.

C. The Board is concerned about adversely affecting the value and meaning of the present comprehensive health physics certification program.

The above considerations not withstanding, the Board concluded that the potential benefits and contributions to the health physics profession and the health physics certification program would outweigh the problems which the offering of specialty certification in power reactor health physics might create.

By granting comprehensive health physics certification, the Board recognizes the professional with a broad, general knowledge in many areas of health physics. With specialty certification in power reactor health physics, the Board will recognize the professional who has detailed knowledge in a restricted area of health physics, namely an in-depth knowledge of power reactor health physics. However, any specialty certification will require knowledge of all health physics fundamentals. The Board hopes that if specialty certification becomes available in a given area, certified health physicists working in that area will seek specialty certification. Conversely, the Board hopes that health physicists with only a specialty certification will broaden their areas of knowledge, and seek comprehensive certification.

to wince at the sight of health physicists having to bear the brunt of an attack upon some facet of nuclear safety? The replies and explanations are usually rich and detailed (with distortion they often further fuel the opposition's attack) and, more often than not, are made in nuclear isolation. How much better it would be if the risk-benefit factors for nonnuclear energy systems were, relatively speaking, as well understood as for nuclear systems and at our fingertips. A more evenhanded evaluation of the drawbacks of each energy alternative would then permit the general public to decide more logically than at present where and how it wants to produce the energy that is its lifeblood.

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Health Physics Manpower in the Atomic Energy Field, 1968–2000

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BEGINNING in 1962, the Bureau of Labor Statistics (BLS) has conducted surveys of employment in the atomic energy field (Su74). These surveys consist of a mailed questionnaire to private and government-owned contractor-operated (GOCO) firms which are engaged wholly or partially in atomic energy-related activities. Excluded are government, medical institution, mining, university and construction workers.

The 1975 survey revealed that there were 705 health physics professionals (HPP) and 1902 health physics technicians (HPT) employed by the 1063 firms responding to the survey. Estimates of the 1975 U.S. health physics professional population ranged from 3000 by Kathren (Ka75) to 1200

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by Michaels (Mi76). The 1976 estimated U.S. technician population ranges from 1885 by Ziemer (Zi75) to 2500 by Baker (Ba77).

Although earlier data are available, changes in survey methodology confined the study to the 1968–1975 period. This period has seen considerable change in the atomic energy field. After more than a decade of rapid growth, the nuclear power industry began to be plagued by rising costs, planned plant cancellations and public concern for industrial safety. The future of the nuclear power industry is uncertain and depends on the outcome of the pronuclear–antinuclear energy debate.

Emphasis has shifted in the atomic energy field from research and development towards commercialization of existing technologies. In 1968 almost 70% of all scientists and engineers in the field were involved in R & D; in 1975 this had fallen to 45% (Su75). Employment in research-oriented GOCO facilities declined, and private employment exceeded GOCO employment for the first time in 1973 (see Table 2).

Utilizing these BLS survey data, this paper examines the structure of employment, historical trends and projections of health physics workers in the atomic energy field.

Historical Trends

Table 1 summarizes the BLS survey results from 1968 to 1975. Total employment grew at an annual rate of 4.6% during this period. Additional firms were added to the survey in 1973 and 1975; therefore, employment additions in these years can be partially attributed to a larger number of firms surveyed.

The historical trend of health physics professional employment is somewhat surprising. These data indicate an annual growth rate in employment of only 1.8% a year for the period 1968–1975. The 1970 total of 674 health physics professionals is 18 workers lower than the 1969 figure; the 1975 total of 705 is 70 workers shy of the 1973 figure.

Table 2 details employment trends for the GOCO and private sectors. This table reveals that all of the decline in HPP employment occurred in the GOCO sector. Examination of individual firm

Table 1. Health physics worker employment in the BLS-defined atomic energy field, 1968–1975

(1) Year	(2) Total Atomic Energy Employment	(3) Health Physics Professionals	(4) Column(3) as Percent of Column (2)	(5) Health Physics Technicians	(6) Column(5) as Percent of Column (2)	(7) Ratio Column (5) to Column(3)
1968	144,355	620	.43	1,417	.98	2.2
1969	149,430	692	.46	1,532	1.03	2.2
1970	154,124	674	.44	1,550	1.00	2.3
1971	156,934	726	.46	1,632	1.04	2.3
1973	170,855	775	.45	1,896	1.11	2.4
1975	197,466	705	.36	1,902	.96	2.7
1968—1975 Annual Compound Growth Rate(%)	4.6	1.8		4.3		

Source: Bureau of Labor Statistics (Su75).

Table 2. BLS health physics worker employment by sector, 1968–1975

	GOCO Employment			Private Employment		
	Total	HPP	HPT	Total	HPP	HPT
1968	98,339	442	944	42,728	178	334
1969	99,636	498	1,000	49,794	194	502
1970	98,609	464	993	55,515	210	552
1971	95,470	480	1,073	61,464	246	619
1973	85,109	455	1,039	85,755	320	857
1975	89,374	372	927	108,092	333	975
Annual Growth Rate	-1.5	-2.4	-0.3	14.4	9.4	16.5

Source: Bureau of Labor Statistics (Su75).

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Table 3. 1975 atomic energy employment by primary industrial segment

Segment	1975 Employment	Percent of Total Employment	Health Physics Professionals		Health Physics Technicians	
			Number	Percent	Number	Percent
Processing of Reactor Materials	11,270	5.8	25	3.5	46	2.4
Chemical Reprocessing of Fuel	8,389	4.3	49	7.0	229	12.2
Design of Nuclear Facilities	34,133	17.4	61	8.7	186	9.8
Reactor Operation and Maintenance	12,572	6.4	104	14.8	444	23.3
Health Physics and Industrial Safety	174	0.1	36	5.1	66	3.5
Weapons Development and Production	31,434	16.0	96	13.6	254	13.4
R&D in Atomic Energy	21,993	11.1	119	16.9	209	11.0
All Other	75,611	37.9	215	30.4	468	24.6
Total	197,445	100.0	705	100.0	1,902	100.0

Source: Bureau of Labor Statistics (Su75).

survey questionnaires indicates that these employment reductions were the result of several "across the board" cutbacks in government GOCO operations expenditures.

Private sector growth in health physics workers over this period has been strong. Table 2 reveals an annual growth rate for the 1968–1975 period of 9.4% for professionals and 16.5% for technicians. If these rates of growth were to continue, manpower requirements in the atomic energy field would double every 8 yr for professionals and every 4.5 yr for technicians.

The 1968–1975 data also reveal a trend towards increasing use of technicians in the field. In 1968 there were 22 technicians employed for every 10 health physics professionals; in 1975 this ratio had increased to 27 technicians per 10 professionals. This trend is likely the result of the declining involvment in research in the field and increase in commercial application. In 1968, 44% of all professionals spent 50% or more of their time in atomic energy-related research; in 1975 only 28% were involved in research.

1975 Employment

The Bureau of Labor Statistics classifies employment in the atomic field into 21 industrial segments ranging from the weapons development and production segment to the biological and medical research segment.* Table 3 details the 1975 survey results by industrial segment.

Both the reactor operation and maintenance segment and the health physics and industrial safety segment employ relatively large numbers of health physics workers. These two segments make up less than 7% of the field's total employment while employing 20% of all professionals and 27% of all technicians. Other segments employing large numbers of health physics workers include chemical reprocessing of fuel, weapons and atomic research and development.

The R & D in atomic energy segment employment declined from 28,245 workers in 1973 to 21,993 in 1975, a 22% reduction. During this same period, HPP employment in this segment decreased by 55% and technician employment decreased by 36%. Over 85% of the 1975 employment in this segment was composed of GOCO workers. Virtually all of the decline in HPP employment from 1973 to 1975 is explained by the employment reductions in this industrial segment.

Future Demand

The future of atomic energy, especially for electricity production, is uncertain. The data examined show declining employment in the GOCO sector and changing demand for health physics workers. What effect will these factors have on future health physics worker employment?

The demand for workers in the GOCO sector is a function of real government expenditures for GOCO facility operation.† Historically, over 80% of the variation in GOCO employment is explained by the variation in real government expenditures. These expenditures were fairly constant during the

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*BLS classifies employment by the concept of "primary segment". That is, total atomic energy employment of any one firm is counted in the single segment that employs the most workers, although many may be involved in other segments.

†The term "real" is used to indicate that expenditures are controlled for inflation, i.e. in constant dollars.

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early 1970's; inflation reduced the level of real expenditures substantially and employment declined.

Given the relationship between government expenditures for GOCO operation and GOCO employment, future GOCO employment estimates could be generated from budget projections. These data are not available. The erratic historic behavior of GOCO employment precludes a simple extrapolation of past growth rates. Total GOCO employment has stabilized at approximately 100,000 workers, and given that most future GOCO growth will be in non-nuclear energy areas, a modest growth rate of 1% per annum was utilized for the projections.

The demand for workers in the private sector is related to the demand for the product they produce. This sector has no single measure of demand such as federal expenditures but consists of a large number of firms engaged in several different industrial segments. In the past, changes in nuclear megawatt electricity capacity explained over 97% of the changes in private sector employment.* Using megawatt capacity as an index of demand produced a better model than did the use of total value of shipments of selected atomic energy products or a simple time trend of growth.

Government estimates of projected nuclear megawatt capacity have undergone considerable revision. In 1972, 1.2 million MW were estimated to be online in the year 2000. In 1974 this estimate was reduced to 1.09 million MW; in 1975 to 0.8 million MW, and in 1976 to 0.51 million MW. The most recent estimate placed the year 2000 capacity figure at 0.38 million MW (Sc77). Given the strong relationship between MW capacity and employment, these revisions in future capacity considerably alter projections of future employment.

Projections of total atomic energy field employment are summarized in Table 4. These projections were generated by using the most recent MW capacity projections (Sc77) and the GOCO employment assumptions. Historically, health physics workers have comprised a fairly stable share of total GOCO and private sector employment. Health physics worker requirements are arrived at by assuming the relative 1975 employment shares of these workers will remain stable over the projection period.

Table 5 compares 1974 Project Independence (Fe74) assumptions of future MW capacity to Schlesinger's estimates for the year 1985. The Project Independence figures produce extremely high estimates of future demand for health physics workers, projecting a doubling of manpower requirements in the field approximately every 6 yr.

Table 4. Projections of health physics workers in the BLS-defined atomic energy field, 1975–2000

(1) Year	(2) MW Capacity	(3) Total Private Sector Employment	(4) Total GOCO Employment	(5) Health Physics Professionals			(6) Health Physics Technicians		
				Private	GOCO	Total	Private	GOCO	Total
1975	36,539	108,100	89,400	333	372	705	975	927	1,902
1980	65,000	176,400	94,700	650	290	940	1,590	980	2,570
1985	130,000	317,300	98,500	980	410	1,390	2,360	1,030	3,390
1990	207,000	470,200	103,500	1,450	430	1,880	4,290	1,030	5,320
2000	380,000	862,000	114,600	2,650	430	3,130	7,770	1,100	8,350
Annual Growth Rates									
1975—1985	13.5	11.4	1.2	11.4	1.0	7.0	11.4	1.0	7.4
1985—2000	3.3	3.7	1.3	4.7	1.3	5.1	3.2	1.0	4.1

This excludes government, medical, construction, mining and academic workers.

Table 5. Comparisons of 1985 employment projections BLS-defined atomic energy field

	MW	Total Employment	Health Physicists Professional	Health Physicists Technicians
Project Independence(1974)	275,000	723,400	2,250	7,560
Schlesinger Estimate(1977)	130,000	412,300	1,390	3,390

Source: Federal Energy Administration, *Project Independence Blueprint Final Labour Report* (Washington: USGPO, 1974), p. 62.

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*The estimated regression equation was: private employment = 34,997 + 2.3 (MW capacity) $R^2 = 0.974$, $F = 168.4$.

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In terms of future employment opportunities, the recent downward planned plant revisions in the nuclear power industry have been very costly to the health physics profession.

While demand growth in other employment areas is not examined here, Kathren's paper provides some projections by sector (Ka76). Kathren's projections of professional requirements for the year 1990 are 1050 in the academic field, 650 in the medical field, 1500 in government and 700 "not elsewhere classified". These total to 3900 health physics professionals outside the BLS-defined atomic energy field in 1990.

Summary

During the 1968 to 1975 period, atomic energy field employment has grown at a rate of 4.6% annually, compared to a rate of 1.8% for the U.S. economy. The majority of this growth has been concentrated in the private sector, while GOCO employment declined from 1968 through 1973.

Data indicate that growth in the private sector is strongly correlated to growth in nuclear megawatt capacity. The recent revisions in projected generation capacity have depressed considerably the growth in future health physics worker demand. Using the most recent estimates of future capacity, health physics professional requirements in the field are expected to grow at a rate of 7.0% annually and technician requirements at a rate of 7.4% annually for the period 1975–1985. These results compare favorably to other published projections, which show a range in growth rates of 5.2% to 7.0% for professionals and from 7.5% to 16% for technicians (Mo76; Mi76; Ka76; Fi75). The Project Independence report is somewhat high, projecting rates of 11.3% for HPP and 14.9% for HPT. All of these studies project faster growth for technicians than for professionals.

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Simplified Shielding for Diagnostic X-ray Rooms

(*Received 25 October 1977; accepted 9 January 1978*)

THE SHIELDING tables in Appendix C of NCRP Report No. 49 are unwieldy. This has resulted from converting distances, shown in feet in NCRP Report No. 34, to meters, instead of actually redoing the tables in even meters. The resulting distances shown in the tables are 1.5, 2.1, 3.0, 4.2, 6.1, 8.4 and 12.2 m. Room plans for shielding design are commonly received from architects. Architects are not likely, in the near future to switch to the metric system. Decimal metric distances are therefore cumbersome to the designer, who must make numerous conversions from one system to another.

Figures 1 and 2 can greatly facilitate shielded room design in the diagnostic energy range. The figures were obtained by graphing data from the tables of Appendix C in NCRP Report No. 49, FROM THE PRESIDENT'S DESK - Paul L. Ziemer

Health Physics Manpower

During the past year or so I have visited over half of the Society's chapters and in most cases have spoken on the theme of health physics education and training needs for the future. To some extent, the projections made on training needs have been highly speculative because they require that one make estimates of present and future manpower levels in health physics. Because of a lack of reliable data, such projections are only educated guesses. The Oak Ridge Associated Universities, Manpower Development Division, provides some useful information through the annual "Radiation Protection Enrollment and Degree Survey" (previously conducted by the AEC). Plans are also underway by the Office of Manpower Development of NIOSH to conduct manpower studies which would include the Health Physics area. The Society hopes to provide input and cooperate in this study if possible. In the meantime, for what they are worth, my own projections are summarized in the table below. For those who are interested in details on how the final figures were obtained, I will provide a summary report upon request. The figures, as given, do not include attrition. Currently, health physics training programs in colleges and universitites are providing (as of 1974) some 55 B.S. level and 205 advanced degrees in health physics per year. Not all of these 260 persons enter the job market (as many as 30% may continue this education), and of the remainder who enter the job market, not all go into the health physics area. Thus, some 150 formally trained health physicists may be entering the profession each year, whereas, the projections indicate a need for over 350 per year for the next 5 years and over 430 per year for the decade from 1980 to 1990. At least part of the difference between the numbers being formally trained and the predicted needs will be provided by individuals trained through on-the-job programs. There may also be a difference in what we identify as the numbers of health physicists required and what the real job market is. Economic and other factors may cause employers to attempt to operate with less than an optimum number of trained health physicists.

The projected increases in the numbers of health physics or radiation protection technicians suggest that special efforts must be directed toward the undergraduate training programs. The need is not only for more such programs, but for programs that have a practical or applied orientation. "Hands-on" experiences in area monitoring and surveying, instrument calibration and use, and other operational health physics experiences are mandatory for technician training programs. If such training cannot be supplied by our colleges and universities alone, cooperative efforts with industrial or government facilities may be called for.

SUMMARY OF PROJECTED HEALTH PHYSICS MANPOWER NEEDS

Employing Group	1975	1980	1990
Nuclear Power			
Reactor H.P. (Pro)	110	274	784
Reactor H.P. (Tech)	330	822	2352
Fuel Cycle (Pro)	30	75	195
Fuel Cycle (Tech)	200	425	1375
Government			
N.R.C.	130	220	385
B.R.H.	60	80	90
Other Federal	240	300	440
State and Local	480	730	830
Medical	705	1000	1500
Academic			
University H.P. (Pro)	240	280	360
University H.P. (Tech)	300	380	540
Teaching	50	55	60
Other (B.O.C.O., Industry & Consult.)	1125	1130	1240
TOTALS	4000	5821	10,151

Radiation Protection Technologists

A need related to the training of technicians is the certification of their competence. This need has been recognized for several years by many in the Society and by the American Board of Health Physics. Thus many of us were pleased that the National Registry of Radiation Protection Technologists (NRRPT) was recently established. The Board of Directors of the NRRPT met for the first time in November, 1975, under the chairmanship of D. W. Marshall (Aerojet Nuclear Company). The NRRPT is currently working on becoming incorporated and on development of a national examination for use in evaluating radiation protection technologists who wish to be a part of the National Registry. On behalf of the Health Physics Society, I extend best wishes to the NRRPT for success.

Health Physics Society Board of Directors Resolution Relative to a Petition by Natural Resources Defense Council to the N.R.C. to Reduce Occupational Radiation Exposure Limits

The Health Physics Society Board of Directors at its meeting in Denver, Colorado on February 9, 1976 reviewed a petition submitted to the U.S. Nuclear Regulatory Commission (NRC) from the Natural Resources Defense Council (NRDC) to reduce current occupational radiation exposure limits. As a result of this review, the Board of Directors has adopted the following resolution and recommendation relating to this petition:

Since 1929, independent international and national scientific committees have continually reviewed scientific information on the exposure of individuals to ionizing radiation and have recommended standards regarding such exposure. These committees are the International Commission on Radiological Protection (ICRP) which is international in scope and the National Council on Radiation Protection and Measurements (NCRP) which is national in origin. These groups, which often pool their technical resources and have in the past generally been in substantial agreement in their recommendations, constitute bodies of the best technical experts available in the world or in this country relative to exposure of individuals to radiation. We recommend that the NRC continue to use the recommendation of the NCRP as the prime basis in the formulation of legal standards on the exposure of individuals to radiation.

The NRDC recently submitted a petition to amend current standards in 10CFR Part 20.101 using as a technical basis for the petition a document would be completely inappropriate. NCRP has already reviewed many of the points raised in the Cochran and Tamplin paper and addressed them in its recently published NCRP Report No. 43 entitled "Review of The Current Status of Radiation Protection Philosophy". Not only has the NCRP reviewed the basis of many of the conclusions drawn by the authors of the report, the NCRP specifically cautioned against drawing such conclusions in its publication. Therefore, we strongly recommend that the NRDC petition be denied.

Lastly, we recommend that the NRDC petition and the associated Cochran and Tamplin document, and any future documents containing technical data pertinent to the setting of radiation safety protection standards be forwarded to the NCRP for review and consideration relative to present recommendations. In this manner, the technical bases for such documents can be carefully reviewed and judged on their merit by the best technical experts available. And in the event that such reports contain new scientific data or meaningful conclusions, the NCRP will be able to consider them in forthcoming recommendations.

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American Board Of Health Physics

ANNUAL NEWSLETTER

April 1978

Dear Colleague:

The American Board of Health Physics has just completed the 19th year of its existence and thanks to the response and support of active Certified Health Physicists, the program continues to be financially stable, active, and is becoming more prestigious with each year.

As indicated in previous annual letters, financial assistance through voluntary subscriptions was initiated as a temporary measure and was dropped last year in favor of the increased fee program. However, deep appreciation and gratitude are expressed to all those who have contributed. It was clear evidence of the fact that the majority of the Certified Health Physicists recognized the need to support such a program which contributes to the profession as a whole as well as to each individual.

The continued efforts of the American Board to restrict expenses to a bare minimum have been successful as evidenced by the fact that the amount of money realized through the examination fees has nearly met the expenses of the program during the past year. However, during the last Board meeting, it was recognized there are some increased expenses resulting from the need to expand the examination questions utilized in Part I, in addition to an increased fee assessment from the Professional Examination Service. In any event, it was felt by the Board that it would be necessary to raise the examination fees for new candidates effective January 1, 1977, in order that the program be self supporting. It should be emphasized, however, that employees of the Board and panel members continue to graciously support the work of the ABHP in the form of secretarial services and travel expenses.

A summary of the highlights of the Board activities is attached for your information.

Thank you for your continued support of ABHP activities.

Sincerely yours,

Mike

Michael S. Terpilak
Secretary-Treasurer

Summary of ABHP 1977 Board Meeting Actions

1. Recertification

The Board approved a Continuing Certification Program and appointed a Continuing Education Panel to initiate and implement the program. Les Slaback is the present Chairman and R. J. Junkins is Vice-Chairman. Carlyle Roberts, as ABHP Vice Chairman, coordinates the activities of the Continuing Education Panel. Information and applications were mailed to all Certified Health Physicists in March 1978. Also enclosed is a list of courses approved by the Continuing Education Panel and a list of frequently asked questions concerning the program.

2. Panel of Examiners

Certification examinations were conducted in July 1977, were graded, and the results approved at the Board meeting in Chicago on September 23, 1977. Of the 52 candidates who took the entire exam, Parts I and II: 15 (29%) passed, 22 (42%) failed, and 15 (29%) were given the option to either take an oral examination or retake the part failed. This year's exam once again was designed to allow specialty groups to demonstrate competence in their area of expectation to a greater extent than in previous years.

3. National Registry of Radiation Protection Technologists

The second National Registry of Radiation Protection Technologists examination was given as scheduled on November 5, 1977. There were 64 applicants approved of which 56 took the examination at 20 locations, and 41 (64%) were successful. The Board does not feel that this higher-than-expected percentage of successful candidates indicates that the exam was too easy. Rather, it is believed that the numerous training programs developed around the country in preparation for the exam were a significant factor.

The NRRPT Board meeting was held on January 15 and 16 at San Diego at which time the results of the exam were approved by the Board. Those applicants which were approved but did not take the exam will still be eligible to take the exam next year. The next NRRPT exam will be given on November 4, 1978.

4. Treasurer's Report

The Treasurer's Report indicates total assets of $12,604.34 as of December 31, 1977. It is anticipated that the present increases in application fees for Parts I and II of the examination will provide sufficient funds to support the examination without additional voluntary subscription from Certified Health Physicists.

5. Exam Panel Officer Appointments and Member Replacements

Retiring	Replacement
Thomas A. Steele	Ronald L. Kathern
Roland H. Jalbert	Paul H. Ruther
Nathaniel A. Greenhouse	Kenneth H. Kase
Ralph H. Thomas	William R. Casey

Panel Officer appointments were:

Richard R. Bowers - Chairman
Joel O. Lubenau - Vice-Chairman

6. ABHP Member Replacements

Retiring	Replacement
Jack S. Krohmer	Nathaniel A. Greenhouse

In addition, the following ABHP officers were elected:

Bryce L. Rich - Chairman
Carlyle J. Roberts - Vice-Chairman
Michael S. Terpilak - Secretary-Treasurer

At this time, the American Board of Health Physics would like to express its sincere thanks and gratitude to outgoing Board Member Dr. Jack Krohmer for his inspiring leadership, guidance, duration, dedication and support during his term of office. Thanks again, Jack, for a job well done!

7. Reactor HP Certification Program

Enclosed in this newsletter package is a letter addressed to all Certified Health Physicists from Chairman Bryce Rich, American Board of Health Physics, summarizing the work of a subcommittee composed of Dave Myers and Dick Bowers concerning specialty certification as it relates to the power health physics area. The questions before the Board and before each Certified Health Physicist is that, in taking all the information presented in this letter into consideration, should the ABHP proceed with development of a specialty certification in the area of power reactor health physics? Please give the Board the benefit of your ideas and opinions in order to help the Board decide its professional responsibilities in this area. Since the Board plans to discuss this important item at its June meeting in Minneapolis, it is important that your ideas and suggestions reach the Chairman, ABHP, by early June so that they can be organized before the meeting.

American Board of Health Physics
Program of Continuing Certification and Education

FREQUENT QUESTIONS CONCERNING THE PROGRAM

1. Q: Who approves my course attendance?

   A: The ABHP does this as part of the review of your application for certification renewal. The CHP certifies his attendance via this application procedure. However, the course itself must previously have been approved by the Continuing Education Panel.

2. Q: What courses are eligible for continuing education credit?

   A: Courses presenting subject matter which is included in a general way on ABHP examinations and on which the certification of diplomates is based may be considered for credit towards the continuing education portion of the certification renewal program. Some credit may also be approved for courses although only a portion of the material is of sufficient relevance to health physics to be considered eligible for credit. Another basic ingredient necessary for approval of continuing education credit is that the course follow a formal "instructional or tutorial" format.

3. Q: Why are the Health Physics Society meetings being considered as part of the continuing education program?

   A: Certainly these technical meetings do not constitute education in formal sense, although they are informative and hence "educational" in a more general context. Essentially this approval was a compromise to assure that there will be adequate opportunity for all CHP's to meet the continuing education requirements during the early years of the program.

4. Q: What about other professional meetings, and courses not approvable as part of the continuing education program?

   A: In the interest of avoiding an unnecessarily elaborate program the continuing education requirement is structured very simply. In other words, the continuing education portion of the renewal program is not intended to encompass the multitude of different "educational" activities that exist. The activities that are not approved for credit as part of the formal continuing education program should be described under the appropriate section of the renewal application.

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5. Q: Why are some basic courses given more credit than some advanced health physics courses?

A: An absolute scale has not been established for course values. Many factors go into establishing the credit assigned to a particular course including content, instructor quality, and course length. Also, an aspect that should not be ignored is the fact that this program is in its formative stages. Once an adequate data base is established it is expected that things will mesh better, although there will certainly still be disagreements on details. It should also be remembered that continuing education is just a portion of the application for certification renewal. Numbers (i.e., credits) aside, the application still must be of an adequate overall quality.

6. Q: How does the CEP know what portion of a course is to be reviewed for continuing education credit?

A: If the applicant did not specifically indicate those portions in his application, a conservative estimate is made based on the descriptive material provided. If this appears overly conservative (i.e., result in a rating that is to low) the application will be returned for more information.

7. Q: How does the CEP distinguish between a basic course in a subject (e.g., internal dosimetry) versus an advanced course with the same title and general description?

A: By reference to supplementary information provided by the applicant. If this material is not present, the evaluation will be based on those assumptions which result in a <u>lower</u> rating or the application will be returned for more information.

8. Q: What if I don't have any detailed information on the qualifications of the instructors?

A: Unless the instructor(s) have such an extensive reputation that they are known by all members of the panel, little or no credit will be allowed for that element of the evaluation. This does not prevent the course from being approved but it may lower the number of credits assigned to the course.

9. Q: What if I don't agree with the number of credits assigned for my course?

A: You may resubmit the application with more information, may vent your wrath on the Chairman or other members of the CEP, or may appeal to the ABHP.

10. Q: Why does it take six weeks to process an application?

A: Consider the steps involved: one-two weeks to process for mailing to panel members, depending on the number being received; two-three weeks for review by the panel members, depending on the mails, their job, and their spouse; one-two weeks to tabulate the results and for the post office to get the reply to you.

11. Q: Why did I not hear anything for three months?

A: The Panel Chairman will attempt to provide some sort of status letter if it appears that the review procedure will extend beyond 8 weeks.

12. Q: Why do course approval applications have to be submitted within 90 days of the end of the course?

A: To keep all the CEP members from resigning in the last half of 1981 because the majority of the CHP's are afflicted with the "April 15" syndrome.

13. Q: Do I have to be a CHP to apply for a course to be assigned continuing education credits?

A: No. Anyone may do so although it would normally be either a CHP attending the course, someone associated with putting the course on, or a local chapter representative doing it as a service for the CHP's.

14. Q: Will the ABHP/CEP organize or put on courses?

A: Not at this time.

15. Q: Will there always be approved courses at annual meetings?

A: This basically depends on the wishes of the program committee of the HPS. The position of the ABHP is to do everything possible to have a program of continuing education at these meetings.

16. Q: How many continuing education credits may be earned by attending the Annual HPS Meeting?

A: In a typical four year renewal period, if you attended at least three full days of the meeting each year, you could earn 3 X 4 or 12 credits, but only 8 would be accepted by the Board. In addition, assuming the Atlanta meeting to be representative of future meetings, you could earn as many as 4 CEC's at each one by attending specifically approved workshops and refresher courses. This would add up to 4 X 4 or 16 more credits. The grand total, therefore, would be 8 plus 16 or 24 CEC's, so you would not even need the 8 credits you received for conference attendance. Also note that a separate request to the CEP for approval of the conference attendance is not necessary.

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17. Q: Can symposia organized by HPS Chapters qualify for continuing education credit?

A: Yes, as long as they meet the requirements of the ABHP, some of which were discussed in question 2. Also, the ABHP would like to encourage local programs as much as possible.

18. Q: Can I get continuing education credit for preparing and giving a lecture on an advanced health physics topic?

A: No. This sort of activity should be reflected on the professional activities portion of the application. However, if this lecture were part of an organized course which was approved as a whole and you participated as a student in the rest of the course then you could take credit for the whole course.

As a final note please recognize the limitations of the Continuing Education Panel in handling course approval applications for all the CHP's. If your application is more than a few pages (5 at most) please send eight (8) copies. Be concise and be sure the course is adequately described, especially as to the level of the content.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL**

Certificate No	Title	Sponsor/Location	Date	Assigned CEC
77-1	Measurement of Particulates in Air	Annual Meeting, HPS Atlanta, GA	6 Jul 77	1
77-2	Environmental Behavior & Dosimetry of Carbon 14	Annual Meeting, HPS Atlanta, GA	6 Jul 77	1
77-3	Recent Developments in the Application of ALARA to Nuclear Medicine	Annual Meeting, HPS Atlanta, GA	6 Jul 77	1
77-4	Environmental Monitoring at Background Radiation Levels & Statistical Treatment of Data	Annual Meeting, HPS Atlanta, GA	7 Jul 77	1
77-5	Workshop on Recent Advances in Neutron Personnel Monitoring	Annual Meeting, HPS Atlanta, GA	7 Jul 77	1
77-6	Respiratory Protection	Annual Meeting, HPS Atlanta, GA	8 Jul 77	1
77-7	SI Units in Health Physics	Annual Meeting, HPS Atlanta, GA	8 Jul 77	1
77-8	Handling Patients Contaminated with Radioactive Material (Short Course)	Western Occupational Health Conference, Livermore, CA	6 Oct 77	3
* 77-9	In-Place Filter Testing Workshop	Harvard School of Public Health Boston, MA	12-16 Sep 77	19
77-10	New ICRP Internal Emitter Dosimetry (long course)	U.S. Nuclear Regulatory Commission Washington, D. C. 20555	29-30 Aug 77	5
77-11	New ICRP Internal Emitter Dosimetry (short course)	U.S. Nuclear Regulatory Commission Washington, D. C. 20555	31 Aug 77	2

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*Approval is restricted to individual named on application only.

**Courses approved through 1 April 1978. In some cases inconsistencies are apparent in the courses approved to date. As the program develops these should be ironed out.

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC
77-12	Air Sampling	Rio Grande Chapter Albuquerque, NM	27 Oct 77	1
77-13	Human Health Risk - Estimate for Inhaled Alpha Emitters from Nuclear Fuel Cycles	Rio Grand Chapter Albuquerque, NM	28 Oct 77	1
77-14	Development & Operation of a Radiation Safety Program	North Carolina State University Department of Nuclear Engineering	20-24 Feb 78	10
* 77-15	Medical Use of Radionuclides	Baylor College of Medicine Houston, TX	25-29 Jul 77	8
77-16	Not Issued			
77-17	Short Course in Basic Health Physics	Louisiana State University Baton Rouge, LA	12-16 Dec77 8-12 May 78	12
77-18	Nuclear Reactor Safety	Louisian State University Baton Rouge, LA	Jan to May 78	28
77-19	Dosimetry Intercomparison Study	Oak Ridge National Laboratory Oak Ridge, TN	13-22 Jul 77	14
77-20	Electron Linear Accelerators in Radiation Therapy	Amer. Assoc. in Physicists in Medicine - Univ of Col Med Ctr Denver, CO	27-29 78	7
77-21	The Physics of Clinical Nuclear Medicine	Univ of KY (AAPM Summer School)	25-29 Jul 77	10
77-22	Workshop on Personnel Neutron Dosimetry	ERDA Washington, D. C.	11-12 Jul 77	8
77-23	Symposium on Transportation Safety & Accident Experience	East Tennessee & North Carolina Oak Ridge, TN	30 Sep & 1 Oct 77	2

*Approval is restricted to individual named on application only.

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC
77-24	Emergency Care of Radiation Injuries (Symposium)	Connecticut Chapter, HPS New Haven, CT	14 Oct 77	5
* 77-25	Health Physics in Radiation Accidents	Oak Ridge Associated Universities Oak Ridge, TN	24-28 Jan 77	17
77-26	DVSRS Health Physics Training/ Refresher Course	Delaware Valley Society for Radiation Safety Philadelphia, PA	1/17 - 5/23/77	25.
77-27	National Waste Terminal Storage Program Siting Nuclear Facilities	North Carolina Chapter, HPS Raleigh, NC	11-12 Mar 77	2
77-28	Biological Effects of Microwaves	North Carolina Chapter, HPS Raleigh, NC	20-21 May 77	4
77-29	Safety in the Transportation of Radioactive Materials	North Carolina Chapter, HPS Raleigh, NC	30 Sep - 1 Oct 77	2
77-30	Pending			
77-31	Health Physics Certification Review	University of Lowell Lowell, MA	12-16 Jan 78	25

* Approval is restricted to individual named on application only.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC
78-1	Pending			
78-2	Health Physics Certification Course	Georgia Institute of Technology Atlanta, GA	29 May - 9 Jun 78	30
78-3	Current ALARA/ALAP Concepts in Radiation Protection	Brookhaven National Laboratory Upton, NY	17 May 78	4
78-4	Planning for Nuclear Emergencies	Harvard School of Public Health Boston, MA	8-12 [illegible] 78	26
78-5	Environmental Radiation Surveillance	Harvard School of Public Health Boston, MA	5-9 Jun 78	23

American Board Of Health Physics

April 1978

Dear Colleague:

Periodically over the years of its existence, the American Board of Health Physics has given serious consideration to providing certification in specialty areas. In the past, the Board has decided against specialty certification for various reasons:

a. The specialty certification required was in an area which was in the fringe area between health physics and other technical specialties and the Board felt that other credentialing groups were better suited to handle specialties involved.

b. Difficulty in preparing, giving and grading different examinations for different groups.

c. Concern for deleteriously affecting the meaning of the present Board Certification.

d. Cost.

For the past three meetings of the Board, the need for again considering a specialty certification has come before the Board for consideration. The Board is giving serious thought to providing specialty certification in areas where it sees a need for such credentials. The Board would like to share with all existing Certified Health Physicists the thoughts it is considering and to solicit comments from each of you to assist the Board in reaching a decision.

First, the Board must keep in mind that the purpose of its existence is to review the credentials of persons working in the area of health physics, and to formally acknowledge those people who have achieved a level of ability which is recognized by peers in the field as being at a high professional level.

Second, the Board must not take any action which would have a deleterious effect on existing Certified Health Physicists.

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As health physics has matured as a scientific career, the discipline area covered has widened and the amount and depth of material in the many sub-areas of the profession has increased significantly. In many ways, the profession of health physics can be compared to the professions of medicine and engineering. As the years have passed during the growth of each of these professions, individual members have tended to become very expert in narrower portions of the overall profession. This occurs because it becomes humanly impossible to keep up with all the information and developments occurring in the overall profession. Certainly, we all recognize that in the recent years of our careers as health physicists many developments in other areas of health physics are occurring without our being knowledgeable about any more than the generalities involved. The medical and engineering professions have recognized this problem in earlier years of their growth, and have met the problem by providing for recognition of expertise in sub-categories of their professions. The question before the Board is "Is the health physics profession at a similar point in its growth?"

Even if specialty certification is decided upon, the Board plans to continue to offer the present certification test and program. The present certification will continue to recognize the professional with broad, general knowledge in many areas of health physics. The specialty certification will be designed to recognize a professional who has detailed knowledge in fewer areas of health physics but who has in-depth knowledge in a specified area. It is intended that any specialty certification will require knowledge of all basic health physics fundamentals. The Board would hope that if specialty certification becomes available in a given area, that presently certified health physicists who work in that area would seek the specialty certification. Similarly, the Board hopes that as persons with only specialty certification widen their areas of knowledge, they will seek the general certification indicating expertise in many (but unspecified) areas.

Because of the sheer logistics, volunteer effort and [illegible]arting specialty certifications in many areas of health physic[illegible] a[illegible]e time, the Board tends to feel that if specialty certification is offered, it should be offered only as a genuine need is recognized in a given area.

The power reactor health physics area is the area presently being given consideration for specialty certification. The Board feels there is a potential need for specialty certification in power reactor health physics because:

a. This specialty of health physics represents a significant number of individuals occupying professional positions. Presently, there are about 50 Radiation Protection Managers (RPM) at power plants [illegible] approximately 125 additional people in professional hea[illegible]ics positions within the utility industry. In additio[illegible]ere are significant numbers of people in architectural-engineering firms, consulting firms and regulatory groups who are involved full time in power reactor health physics.

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b. Since the number of nuclear power plants is expected to increase significantly, the number of professionals needed in this area will also increase. Paul Ziemer in a study of future personnel needs (Health Physics Society Newsletter, March 1976) predicts that 274 health physics professionals will be needed in the power reactor area by 1980, and 784 by 1990.

c. There are a limited number of individuals having the special qualifications required for these professional positions. As the needs increase, it will become more important for people to be able to demonstrate their capability (or lack of it) in this area.

d. The importance of power reactors as a source of radiation exposure is evidenced by the trend of increasing man-rem per reactor. The need for competent people to help direct the minimization of exposure from this growing source is apparent.

e. The public has shown less than complete confidence in the radiation safety of the nuclear power industry. It is important that persons dealing with the public be knowledgeable and be (or have access to) recognized professionals to help gain the confidence of the public.

f. The Nuclear Regulatory Commission has indicated that it is considering the question of requiring further documentation of capability for filling Radiation Protection Manager (RPM) positions.

g. While the comprehensive knowledge expected of a present Certified Health Physicist is <u>desirable</u>, it is not <u>required</u> for adequate functioning as an RPM in a nuclear power plant.

h. A Certified Health Physicist does not necessarily have the special qualifications and knowledge required by a nuclear power plant RPM without receiving further training and experience. (Thus, the statement on "Professional Responsibilities of Certified Health Physicists" specifies that "The Certified Health Physicist shall represent himself as an authority in only those areas in which he is considered expert by his peers.").

i. Requiring all RPMs to be certified under the present Board program and also have training and experience in nuclear power plant health physics is unrealistic in view of the current and expected near-term availability of such personnel.

If the Board decides to offer specialty certification in the area of power reactor health physics, the Board envisions creating a Power Reactor Specialty Panel of Examiners to determine and evaluate the credentials of potential candidates. Health physicists from power reactors are expected to be well represented on this Panel.

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The question before the Board, and before you, is that, taking all the information presented in this letter into consideration, should the Board proceed with development of a specialty certification in the area of Power Reactor Health Physics? Please give the Board the benefit of your ideas and opinions to help it decide its professional responsibilities in this area. Since the Board plans discussion of this important item at its June 1978 meeting in Minneapolis, it is important that your ideas and suggestions reach me by early June so that they can be organized before the meeting.

Sincerely,

Bryce L. Rich

Bryce Rich
Chairman
American Board of Health Physics

American Board Of Health Physics

CONTINUING EDUCATION PANEL
Armed Forces Radiobiology Research Institute
National Naval Medical Center - Bldg. 42
Bethesda, Maryland 20014

Education Approved for Credit Towards ABHP Certification Renewal

1. The attached list includes all 1978 and 1979 courses approved through 1 February 1979.

2. The list of 1977 courses is available upon request.

3. The list does not include the mid-year topical symposium in the annual HPS conference for which approval has been separately granted.

4. Also not included is the approval for the 1977 IRPA meeting. Approval was granted for attendance at this meeting on the same basis as the HPS meetings and subject to the same 8 continuing education credits limitation. See the 1978 ABHP newsletters for additional details.

5. Assigned credits are based on the information provided by the applicant. Because of differences in detail provided a direct comparison of credits assigned cannot be made since the credits assigned a particular course may not reflect the absolute maximum achievable. This also infers that an individual may be able to obtain more credit for a particular course by submitting a more detailed application after attending the course (but within the 90 day rule). While this latter point may be true it is suggested that the Chairman of the CEP be contacted prior to such a submission in order to avoid unnecessary duplicate applications.

LESTER A. SLABACK, Jr.
Chairman

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC**
78-1	Short Course on Radiation Protection	Institute of Environmental and Industrial Health, Univ of Mich Ann Arbor, MI	1-12 May 78	3
78-2	Health Physics Certification Course	Georgia Institute of Technology Atlanta, GA	29 May-9 Jun 78	SR
78-3	Current ALARA/ALAP Concepts in Radiation Protection	Brookhaven National Laboratory Upton, NY	17 May 78	4
78-4	Planning for Nuclear Emergencies	Harvard School of Public Health Boston, MA	8-12 May 78	SR
78-5	Environmental Radiation Surveillance	Harvard School of Public Health Boston, MA	5-9 Jun 78	SR
78-6	Basic Radiation Protection	Harvard School of Public Health Boston, MA	3-7 Apr 78 11-15 Sep 78	3
78-7	Recent Advances in Health Physics Instrumentation	Los Alamos Scientific Laboratory Los Alamos, NM	7 Apr 78	1
78-8	Short Course in Basic Health Physics	Louisiana State University Baton Rouge, LA	11-15 Dec 78	1
78-9	Effluent & Environmental Radiation Surveillance	American Society for Testing & Materials, Philadelphia, PA	9-14 Jul 78	3
78-10	Radiation Safety for Industrial Radiographers	U.S. Nuclear Regulatory Commission Washington, D. C.	12-15-77, 3-7-78 3-22-78, 4-4-78 4-6-78	3

* Approval is restricted to individual named on application only.

** The above credits are based on the assumption of full participation in all aspects of the program as represented in the application to the CEP/ABHP unless otherwise stated on the approval certificate. Any other type of participation requires separate application to the CEP.

SR Satisfies continuing education requirements for certification renewal.

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COURSES APPROVED BY THE CONTINUING EDUCATION PANEL⁺

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC**
78-11	Summer School on Radiation Protection Dosimetry	Health Physics Society	26-30 Jun 78	SR
78-12	Safety Controls in Reactor Operations	Rensselaer Polytechnic Institute Troy, NY	Annually Spring-Semester 78-79	SR
78-13	Sigma Xi Lecture	Rensselaer Polytechnic Institute Troy, NY	4 Apr 78	1
78-14	Radiological Engineering	Rensselaer Polytechnic Institute Troy, NY	Annually Fall Semester 77-78-79	3
*78-15	Nuclear Engineering Seminar	Rensselaer Polytechnic Institute Troy, NY	Yearly, Fall & Spring Semester 1977-78	6
*78-16	Biomagnetic Effects Workshop	Lawrence Berkeley Laboratory Berkeley, CA	6-7 Apr 78	4
78-17	Annual Conference Meeting	National Conference of Radiation Control Program Directors Little Rock, AR	19-23 Jun 77	3
78-18	Symposium of Short Courses in the State of the Art of the Health Physics	Delaware Valley Health Physics Society Chapter, et al Philadelphia, PA	12 May 78	4
*78-19	Seminar for Industrial Radiographers to Discuss Radiation Safety & NRC Requirements	Region V, USNRC, Walnut Creek, CA	6 Apr 78	3
78-20	Workshop on TLD	East Tennessee Chapter, HPS Oak Ridge, TN	27 Apr 78	2
78-21	Primary Management of Radiation Injury	Radiation Management Corp. Philadelphia, PA	11 Apr 78	3

* Approval is restricted to individual named on application only.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC **
78-22	On-Line Sample Analysis by Gamma Spectrometry	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-23	Review of ICRP 26-Recommendations of the International Commission on Commission on Radiation Protection	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-24	Radioactive Waste Disposal Classifications	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-25	Transportation of Radioactive Materials - A. Review of Current Regulations	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-26	Transportation of Radioactive Materials - B. Hazard Assessments in Urban Environments	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-27	Current Status of Personnel Dosimetry	Continuing Education Courses at Annual HPS Meeting Minneapolis, MN	20-23 Jun 78	1
78-28	Radiation Surveillance	Harvard School of Public Health Boston, MA	13-17 Jun 78	See 78-5
78-29	Radiation Shielding Course	Portland General Electric Co. Portland, OR	15-19 May 78	4
78-30	Laser/Microwave Hazards Course	Health Physics Society, Northern California, Livermore, CA	22 Mar 78	3
78-31	Personnel Monitoring	Greater New York Chapter HPS Columbia Univ., New York, NY	28 Mar 78	1

* Approval is restricted to individual named on application only.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC**
78-32	Health Physics & Radiation Protection	Nuclear Regulatory Commission/Oak Ridge Assoicated Universities Oak Ridge, TN	77-78	8
78-33	Orientation Course in Regulatory Practices & Procedures	Nuclear Regulatory Commission Bethesda, MD	77-78	3
78-34	Inspection Procedures	NRC, Region III	77-78	2
78-35	Course in Medical Use of Radionuclides for State Regulatory Personnel	NRC, Baylor College of Medicine The Methodist Hospital	77-78	3
78-36	Seminar On Calibration of Teletherapy Machines	NRC, Univ. of Texas System Cancer Center, Houston, TX	77-78	3
78-37	Course in Safety Aspects of Industrial Radiography	NRC, Louisiana State University	77-78	1
78-38	Gas & Oil Well Logging for State Regulatory Personnel	NRC, Schlumberger Well Services Houston, TX	77-78	1
*78-39	Envir. Radiation - Sources and Measurement Techniques	Greater New York Chapter, HPS	16 May 78	1
78-40	The Teaching of Medical Physics	AAPM Summer School Course for 78 Univ of California, Los Angeles, CA	23-29 Jul 78	4
*78-41	PWR Fundamentals	U.S.N.R.C. Washington, DC	17-21 Apr 78	4
78-42	Conference of Radiation Control Program Directors	NRC, BRH, State of Pa., etc. Harrisburg, PA	1-4 May 78	4
*78-43	BWR Fundamentals	U.S.N.R.C. Washington, DC	9-13 Jan 78	4

* Approval is restricted to individual named on application only.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC**
78-44	Preparation Course for the ABHP Certification Examination	Baltimore-Washington Health Physics Society	11 Jan-17 May 77	6
*78-45	Preparation Course for the ABHP Certification Examination	Baltimore-Washington Health Physics Society	11 Jan-17 May 78	4
78-46	Innovations in Practical Health Physics Technology & Methods	North Carolina Chapter, HPS Raleigh, NC	5 May 78	2
*78-47	Applications of Reliability & Risk Analysis with Emphasis on Nuclear Power Plants	George Washington University Washington, DC	10-14 Apr 78	4
78-48	5th Intl Symposium on Packaging & Transp of Radioactive Waste	Sandia Corp. Albuquerque, NM	7-12 May 78	6
78-49	Environmental Protection Criteria for Radioactive Waste	EPA Waste Environmental Standards Washington, DC	3/30-4/1/78	1
78-50	BWR/PWR Radwaste	U.S. Nuclear Regulatory Commission Washington, DC	26-30 Jun 78	13
78-51	Not used			
78-52	Medical Management of Radiation Casualties	Yankee Atomic Electric Co. & Peter Bent Brigham Hospital Westborough, MA	13 Oct 78	4
78-53	Basic Radiological Defense Officer Course	University of Lowell Lowell, MA	1978-79	2
78-54	Fall Meeting Nuclear Power	Alabama Chapter of the HPS Muscle Shoals, AL	13-14 Oct 78	2

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COURSES APPROVED BY THE CONTINUING EDUCATION PANEL[+]

Certificate No.	Title	Sponsor/Location	Date	Assigned CEC[**]
78-55	1978 All Agreement State Meeting	U.S. Nuclear Regulatory Commission Washington, DC	3-5 Oct 78	3
78-56	Radiation Emergency Planning	North Carolina Chapter, HPS Chapel Hill, NC	13-14 Oct 78	1
78-57	Nuclear Waste Management	East Tennessee & Atlanta Chapters HPS, Oak Ridge, TN	13-14 Oct 78	1
78-58	Waste Management Contractors	U.S. Nuclear Regulatory Commission Washington, DC	18-20 Sep 78	2
*78-59	Reduced Dose Mammography	Roswell Park Memorial Institute Buffalo, NY	4-6 Oct 78	2
78-60	Basic MORT Seminar	DOE Sys. Saf. Dev. Ctr Clearwater, FL	12/8-15/77 10/16-20/78	3
78-61	Advanced Radiological Defense Officer	Staff College, Defense Civil Preparedness Agency Battle Creek, MI	13-17 Mar 78	5
*78-62	Nuclear Fuel Cycle	Catholic University of America Washington, DC	5 Sep - 13 Dec 78	11

* Approval is restricted to individual named on application only.

COURSES APPROVED BY THE CONTINUING EDUCATION PANEL[+]

Certification No.	Title	Sponsor/Location	Date	Assigned CEC[**]
79-1	Spring Seminar AAPM	Southern California Chapter AAPM Loma Linda University Hospital Loma Linda, CA	23-25 Apr 79	2
79-2	Not used			
*79-3	Medical Oncology MEDI 604M	Foundation for Advanced Education in the Sciences, Inc., National Institutes of Health, Bethesda, MD	2/5-5/25/79	2
79-4	Recent Developments in Applied Health Physics	Health Physics Society Richland, WA	3-4 Feb 79	3
79-5	Short Course on Radiation Protection	The University of Michigan Ann Arbor, MI	1-12 May 78	3
79-6	Microwaves Laser & Ultraviolet Biophysical & Biological Basic Applications & Hazards in Medicine and Industry	Mass. Institute of Technology Cambridge, MA	1978-79 Presentations	9
79-7	Ionizing & Nonionizing Radiation in Medicine Theory - Practice - Protection (Summer Presentation)	Health Physics Society Bethesda, MD	2-6 Jul 79	10
79-8	Application of Optical Instrumentation in Medicine VII	SPIE (BRH So-sponsor) Bellingham, WA	25-27 Mar 79	In review
79-9	Neutrons for Electron Medical Accelerators	NBS, BRH	9-10 Apr 79	In review

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* Approval is restricted to individual named on application only.

AMERICAN BOARD
OF
HEALTH PHYSICS

AMERICAN BOARD OF HEALTH PHYSICS
HISTORY

Shortly after its organization, the Health Physics Society established a Committee to study the need for certification of health physicists and to develop plans for certification if this appeared to be desirable. After an intensive study, the Committee recommended that an American Board of Health Physics be established to develop standards and procedures, to examine candidates, and to issue written proof of certification to individuals who have satisfied the requirements established by the Board. The Board of Directors of the Society decided that these recommendations had merit and appointed a temporary American Board of Health Physics on November 8, 1958.

The temporary ABHP developed a set of minimum requirements for certification after carefully reviewing the professional background of 100 selected individuals believed to be representative of those recognized as competent health physicists. These minimum requirements were submitted to the membership of the Society for comment. At the Society's Annual Meeting in June 1959, the matter was discussed in an open meeting and there was general support for the plan. The Board of Directors of the Society formally established the American Board of Health Physics by approving an amendment to the By-Laws of the Society on October 29, 1959.

The ABHP was incorporated in the State of New York on December 1, 1960. Provision was made for organizations other than the Health Physics Society to be represented on the Board.

The Board has seven members. Five are sponsored by the Health Physics Society, one by the American Association of Physicists in Medicine, and one by the American Public Health Association. Each member serves a 5-year term.

An Examination Panel consisting of Certified Health Physicists appointed by the Board prepares, administers, and grades the written certification examination under the guidance and approval of the Board.

PURPOSES OF THE BOARD

First: To elevate the standards and advance the profession of health physics by encouraging its study and improving its practice.

Second: To encourage and insist on the highest standards of professional ethics and integrity in the practice of health physics.

Third: To determine the competence of specialists in health physics and to arrange, control, and conduct investigations and examinations to test the qualifications of voluntary candidates for certificates to be issued by the Board.

Fourth: To grant and issue certificates in the field of health physics to voluntary applicants and to maintain a registry of holders of such certificates.

MEANING OF CERTIFICATION

The certificate indicates that its holder has completed certain requirements of study and professional experience, which the Board considers to constitute an adequate foundation in health physics and has passed an examination designed to test his competence in this field.

It should be recognized that the certificate awarded by the Board is not a license and, therefore, does not confer a legal qualification to practice health physics.

PROFESSIONAL RESPONSIBILITIES OF CERTIFIED HEALTH PHYSICISTS

In achieving certification, the Certified Health Physicist recognizes and assumes responsibilities due the profession of health physics.

In order to maintain his technical competence, the Certified Health Physicist has a commitment to remain active in the field of health physics and acquainted with the scientific, technical and regulatory developments in his field.

In order to uphold the professional integrity of health physics implied in this certification, his relations with others, including clients, colleagues, governmental agencies, and the general public shall always be based upon and reflect the highest standards of professional ethics and integrity.

The Certified Health Physicist shall represent himself as an authority only in those areas in which he is considered expert by his peers.

GENERAL REQUIREMENTS

Requirements for Candidates for certification are as follows:

1. ACADEMIC. The Applicant must have a Bachelor's Degree in a physical science or in a biological science with a minor in physical science. In exceptional cases, persons who have demonstrated adequate knowledge of health physics but who are deficient in these academic requirements may, at the discretion of the Board, be permitted to substitute experience for academic requirements.

2. EXPERIENCE. An applicant must have at least six years of FTE (full-time equivalent) professional experience in health physics. At least three years of the experience must have been in applied radiation protection work. Additional education may be substituted for up to a maximum of 2½ years of experience as follows:

Type of Study	**Years of study or degree**	**Equivalent credit for experience**
General—related to HP	1	½
General—related to HP	2 or MS	1
General—related to HP	PhD	2
Health Physics	1	1
Health Physics	2 or MS	1½
Health Physics	PhD or ScD	2½

An applicant may not claim professional experience for an advanced degree and work experience for the same period. For example, if an applicant attends night school for 4 years resulting in an MS degree and during the same period he is employed as a health physicist, he may claim four years professional experience, but may not claim an additional year of experience for his MS.

3. PROFESSIONAL. Each applicant must be engaged in the professional practice of health physics a substantial portion of his time. Reference statements are required from the applicant's supervisor (if appropriate)

and from at least two other individuals who are professionally qualified to evaluate the applicant's ability in health physics. It is recommended (but not required) that at least one reference be a health physicist already certified by the ABHP.

4. WRITTEN REPORT. The Board, after examination of the application for certification, may request reports on radiation protection evaluations made personally by or under the supervision of the applicant. Each applicant must be capable of making a satisfactory evaluation on several installations or operations involving possible radiation hazards of which those listed below are examples:

   a. Radiographic installation—industrial medical
   b. Fluoroscopic installation
   c. Therapy installation
   d. Radionuclide laboratory
   e. Air and water sampling and environmental survey
   f. Nuclear fuel processing plant
   g. Nuclear reactor
   h. Major decontamination operation
   i. Particle accelerator

5. EXAMINATION. Written examinations will be mandatory; oral examinations will be at the discretion of the Board. The written examination has two parts. Part I determines competence of the applicant in fundamental aspects of health physics and Part II determines his competence in practical health physics topics. The examination must be taken within two years of notification of eligibility, or a new application must be submitted.

EARLY ADMISSION TO WRITTEN EXAMINATION

Applicants are permitted to take Part I of the written examination if they have fulfilled the academic requirements for the MS Degree in Radiation Safety or have two years of professional experience at the time of the examination. Applicants must meet all the requirements listed in the preceding section before being admitted to Part II.

The purpose of early admission to Part I of the examination is two-fold: (1) to allow the recent graduate an opportunity to demonstrate his competence in the fundamentals of health physics at the beginning of his career, and (2) to encourage younger health physicists to proceed toward certification. Applicants who successfully complete this step in the examination procedure will be required to take only Part II of the written examination when they later apply for regular certification.

APPLICATION AND FEE

Application for examination must be made on the prescribed form which is available from the Chairman. Applications should be filed with the Chairman at least two months before the date of the examination. Certification fees are as follows:

Certification Step	**Fee**
Application to take Part I of written examination	$50
Application for Regular Examination to take Parts I and II of the written examination together	$100
Application to take Part II of written examination only	$50
Charge for certification plaque	$15

Re-examination fees following failure of the exam are the same as the original application fee schedule above.

*Effective January 1, 1977.

EXAMINATIONS

Examinations are usually given once a year—at the time of the Annual Meeting of the Health Physics Society. They are held at the location of the Society's meeting and at other selected locations where the demand warrants.

Permits are required for entry into the examination room. No reference material may be brought into the room.

RE-EXAMINATIONS

A candidate who fails his first examination may be admitted to a second examination after one year. A candidate who fails to appear for re-examination within two years must submit a new application.

After a second failure, a new application must be filed. The candidate must also submit evidence of substantial additional study before he may take the examination for the third time.

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FINAL ACTION OF THE BOARD

The final action of the Board is based on its evaluation of the applicant's total professional record, i.e., his training and experience, the achievements he has obtained in health physics and related fields, the maturity of his judgment, and the ethical nature of his professional conduct as indicated by his associates and peers, and often the results of oral interviews as well as the written examinations. Anyone meeting the education and experience requirements and who is practicing health physics in a competent and ethical manner is strongly urged to apply to the Board for admission to the written examination. Although satisfactory performance on the written examination is a necessary but not a sufficient requirement, persons who are admitted to and who perform well on the examination usually receive certification by the Board.

REVOCATION OF CERTIFICATE

Certificates may be revoked for actions considered by the Board to be in violation of the statement "Professional Responsibilities of Certified Health Physicists." Any person for whom such action is contemplated shall have the right of appearance before the Board.

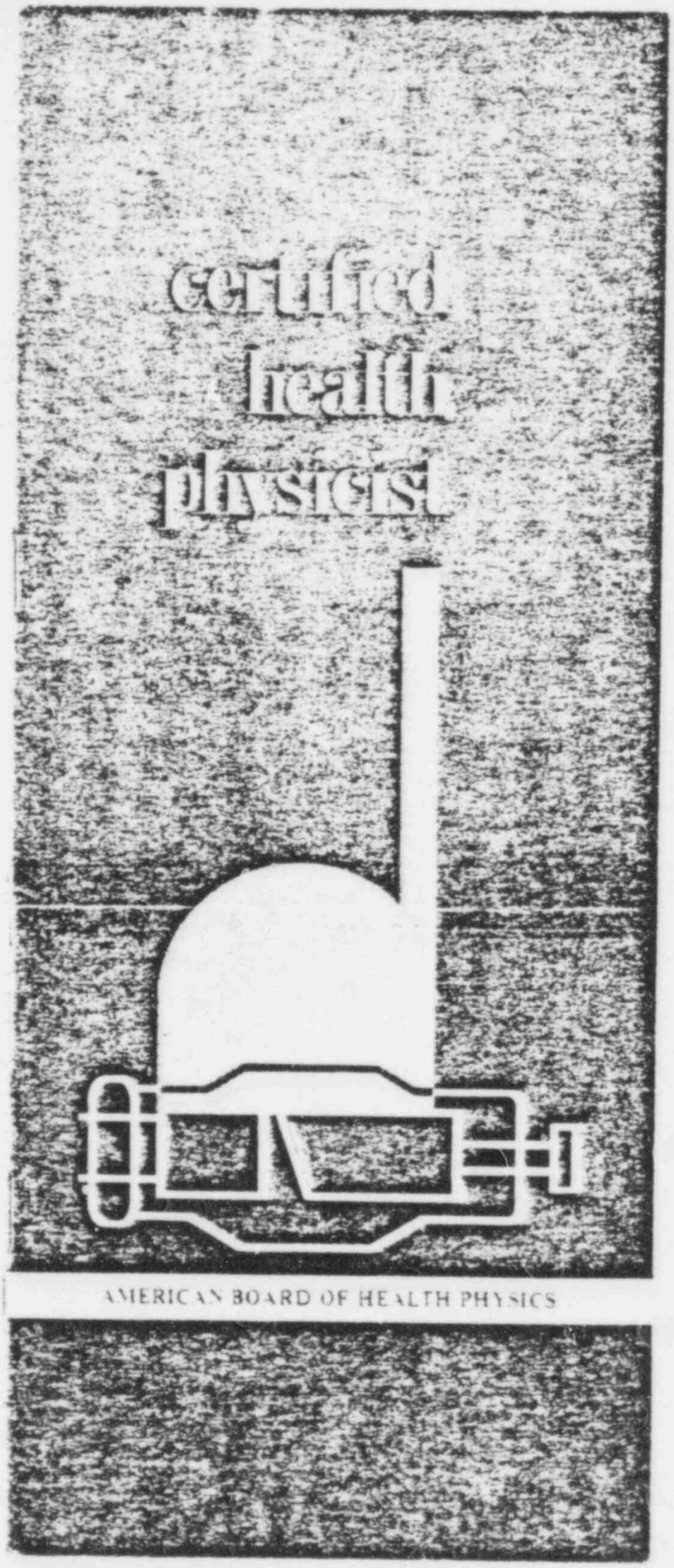
CHANGE IN REQUIREMENT

Current requirements, procedures, and fees of the American Board of Health Physics are described in this brochure. These are subject to change without notice; however, changes will be published before their effective date whenever practical. No changes will be retroactive.

CORRESPONDENCE

All correspondence to the American Board of Health Physics should be sent to:

Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, Maryland 20857



certified health physicist

AMERICAN BOARD OF HEALTH PHYSICS

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"Certified Health Physicist" is a professional title. It is a recognition of professional competence conferred by the American Board of Health Physics, an organization founded in 1960 to establish standards of education, experience and competence in the practice of health physics. The certificate indicates that its holder has completed certain requirements of study and professional experience which the Board considers to constitute an adequate foundation in health physics*, and that he has passed a comprehensive examination designed to test his competence in this field.

The Certified Health Physicist today is ably assisting government and industry, and the research and health professions in achieving the maximum benefits of the nuclear age with a record of safety that is unsurpassed. With the

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*Requirements for application for certification include a bachelor's degree in science and/or engineering and six years of responsible professional experience in health physics.

commitment of the nation to nuclear energy for electrical power production, and with the increased use of radiation producing equipment in medicine and industry the role of the Certified H.P. takes on new and greater significance. The industry and indeed the general public, expects nothing less than the high standard of safety that the nuclear field has enjoyed to date. Certified Health Physicists are already applying their expertise to meet this necessary objective both effectively and economically.

Recognizing the demonstrated professional competence of CHP's government agencies, industry and other organizations require Certified Health Physicists in certain key radiation protection positions.

Within their commitment to keep radiation doses to employees and the public as low as practicable, CHP's provide the following services:

Radiation Safety Analyses

Perform analyses on new or existing facilities to determine and minimize their impact on employee radiation dose and the public health and safety.

Monitoring Programs

Continually assess the adequacy of radiation protection control facilities and procedures, by thorough monitoring programs as part of the facility operation.

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Shielding and Containment

Designs to protect personnel and the general public from radiation exposure and the disposal of radioactive materials.

Dosimetry

Detect, evaluate and control radiation exposures from external sources through portable and fixed radiation detection devices and to detect, evaluate and control radiation doses from internal sources through calculations based on bioassay analyses and whole body counters.

Instrumentation

Select, calibrate, and interpret results from:

1. effluent monitors for liquid and gaseous wastes
2. portable survey meters
3. laboratory detectors, ranging from surface contamination counters to multi-channel spectrometers
4. area monitors for direct radiation and airborne radioactive materials

Plans and Procedures

Develop and keep current the plans and procedures necessary to control on-and off-site exposures.

Emergency Planning

Participate in and guide the development of appropriate plans to minimize the consequences of radiation accidents.

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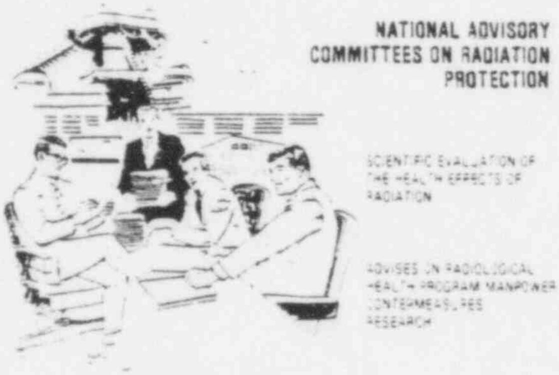
POOR ORIGINAL

Environmental Evaluation

Design and carry out sampling and analytical programs to detect minute levels of all radionuclides in the environs of nuclear facilities (flora, fauna, soil, water, air). Evaluate the possible short and long-term consequences to man and his environment from these levels or postulated levels.



Waste Management

Programs to control releases of radioactivity and ensure the safe storage of radioactive wastes.

Manage Regulatory Programs

At all levels within government and industry to ensure compliance with Federal, State and local regulations.

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Educational Programs

Provide general and specific training or orientation in all aspects of radiation safety.

TRAINING

A Certified Health Physicist on your staff or as a consultant will provide a competent and professional approach to radiation protection and control problems. For a Registry of Certified Health Physicists or further information, please write to the Chairman of the American Board of Health Physics.

Michael S. Terpilak, Chairman
American Board of Health Physics
HEW, PHS, FDA, BRH (HFX-460)
12720 Twinbrook Parkway
Rockville, MD 20857

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AN INSIDE VIEW OF
AMERICAN BOARD OF HEALTH PHYSICS PROGRAMS
REPORT ON
AMERICAN BOARD OF HEALTH PHYSICS EXAMINATION PROGRAM
PART I
1968 - 1975

by

Mr. Michael S. Terpilak

For Presentation at the
Twentieth Anniversary Meeting
of the
Health Physics Society
July 16, 1975
Buffalo, New York

American Board of Health Physics
Chairman, Panel of Examiners
c/o Bureau of Radiological Health
12720 Twinbrook Parkway
Rockville, Maryland 20852

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Report on
American Board of Health Physics
Examination Program
1968 - 1975

Background - Nature of Program

In the Spring of 1968, the Panel of Examiners, American Board of Health Physics (ABHP), under Contract No. PH 128-68-1 with the U. S. Public Health Service, Department of Health, Education, and Welfare, in cooperation with the Professional Examination Service (PES) developed a multiple-choice examination for use in certifying health physicists. This contract was supported by the National Center for Radiological Health as a part of the Center's responsibility in assuring that those individuals that carry out radiation protection activities are adequately qualified. This was the first time the ABHP used multiple-choice questions in its qualifying examination which previously consisted entirely of essay questions, presented in two parts. The decision of the Panel of Examiners to use an objective, multiple-choice test was based upon the difficulty and unreliability of scoring essay examinations and the cumbersome and time-consuming procedures required. The Panel felt, however, that the essay form of examination should be retained, at least in part, to enable candidates to identify the specific steps followed in answering the questions. It was therefore decided that Part I, the multiple-choice part of the test, would cover the fundamentals of health physics and represent a general body of informational knowledge, and Part II, the essay test would involve more specialized problems in health physics.

Examination Development

The first meeting of the ABHP Panel of Examiners and the staff of the Professional Examination Service was held on February 20 and 21, 1968. The task of the Panel was to prepare and outline the subject-matter areas to be included in Part I of the Written Examination and to select appropriate test questions from the PES file of questions in radiological health. It was decided that 150 test questions would most effectively satisfy the limitations of time and the demands of adequate coverage. The Part I Written Examination developed consisted of questions assigned to the following areas:

Content Area	Number of Questions
I. Fundamentals	50
II. Measurement	30
III. Occupational Health Physics Problems	25
IV. Non-occupational Health Physics Problems	25
V. Health Physics Administration	20

The examination was so constructed that four scores could be obtained: (a) a total score based on 150 questions; (b) a subscore based on the 50 questions in Section I; (c) a subscore based on the 30 questions in Section II; (d) a subscore based on the 70 questions in Section III, IV, and V combined.

A manual of instructions was prepared to guide proctors in administering the test.

The first examination was administered on June 17, 1968 to 68 candidates qualified for regular certification by the ABHP and to 15 candidates qualified under an associate program for persons lacking the experience requirement for regular certification.

Item Development

The ABHP established its own bank of examination questions which has been expanded by periodically soliciting new questions from health physicists previously certified by the Board. Question writers are provided with instructions describing the kinds of questions used in the examination. The new questions are screened and classified by subject-matter consultants and by test specialists on the PES staff to ensure content accuracy and relevancy and conformance and psychometric principles. They are then sent to panels of three experts in the field for independent subject-matter review. The reviewers' comments are used by the subject-matter consultants and test editors in the final review of each question. The questions are then submitted to the Panel of Examiners for final approval. Acceptable questions are included in the ABHP file from which the Panel of Examiners select questions for inclusion in each revision of the test.

Since the beginning of the ABHP program in 1968, 65 health physicists have contributed some 400 questions for the examination and these questions have been reviewed by 36 certified specialists in the field.

On-Going Examination Development

To assist the ABHP in up-dating and maintaining the initial examination, Federal funding continued through 1971. This support provided for the analysis of the test results; a correlation study between scores on Part I, the multiple-choice examination, and Part II, the essay examination, administered in 1968; solicitation of new questions and the establishment of the Board's own bank of questions; revision of the examination, and the administration of the examinations. Over the four-year period, (1968-1971) government contracts were awarded PES totaling $29,073.00 for the development of ABHP examination materials as follows:

1968	$ 4,918.00	(PH 128-68-1)
1969	8,355.00	(CPE-R-69-17)
1970	8,000.00	(CPE-R-70,0018)
1971	7,800.00	(68-05-0002)

Since 1971, the ABPH Part I-Written Examination program has been supported by the Board and voluntary subscriptions from certified health physicists. The examination is reviewed annually by members of the Panel of Examiners to maintain the quality and relevance of the Examination, and insure that it covers up-to-date concepts. Revisions are made in the examination by rewording questions or replacing questions on the basis of subject-matter considerations and in conjunction with item analyses. The examination subject-matter outline was revised in 1973 to reflect more accurately the actual test content, and presently has the following content distribution:

Area	Number of Questions
Fundamentals	50
Measurement	30
Operational Health Physics	70

Examination Scores

The candidates' marked answer sheets are scored by PES and a report of the results is forwarded to the Board. The score reports present (1) a listing of the raw scores obtained by each candidate for the total test and for each of the three subtests, (2) statistical data based on the group of candidates tested, and additional interpretive information to help the Board evaluate the candidates' performance, including a comparison of the results of the test from year to year and comparison of the difficulty level of the subtests and total test between each of the years that the examination has been administered.

Examination Usage

The examination has been administered to a total of 445 candidates from 1968 through 1974.

Professional Examination Service
American Board of Health Physics

	Maximum Raw Scores	Range of Raw Scores	Standard Deviations	Average Raw Scores	Average Percent Scores
66 Candidates - 1974					
Total	150	48 - 128	18.86	94.03	62.69
Fundamentals	50	14 - 47	7.85	32.88	65.76
Measurement	30	6 - 27	4.70	17.74	59.14
Operational Health Physics	70	19 - 63	8.84	43.41	62.01
34 Candidates - 1973					
Total	150	46 - 130	18.94	97.18	64.78
Fundamentals	50	20 - 45	6.66	34.44	66.88
Measurement	30	9 - 27	4.73	19.71	65.69
Operational Health Physics	70	16 - 60	9.33	43.03	61.47
78 Candidates - 1972					
Total	150	45 - 125	18.00	87.47	58.32
Fundamentals	50	8 - 42	7.33	29.01	58.03
Measurement	30	7 - 28	4.67	17.82	59.40
Problems and Admin.	70	20 - 60	8.51	40.64	58.06
45 Candidates - 1971					
Total	150	51 - 125	18.23	87.36	58.24
Fundamentals	50	17 - 44	7.13	30.13	60.27
Measurement	30	9 - 27	4.85	17.73	59.11
Problems and Admin.	70	20 - 60	9.19	39.49	56.41
74 Candidates - 1970					
Total	150	40 - 129	17.23	96.28	64.09
Fundamentals	50	13 - 46	6.94	33.76	67.52
Measurement	30	7 - 28	4.32	18.68	62.27
Problems and Admin.	70	9 - 59	8.58	43.85	62.64

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Professional Examination Service
American Board of Health Physics

	Maximum Raw Scores	Range of Raw Scores	Standard Deviations	Average Raw Scores	Average Percent Scores
63 Candidates - 1969					
Total	150	50 - 128	18.18	96.81	64.54
Fundamentals	50	15 - 46	7.12	33.76	67.52
Measurement	30	9 - 28	4.43	18.68	62.27
Problems and Admin.	70	10 - 60	9.10	44.37	63.30
67 Candidates - 1968					
Total	150	55 - 137	16.13	103.55	69.03
Fundamentals	50	20 - 48	5.91	37.69	75.38
Measurement	30	9 - 29	4.00	21.85	72.83
Problems and Admin.	70	14 - 62	8.03	44.01	62.87

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program.

(1) Complete set of application and handout materials required of prospective candidates in order to quality for the ABHP Certification Examination.

(2) American Board of Health Physics Item Classification Scheme.

(3) ABHP Examination Preparation Guide, 1979, with addendum for Power Reactor Health Physics Specialty Examination.

(4) American Board of Health Physics Board and Panel Members.

(5) Draft copy of proposed American Board of Health Physics Brochure (including the Power Reactor Health Physics Specialty).

(6) The ABHP Continuing Certification Program.

(7) Paper entitled "An Inside View of the American Board of Health Physics Programs Report on ABHP Examination Program Part I 1968-1975," Michael S. Terpilak, Health Physics Society Meeting, July 16, 1975, Buffalo, New York.

The Board certainly hopes that these comments will be useful to the NRC and appreciates the opportunity to comment on this proposal.

Michael Terpilak
Michael S. Terpilak
Chairman, ABHP

H. An individual with comprehensive health physics certification does not necessarily have the special qualifications and knowledge required by a nuclear power plant RPM without receiving further training and experience. The specialty certified HP will necessarily have these prerequisites.

I. Requiring that all RPMs hold comprehensive health physics certification and also have training and experience in nuclear power plant health physics is unrealistic in view of the current and expected near-term availability of such personnel.

The Board realizes that offering specialty certification presents some possible problems. In the past, it decided against specialty certification for various reasons, some of which are listed as follows:

A. The specialty certification being considered was in a fringe area between health physics and other technical specialties and the Board felt that other credentialing groups were better suited to handle these situations.

B. There is great difficulty and effort in preparing, giving, and grading different examinations for various groups.

C. The Board is concerned about adversely affecting the value and meaning of the present comprehensive health physics certification program.

D. Resources and Cost.

The above considerations notwithstanding, the Board concluded that the potential benefits and contributions to the health physics profession and the health physics certification program would outweigh the problems which the offering of specialty certification in power reactor health might create.

By granting comprehensive health physics certification, the Board recognizes the professional with a broad, general knowledge in many areas of health physics. With specialty certification in power reactor health physics, the Board will recognize the professional who has detailed knowledge of power reactor health physics. However, any specialty certification will require knowledge of all health physics fundamentals. The Board hopes that if specialty certification becomes available in a given area, certified health physicists working in that area will seek specialty certification. Conversely, the Board hopes that health physicists with only a specialty certification will broaden their areas of knowledge, and seek comprehensive certification.

Also enclosed is a copy of the ABHP November 1978 newsletter which details the "Power Reactor Health Physics Certification Program" (Enclosure 4).

The Board would also like to submit the following information and documentation to the NRC dealing with the current ABHP certification any possible future specialty areas, an individual with comprehensive health physics certification will automatically be eligible for the specialty certification if the individual has the requisite experience.

As discussed previously, the American Board of Health Physics has decided to offer specialty certification in power reactor health physics. The Board made this decision for the following reasons:

A. Power reactor health physics represents a significant number of professionals. Presently, there are about 50 radiation protection managers (RPM) at power plants and about 125 additional health physics professionals within the utility industry. In addition, significant numbers of people in architect/engineering firms, consulting firms, and regulatory groups are involved full time in power reactor health physics.

B. Because the number of nuclear power plants is expected to increase significantly, the number of professionals needed in this area will also increase. Paul Ziemer, in a study of future personnel needs (Health Physics Society Newsletter, March 1976 (Enclosure 2), predicts that 274 health physics professionals will be needed in the power reactor area by 1980 and 784 by 1990. A reprint from Health Physics, November 1978, entitled "Health Physics Manpower in the Atomic Energy Field," 1968-2000 is also enclosed (Enclosure 3).

C. A limited number of individuals have the special qualifications required for these professional positions. As the need increases, it will become more important to insure that these critical positions are filled by persons with demonstrated capability in power reactor health physics. The specialty certification offers one mechanism for providing this assurance.

D. The importance of power reactors as a source of occupational radiation dose is evidenced by the trend of increasing person-rem per reactor. The need for competent people to minimize exposure from this source is apparent.

E. The public has shown less than complete confidence in the radiation safety of the nuclear power industry. It is important that persons dealing with the public be knowledgeable and be recognized professionals in order to gain the confidence of the public.

F. The Nuclear Regulatory Commission has indicated that it has under consideration a requirement for further documentation of capability for individuals who are designated to radiation protection manager (RPM) positions.

G. While the broad knowledge implied by a comprehensive health physics certification is desirable, it is not required for adequate functioning as a RPM in a nuclear power plant. The specialty certification will be of more obvious and direct relevance.