NUCLEAR REACTOR LABORATORY
AN INTERDEPARTMENTAL CENTER OF
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

O.K. HARLING
Director

138 Albany Street, Cambridge, Mass. 02139
Telefax No. (617)253-7300
Telex No. 92-1473 MIT CAM
Tel. No. (617) 253-4202

J.A. BERNARD, JR.
Director of Reactor Operations

March 10, 1992

U.S. Nuclear Regulatory Commission,
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Generation of Medical Therapy Facility Beam for Human Therapy, License No. R-37, Docket No. 50-20

Gentlemen:

The Massachusetts Institute of Technology hereby submits an application to amend its Facility Operating License No. R-37. The requested amendment concerns the generation of the MIT Research Reactor's Medical Therapy Facility beam for human therapy. This amendment is submitted at the request of the U.S. Nuclear Regulatory Commission and reflects previous discussions and correspondence between MIT and NRC. It is requested that this amendment be given your immediate attention so as not to delay human therapy trials which are scheduled to begin late in the second quarter of 1992. Also enclosed, per NRC request, is a 'Quality Management Program' that addresses the generation of the medical therapy facility beam. This is a related item for approval but it is not part of the aforementioned requested amendment to the operating license.

This request has been reviewed and approved by the MIT Reactor Safeguards Committee.

Sincerely,

John A. Bernard, Ph.D.
Director of Reactor Operations
MIT Research Reactor

JAB/gw

Enclosures: Safety Reviews #0-91-17 and #0-92-3.

cc: MITRSC (with enclosures)

USNRC - Project Manager,
NRR/PDNP

USNRC - Region I - Chief,
Effluents Radiation Protection Section (ERPS)
FRSSB/DRSS

USNRC - Region I - Project Scientist,
Effluents Radiation Protection Section (ERPS)
FRSSB/DRSS

USNRC - Director,
NRR/PDNP

A020

Safety Review Form No. 0-91-17

Item: Technical Specification #6.5, "Generation of Medical Therapy Facility Beam for Human Therapy"

Submitted by J. Bernard Date 30 Sept. 1991

Q/A number if required M-92-4

Does the item change or contradict the

Technical Specifications? X Yes* ____ No

SAR? ____ Yes* X No

* Attach explanation

Description of Change (Attach extra pages if necessary):

See attached sheet.

Safety Evaluation (Attach extra pages if necessary):

See attached sheet.

Summary of Review:

a) Does the proposal:	Yes	No
i) involve an unreviewed safety question (10CFR50.59(a)(2))	___	X
ii) decrease scope of requalification program (10CFR50.54(i-1))	___	X
iii) decrease effectiveness of security plan (10CFR50.54(p))	___	X
iv) decrease effectiveness of emergency plan (10CFR50.54(q))	___	X

b) Reviewer's Comments:

NRC ____ Date ____

MITRSC [illegible] Date 11/25/91

MIT RPO [illegible] Date 3-6-92

Recommend Approval ✓ Yes ____ No

Reviewer [signature] Date 03/06/92

Reviewer [signature] Date 3/6/92

Approved [signature] Date 3.6.92
(Director of Reactor Operations)

10CFR50.59 & 50.54(p and q) changes logged for reporting to NRC, Date ____

Copy to Director for Operations
Copies circulated to and initialled by all Licensed Personnel
Original to Safety Review File

Unreviewed Safety Question (URSQ) Determination

for SR#-0-91-17

This safety review establishes a new technical specification that delineates design and procedural practices regarding the MIT Research Reactor's medical therapy facility beam. This new specification does not alter or in any way impact any existing technical specification and/or its basis. No safety issue or unreviewed safety question has been found to exist. The basis for this negative finding is documented below as required by 10 CFR 50.59(b).

(a) The change does not meet any of the three criteria that define an URSQ. This is shown below:

- No increase in probability or consequences of an analyzed accident because the new technical specification is a concise compilation of design and procedural practices regarding the medical therapy facility beam.

- No new type of accidents are created.

- No margin of safety is reduced, again because the change is only to summarize design features and operational practices in a concise format.

Safety Review No. 0-91-17

Technical Specification #6.5 – Generation of Medical Therapy Facility Beam for Human Therapy

Description of Change

A new Technical Specification, #6.5, is created that addresses the generation of the MIT Research Reactor's medical therapy facility's beam for human therapy. This specification was prepared at the request of the U.S. Nuclear Regulatory Commission as specified in the letter of 02/19/92 from S.H. Weiss, Director Non-Power Reactors, Decommissioning and Environmental Project Directorate, to O.K. Harling, Director MIT Nuclear Reactor Laboratory. That letter listed eight specific items for which information was requested. Seven of these are contained in the proposed technical specification. The eighth, which concerned FDA requirements, is provided as an item of information. A summary of MIT's response to these eight items is given in the 'safety analysis' section of the enclosed safety review.

The use of beams from research reactors to treat patients is not addressed in any detail in the Code of Federal Regulations. The most relevant material is to be found in Subpart I, 'Teletherapy' of 10 CFR 35, "Medical Use of Byproduct Material." This safety review is structured so as to show the relation between the new MITR Technical Specification and the relevant provisions of 10 CFR 35. However, it is important to recognize that a one-to-one correspondence would not be appropriate. Subpart I concerns the use of Co-60 or Cs-137 sources for medical use. MITR Technical Specification #6.5 addresses the use of a research reactor to produce a beam of radiation. There are many differences between an operating reactor and an installed gamma radiation source. These include:

(a) The reactor can be shut down or scrammed thereby greatly reducing the beam. This feature makes use of a research reactor to produce a beam far less hazardous than the use of a sealed gamma source. Radiation from the latter can only be halted by the use of shields. In contrast, the intensity of the reactor's beam can be greatly reduced either with shutters or by a shutdown action.

(b) The reactor is heavily regulated and has NRC-approved quality assurance, training, and radiation protection programs in place.

(c) The Reactor Staff is committed under the provisions of the reactor's operating license to report any instance of non-compliance with its technical specifications. In contrast, medical licensees are only required to report those items that are listed in 10 CFR 35 as being reportable.

Each provision of Technical Specification #6.5 is listed below together with a reference to the relevant requirement of either Subpart I of 10 CFR 35, 10 CFR 35.33, or 10 CFR 35.2. Whenever a match is not appropriate, the reason for it is listed as reactor-specific (R/S).

10 CFR 35		Technical Specification #6.5
R/S	–	Patients are accepted only in accordance with a written directive from NRC Medical Use Licensee No. 20-03857-06, which is licensed by NRC for use of the MIT Research Reactor's Medical Therapy Facility beam, or from any other medical use licensee that has been similarly authorized by NRC to utilize the MIT Research Reactor's Medical Therapy Facility beam for human therapy.
R/S	–	Delineates division of responsibility between MIT and the referring medical licensee. Also, establishes both the authority and protocol for initiating and terminating a radiation therapy.
R/S	–	Provision to scram the reactor thereby greatly reducing the beam as a source of radiation.
35.615(a) Access Control	–	Provision (4) of the specification.
35.615(b) Interlocks	–	Provision (5) of the specification. Subprovisions (a) and (b) of the specification correspond to subclauses (b(1)) and (b(2)) of 10 CFR 35.615. Subclause (b(3)) is not applicable because there is no 'reset' for a reactor beam. Subprovisions (c) and (d) of the technical specification impose design requirements on the shutters that are more conservative than Part 35.
35.615(c) Indicator Lights	–	Provision (6) of the specification.
35.615(d) Radiation Monitor	–	Provision (7) of the specification. Subclauses (1), (2), (3), and (5) of 10 CFR 35.615(d) are directly addressed in the subprovisions of the specification. Subclauses (4) and (6) are not so addressed because these items are covered as part of the MIT Research Reactor's radiation protection and maintenance programs.
R/S	–	Provision (8) of the specification establishes a means for two-way communication between personnel at the medical therapy facility's local control panel and the reactor operator stationed at the reactor control room console.

R/S	–	Provision (9) of the specification imposes requirement for manual opening of the door to the medical therapy facility. This requirement is necessary because the door also acts as a shield and is specially-designed so as to be movable without electric power.
35.615(e) Patient Observation	–	Provision (10) of the specification.
35.2 Clauses 4(iii) and 4(iv) of Definition of Misadministration	–	Provision (11) of the specification establishes criteria for the accuracy of the radiation fluence delivered by the medical therapy facility beam. The exposure of the boronated cancer cells in the patient's tumor to this fluence will have the desired medical effect. This provision represents another difference between the use of a reactor beam and a sealed source for medical therapy. The reactor treatment is a two-step process involving delivery of a fluence and a subsequent nuclear reaction in the tumor based on the boron concentration in tissue. It is this nuclear reaction that generates a major portion of the dose. In contrast, the use of a sealed source is a one-step process with the dose in the tumor being that delivered by the source. Provision (11) was inserted in the specification to establish allowable limits on the delivered radiation fluence. Issues of mis-administration and recordable events as they concern generation of the medical therapy facility beam are delineated in definitions (7) and (8) of this specification.
R/S	–	Provision (12) of the specification establishes criteria for the testing of all interlocks and channels. (Note: Testing of the radiation monitor is addressed separately in provision 7(b)).
R/S	–	Provision (13) of the specification establishes criteria for testing the manual operation of the facility's shield door.
35.632 / 35.634	–	Provision (14) of the specification specifies frequencies for full characterization and calibration checks of the beam. These terms, which are defined in the specifications, correspond roughly to the words 'full calibration measurements' and 'periodic spot-checks' in 10 CFR 35.632 and 35.634 respectively. However, there are major differences. A sealed source provides one type of radiation. The reactor beam has fast

neutron, thermal neutron, and gamma components. While the reactor beam has many components, its characteristics correlate with the reactor's power level making it relatively easy to reproduce from day to day. It should be recognized that the criteria listed in 10 CFR 35.632 and 10 CFR 35.634 are specific to sealed sources and can not be applied directly to a reactor-produced beam.

35.605 – Provision (15) of the specification provides for the proper supervision of all maintenance and repair activities. As such, it fulfills the same function as 10 CFR 35.605.

35.610 – Provision (16) of the specification provides for the training of non-licensed personnel to operate the medical therapy facility beam. Also, it provides for the posting of instructions to be followed in the event of an abnormality. This provision is similar in many respects to 10 CFR 35.610.

35.33 – Provision (17) of the specification provides for the recording of 'recordable events' and the reporting of 'misadministrations.'

35.2 Misadministration – Definition (7).

35.2 Recordable Event – Definition (8).

35.2 Written Directive – Definition (9).

Safety Analysis

The issuance of Technical Specification #6.5 will have no impact on reactor safety because it does not entail any design or procedural changes to the reactor or its operation. Rather it delineates design requirements and operational practices for the medical therapy facility beam. Similarly, its issuance will have no effect on patient safety because the provisions in Technical Specification #6.5 that pertain to patient treatment are already contained in various medical protocols.

The significance of Technical Specification #6.5 is that it provides a concise summary of the various requirements that are to be observed in the generation of a reactor-produced beam to treat patients. This is, of course, the principal purpose of a technical specification. Namely, relevant material is culled from the reactor's safety analysis report and other pertinent documents to provide a set of readily implementable criteria for operation of the facility.

In its letter of 02/19/92 from S.H. Weiss to O.K. Harling, the U.S. Nuclear Regulatory Commission requested that MIT "submit an amendment to NRC Facility

Operating License No. R-37 to add requirements to the technical specifications that are equivalent to the regulations of Subpart I of 10 CFR Part 35." The amendment contained herein is submitted in response to that request. In addition, NRC requested information on eight specific items. MIT's response to that request is provided below:

(1) Provision (1) of the specification is a commitment to limit the therapeutic delivery of neutrons to human subjects pursuant to a written directive from NRC Medical Use Licensee No. 20-03857-06 or from any other medical use licensee that has been similarly authorized by NRC to utilize the MIT Research Reactor's Medical Therapy Facility beam for human therapy. The term 'written directive' is defined in definition (9) of the specification.

(2) Provision (17) of the specification is a commitment to record events equivalent to 'recordable events' in 10 CFR 35.2 and to report events equivalent to 'misadministrations' in 10 CFR 35.2. The criteria for defining a recordable event and a misadministration are given in definitions (7) and (8) of the specification. A 'Quality Management Program' which follows 10 CFR 35.32 is enclosed.

(3) Provision (11) of the specification establishes allowable limits on the radiation fluence for the treatment as a whole and for any given fraction. Provision (14) of the specification in conjunction with definitions (3), (4), and (6) provide a methodology to ensure that the neutron flux and spectrum are as requested.

(4) Virtually all of the provisions contained in the proposed specification address the issue of patient and user safety. Those that are specific to some aspect of the medical therapy facility beam delivery system include:

Provision #		Purpose
3	–	Capability to reduce beam intensity by initiation of a reactor scram.
5	–	Functional description of the shutters and shutter interlocks that control beam delivery. (Also see definition (1).)
6	–	Indication lights for shutter position.
7	–	Radiation monitor for the medical therapy facility.
10	–	Methods for patient observation during treatment.
11	–	On-line beam monitors for determining the delivered fluence.
12/13	–	Surveillance requirements.

14	–	Provision for periodic characterizations and calibration checks of the beam. (Also see definitions (3) and (4).)
15/16	–	Proper maintenance of the beam delivery system and proper training of those using it.

Each of the above provisions is part of the proposed technical specification. Hence, once they are approved by the U.S. Nuclear Regulatory Commission, they cannot be changed without a further license amendment. Note however that MIT has reserved the right to make certain modifications. For example, it might be desirable to modify the beam design as new developments occur in both medicine and reactor physics. This is allowed provided that, as provided by provision (14), the beam is fully characterized upon completion of the modification. Similarly, under definition (1), it is permitted to alter the shutter configuration provided that the net effectiveness of the shutters is not reduced.

(5) Provision (2) specifies the protocol for both initiating and terminating the treatment exposures. Provision (8) specifies the means of communication.

(6) The only activity that will alter the beam's characteristics is a change in one or more of the neutron filter components. Other activities such as alterations in the medical therapy facility and reactor refuelings have little or no effect on the beam. In order to be certain that no change occurs without its being detected, definition (5) defines a 'design modification' as any change that alters the "dose versus depth profile of the fast neutrons, thermal neutrons, or gamma rays in the beam as sensed by the calibration check." Provision (14) of the specification requires that calibration checks be done "at least weekly for any week that the beam will be used for human therapy." Definition (4) describes the possible methods for doing a calibration check.

(7) Many provisions of the specification address the use of interlock systems and safety precautions. Some of these overlap with those listed in response to NRC question #4 on design aspects of the medical therapy facility beam delivery system. Portions of the technical specification that are specific to interlocks include provision (3) on the scram capability, provision (4) on access control to the medical therapy facility, provision (5) on shutter interlocks, provision (6) on shutter position indicator lights, provision (7) on the radiation monitor that is located in the medical therapy facility, provision (9) on manual operation of the facility's shielded door, provisions (12) and (13) on surveillance requirements, and provisions (15) and (16) on the qualification of personnel authorized to maintain and use the facility. The safety precautions to be followed before, during, and after treatment to limit occupational exposure to ionizing radiation are addressed by (a) mandatory training in radiation safety given to all prospective users of the MIT Research Reactor, (b) the training requirements of provision (16) of the proposed specification, and (c) the posted procedures that are required by provision (16).

(8) The U.S. Food and Drug Administration (FDA) requirements that are applicable to the use of boron nuclear capture therapy (NCT) for the

treatment of human patients are addressed in Investigatory New Drug Application #32,559 (FDA-IND #32,559) as amended. These concern the toxicity of the boronated drug that is used in the therapy and the combined toxicity of this drug and neutron radiation. The primary sponsors for this IND are Allen G. Meek, M.D. and Juan Madariaga, M.D., both of the State University of New York at Stony Brook. Background on this document is as follows:

(a) As originally conceived by Dr. Meek, IND #32,559 addressed "the collection, and *in-vitro* analysis of tumor, skin, urine, and blood tissues [from human patients] after administration of a drug called BPA to the patient." This research is referred to as a 'Phase I Biodistribution/Toxicity Study.' (Note: BPA stands for p-Boronophenylalanine. It is an amino acid and a tyrosine analog that was previously shown in animal studies to have low (if any) toxicity and high tumor-to-blood and tumor-to-normal tissue concentrations. These properties make it ideal for NCT.) Samples were to be collected from melanoma patients. The maximum allowed dose of L-BPA was 189 mg/kg. (Note: BPA is available in either of two isomeric forms. Only the 'L' form is used for NCT.) Also, no patient treatment was requested under the original IND. The original IND was submitted to the FDA by Dr. Meek on behalf of several research institutions on 3 February 1989. FDA subsequently approved it.

(b) On 13 December 1989, Dr. Meek submitted an amendment to the original IND that allowed the Massachusetts Institute of Technology and the Tufts - New England Medical Center to become collaborating institutions. Also, the study was extended to include the collection of samples from glioblastoma and breast carcinoma patients. FDA approved this request on 13 January 1990. (Note: This request was submitted to Dr. John F. Palmer, M.D., Director, Division of Oncology and Radiopharmaceutical Drug Products, Office of Drug Evaluation I, Center for Drug Evaluation & Research, Dept. of Health and Human Services, USFDA.)

(c) On 29 January 1992, Dr. Meek submitted another amendment. It requested (1) that approval be given to increase the administered dose of L-BPA from 189 mg/kg to 500 mg/kg and (2) that a "concurrent Phase I toxicity study of BPA with neutron radiation" be initiated. It is this latter request that addresses the irradiation of humans for the study of NCT. This research is referred to as a 'Phase I Combined BPA/Neutron Radiation Toxicity Study' and, as the name implies, its objective is to investigate the toxicity associated with the combined effects of BPA and neutron radiation. The protocol calls for a stepwise escalation in radiation fluence from levels that are expected to produce no toxicity to levels where the appearance of toxicity is anticipated. The patients participating in this Phase I study will probably not derive any benefit from it. Once the Phase I study is complete and, assuming it to be successful, a further amendment will be prepared for the use of NCT with therapeutic intent (a Phase II study). The 01/29/92 amendment is now in effect pursuant to Federal Register Vol. 52, No. 53;

Thursday March 19, 1987; Rules and the Regulations, Section 312.30. (Note: The 01/29/92 amendment was submitted to Ms. Susan Lange, Consumer Safety Officer, Division of Medical Imaging, Surgical and Dental Products, USFDA. Earlier reports on this topic were submitted to Ms. Lange's immediate predecessor, Mr. Mark Anderson.)

(d) An amendment to IND #32,559 is currently being prepared for submission to the USFDA for the purpose of designating the MIT Research Reactor's medical therapy facility beam as an approved 'device.' Submission is expected in about a month.

The FDA is, as noted above, concerned with issues of toxicity relative to both the drug (L-BPA) and the combination of the drug with neutron radiation. Other issues are also involved including patient selection criteria, right to privacy, informed consent, etc. These issues as well as the ones that are of concern to either the FDA or NRC are reviewed by several internal committees. At MIT, these are the Committee on Reactor Safeguards, the Committee on the Use of Humans as Experimental Subjects, the Committee on Radiation Exposure to Human Subjects, and the Radiation Protection Committee. At NEMC, these include the Human Investigational Review Committee, the Radiation Safety Committee, and the Clinical Study Unit Scientific Advisory Committee. All of the above committees have been provided with information on the proposed use of NCT for human therapy. The MIT Reactor Safeguards Committee approved the proposal as it concerns the generation of the medical therapy facility beam on 11/25/91. Submission for approval from the other MIT committees is scheduled. All of the NEMC committees have given approval for the Phase I study.

Finally, it should be noted that the above information on FDA approval of NCT at the MIT Research Reactor is provided to the U.S. Nuclear Regulatory Commission only as an item of information. Changes, such as the use of a drug other than L-BPA, are conceivable. Please be assured that any such changes will be subject to the appropriate USFDA reviews.

6.5 Generation of Medical Therapy Facility Beam for Human Therapy

Applicability

This specification applies solely to the generation of the medical therapy facility beam for the treatment of human patients. It does not apply to any other use of the medical therapy facility and/or its beam.

Objective

To provide for the protection of the public health and safety by ensuring that patients are treated in accordance with the treatment plan established by their physician and that the ALARA principle is observed for all non-therapeutic radiation exposures.

Specification

1. Patients accepted for treatment shall have been referred by written directive from NRC Medical Use Licensee No. 20-03857-06 or from any other medical use licensee that has been similarly authorized by NRC to utilize the MIT Research Reactor's Medical Therapy Facility beam for human therapy.

2. All medical treatments, including irradiations and analyses of the neutron capture agents in the patients, are the responsibility of the licensed physician in charge of the therapy and the medical physicists from the NRC-licensed medical center. The Massachusetts Institute of Technology is only responsible for delivery of the desired radiation fluence as requested by the medical physicist in charge of the therapy. Before the start of a therapy both a certified medical physicist and the Director of the Nuclear Reactor Laboratory, or his designate, must agree that the therapy can be initiated. A certified medical physicist is responsible for monitoring the therapy and for directing its termination. However, a radiation therapy can also be terminated at any time if either the physician or the NRL Director, or their designates, judge that the therapy should be terminated.

3. It shall be possible to initiate a minor scram of the reactor from a control panel located in the medical therapy facility area. In the event that the medical facility

minor scram is inoperable, it shall be acceptable to use one of the control room scrams via communication with the reactor operator as a temporary means of satisfying this provision.

4. Access to the medical therapy facility shall be controlled by means of the shield door located at its entrance.

5. The following features and/or interlocks shall be operable:

   (a) An interlock shall prevent opening of the shutters that control beam delivery unless the medical therapy facility's shield door is closed.

   (b) The shutters that control beam delivery shall be interlocked to close automatically upon opening of the medical therapy facility's shield door.

   (c) The shutters that control beam delivery shall be designed to close automatically upon failure of electric power or on low air pressure if the shutter is operated pneumatically.

   (d) Shutters that control beam delivery and which are normally pneumatically-operated can be closed manually.

6. Each of the shutters that controls beam delivery shall be equipped with a light that indicates the status of the shutter. These lights shall be visible at the medical therapy facility's local control panel. In the event of a status light malfunction, it shall be acceptable to use the affected shutter provided that an alternate means of verifying position is available.

7. The medical therapy facility shall be equipped with a monitor that provides a visual indication of the radiation level within the facility and which indicates at the local control panel.

   (a) This radiation monitor shall be equipped with a backup power supply such as the reactor emergency power system or a battery.

   (b) This radiation monitor shall be checked for proper operation by means of a check source within 24 hours prior to any patient irradiation.

(c) In the event that this monitor is inoperable, personnel entering the medical therapy facility shall use either portable survey instruments or audible alarm personal dosimeters. These instruments/dosimeters shall be in calibration as defined by the MIT Research Reactor's radiation protection program.

8. An intercom or other means of two-way communication shall be operable between the medical therapy facility and the reactor control room.

9. It shall be possible for personnel monitoring a patient to open the medical therapy facility's shield door manually.

10. It shall be possible to observe the patient through both a viewing port and by means of a closed-circuit TV camera. Both methods of patient visualization shall be operable at the outset of any patient irradiation. Should either fail during the irradiation, the treatment can be continued at the discretion of either the patient's physician or medical physicist. Adequate lighting to permit such viewing shall be assured by the provision of emergency lighting.

11. The total radiation fluence delivered by the medical therapy facility beam as measured by on-line beam monitors shall not exceed that prescribed in the patient treatment plan by more than 20%. The treatment is normally delivered in fractions in accordance with standard practice for human therapy. The 20% criterion applies to the sum of the radiation fluences associated with all fractions in a given treatment plan. A criterion of 30% applies to any given fraction.

12. The following interlocks or channels will be tested at least monthly and prior to treatment of human patients if the interlock or channel has been repaired or deenergized:

	Interlock or Channel	Surveillance
a)	Medical therapy facility minor scram	Scram test
b)	Shutters close upon opening of shield door	Operational test
c)	Shutters close on loss of electrical power and/or reduction of pressure in pneumatic operators	Operational test
d)	Manual closure of pneumatic shutters	Operational test
e)	Beam-monitoring instrumentation	Functional check

13. Manual operation of the medical therapy facility's shield door shall be verified semi-annually. (Note: Operability of the interlock for automatic closure of the shutters upon manual opening of the shield door is verified monthly as part of provision 12(b) of this technical specification.)

14. The medical therapy facility beam shall be characterized dosimetrically prior to the initiation of patient irradiations. Similarly, a characterization shall be performed prior to patient irradiations following design modifications to the beam. In the event that components of a given design are replaced as opposed to modified, then a calibration check as opposed to characterization shall be performed. Calibration checks of the beam shall be made at least weekly for any week that the beam will be used for human therapy. A characterization shall have been done not less than six months prior to any patient irradiation.

15. Maintenance, repair, and modification of the medical therapy facility shall be performed under the supervision of a senior reactor operator who is licensed by the U.S. Nuclear Regulatory Commission to operate the MIT Research Reactor. The 'medical therapy facility' includes the beam, beam shutters, beam monitoring equipment, medical therapy facility shielding, shield door, and patient viewing

equipment. The operating couch, patient positioning equipment, medical instruments, and other equipment used for the direct medical support of the patient are not considered part of the medical therapy facility for purposes of this provision.

16. Personnel who are not licensed to operate the MIT Research Reactor but who are responsible for either the medical therapy or the beam's design including construction and/or modification may operate the controls for the medical therapy facility beam provided that:

(a) Training has been provided and proficiency satisfactorily demonstrated on the design of the facility, its controls, and the use of those controls. Proficiency shall be demonstrated annually.

(b) Instructions are posted at the medical therapy facility's local control panel that specify the procedure to be followed:

(i) to ensure that only the patient is in the treatment room before turning the primary beam of radiation on to begin a treatment;

(ii) if the operator is unable to turn the primary beam of radiation off with controls outside the medical therapy facility, or if any other abnormal condition occurs. A directive shall be included with these instructions to notify the reactor console operator in the event of any abnormality.

(c) In the event that a shutter affects reactivity (e.g., the D_2O shutter), personnel who are not licensed on the MIT Research Reactor but who have been trained under this provision may operate that shutter provided that verbal permission is requested and received from the reactor console operator immediately prior to such action. Emergency closures are an exception and may be made without first requesting permission.

Records of the training provided under subparagraph (a) above should be retained in accordance with the MIT Research Reactor's training program or at least for three

years. A list of personnel so qualified shall be maintained in the reactor control room.

17. Events defined as 'recordable' under definition 7 of this specification shall be recorded and the record maintained for five years. Events defined as 'misadministrations' under definition 8 of this specification shall be reported to the U.S. Nuclear Regulatory Commission (24 hours verbal, 15 day written report).

Definitions

1. The medical therapy facility is equipped with shutters that are used (i) to control beam delivery and (ii) to adjust the neutron energy spectrum of the beam. The former currently include lead, boral, and light water shutters as described in Reference 6.5-1. The heavy water blister tank, which is also described in Reference 6.5-1, is an example of the latter. It is conceivable that these designations may change should it be found desirable to alter the beam configuration. Accordingly, the phrase "shutters that control beam delivery" refers either to the aforementioned three existing shutters or to any future shutter or group thereof which provides an equivalent or greater reduction in beam intensity. Shutter-effect analyses shall be documented through the standard safety review process including where appropriate an SAR revision and submission to NRC under 10 CFR 50.59.

2. The functional check listed as the surveillance requirement for the beam-monitoring instrumentation shall consist of verifying that the system output is consistent (± 10%) with previously measured values upon normalization to a common reactor neutronic power level.

3. The term 'characterization' refers to the process of obtaining the dose versus depth profile in phantoms as described in Reference 6.5-2 or an equivalent process. The dose versus depth profile from the surface of the phantom to a depth at least equivalent to the total thickness of the body part to be treated on a central axis is

deemed adequate for a characterization. Fast neutron, thermal neutron, and gamma ray components are determined in a full characterization and monitors are normalized by this characterization.

4. The term 'calibration check' refers to the process of checking the beam intensity and quality via one or more of the following: foil activation; use of a fission chamber; use of an ion chamber; or an equivalent process. The purpose of a calibration check is to ensure that the beam has not changed in a significant way (e.g., energy spectrum or intensity) from the beam that was characterized.

5. The term 'design modification' as applied to the medical therapy facility beam refers to a change that is shown to alter the dose versus depth profile of the fast neutrons, thermal neutrons, or gamma rays in the beam as sensed by the calibration check.

6. The term 'radiation fluence' means the total fluence of neutrons and gamma radiation that is emitted in the medical therapy facility beam. The determination of the ratios of gamma, fast neutron, and thermal neutron fluences is part of the beam characterization. Knowledge of these ratios allows the total radiation fluence to be monitored by the on-line detectors, which are neutron-sensitive. Compliance with the limits specified on radiation fluence by this specification is determined by reference to the fluence monitored by these detectors.

7. The term 'recordable event' means the administration of:

   (a) A radiation treatment without a written directive where a written directive is required and where the treatment is appropriate;

   (b) A radiation treatment where a written directive is required without the per treatment recording of administered radiation fluence in the appropriate record;

   (c) A treatment delivery for which the administered radiation fluence for any given fraction is 15% greater than prescribed.

8. The term 'misadministration' means the administration of a radiation therapy:

(a) Involving the wrong patient, wrong mode of treatment, or wrong treatment site;

(b) When the treatment delivery is not in accordance with provision 11 of this specification.

9. The term 'written directive' means an order in writing for a specific patient, dated and signed by an authorized user prior to the administration of radiation and which specifies the total radiation fluence, radiation fluence per fraction, treatment site, and overall treatment period.

10. The term 'human therapy' means radiation treatments that are of direct therapeutic benefit to the patient and/or part of investigatory studies that involve humans.

11. The term 'certified medical physicist' means a medical physicist certified in either radiological physics or therapeutic radiation physics by the American Board of Radiology, or in therapeutic radiation physics by the American Board of Medical Physics.

Basis

The stipulation that patients only be accepted from NRC Medical Use Licensee No. 20-03857-06 or from any other medical use licensee that has been similarly authorized by NRC to utilize the MIT Research Reactor's Medical Therapy Facility beam for human therapy, ensures that medical criteria imposed by NRC on such licensees for the use of the MIT Research Reactor's medical therapy facility beam for human therapy will be fulfilled. The second provision delineates the division of responsibilities between the Massachusetts Institute of Technology and the medical licensee which refers the patient. Also, it establishes administrative authority and protocol for initiating and terminating a radiation therapy.

The requirement that it be possible to initiate a minor scram from a control panel located in the medical therapy facility area assures the attending physician and/or medical physicist of the capability to terminate the treatment immediately should the need arise. The

provision that access to the medical therapy facility be limited to a single door ensures that there will be no inadvertent entries. The various interlocks for the shutters that control beam delivery ensure that exposure levels in the medical therapy facility will be minimal prior to entry by personnel who are attending the patient. The shutter-indication lights serve to notify personnel of the beam's status. The provision for a radiation monitor ensures that personnel will have information available on radiation levels in the medical therapy facility prior to entry. The intercom provides a means for the prompt exchange of information between medical personnel and the reactor operator(s).

The provision for manual operation of the medical therapy facility's shield door ensures access to any patient in the event of a loss of electrical power. The presence of the viewing window and a closed-circuit TV camera provide the attending physician and/or medical physicist with the opportunity to monitor the patient visually as well as through the use of various instruments. The viewing window will function even during an electric power failure because of the provision for emergency lighting.

The specification that the total radiation fluence for a therapy (i.e., the radiation fluences for the sum of all fractions specified in a given treatment plan) not exceed that prescribed in the patient treatment plan by 20% establishes an allowable upper limit on the delivered fluence. The 20% criterion is based on the definition of misadministration (clause 4(iv)) as given in 10 CFR 35.2. The criterion for any single fraction is set at 30%. This is also in accordance with the definition of misadministration (clause 4(iii)) as given in 10 CFR 35.2. The various surveillance requirements as well as those for beam characterization and/or calibration checks provide a mechanism for ensuring that the medical therapy facility and its beam will perform as originally designed.

The specification on maintenance and repair of the medical therapy facility ensures that all such activities are performed under the supervision of personnel cognizant of quality assurance and other requirements such as radiation safety. The provision on the training and proficiency of non-licensed personnel ensures that all such personnel will receive

instruction equivalent to that given to licensed reactor operators as regards use of the medical therapy facility beam. (Note: Licensed personnel may, of course, operate the medical therapy facility beam.) Also, this provision provides for the posting of instructions to be followed in the event of an abnormality.

The specification on 'recordable events' and 'misadministrations' provides for the documentation and reporting to the U.S. Nuclear Regulatory Commission of improper events regarding the generation of the medical therapy facility beam.

References

6.5-1 MITR Staff, "Safety Analysis Report for the MIT Research Reactor (MITR-II)," Report No. MITNE-115, 22 Oct. 1970, Section 10.1.3.

6.5-2 Choi, R.J., "Development and Characterization of an Epithermal Beam for Boron Neutron Capture Therapy at the MITR-II Research Reactor," Ph.D. Thesis, Nuclear Engineering Department, Massachusetts Institute of Technology, April 1991.

Safety Review Form No. 0-92-3

Item: Quality Management Program for Generation of Medical Therapy Facility Beam for Human Therapy

Submitted by J. Bernard Date February 21, 1992

Q/A number if required M-92-4

Does the item change or contradict the

Technical Specifications?	Yes*	X	No
SAR?	Yes*	X	No

* Attach explanation

Description of Change (Attach extra pages if necessary):

See attached sheets.

Safety Evaluation (Attach extra pages if necessary):

See attached sheets.

Summary of Review:

a) Does the proposal:	Yes	No
i) involve an unreviewed safety question (10CFR50.59(a)(2))		X
ii) decrease scope of requalification program (10CFR50.54(i-1))		X
iii) decrease effectiveness of security plan (10CFR50.54(p))		X
iv) decrease effectiveness of emergency plan (10CFR50.54(q))		X

b) Reviewer's Comments:

NRC _____ Date _____

MITRSC [signature] Date 11/25/91

Recommend Approval ✓ Yes _____ No MIT RPO [signature] Date 3-6-92

Reviewer [signature] Date 03/06/92

Reviewer [signature] Date 3/6/92

Approved [signature] Date 3-6-92
(Director of Reactor Operations)

10CFR50.59 & 50.54(p and q) changes logged for reporting to NRC, Date _____

Copy to Director for Operations
Copies circulated to and initialled by all Licensed Personnel
Original to Safety Review File

Unreviewed Safety Question (URSQ) Determination

for SR#-0-92-3

This safety review establishes a quality management program concerning the generation of MIT Research Reactor's medical therapy facility beam for human therapy. This new program does not alter or in any way impact any existing technical specification and/or its basis. No safety issue or unreviewed safety question has been found to exist. The basis for this negative finding is documented below as required by 10 CFR 50.59(b).

(a) The change does not meet any of the three criteria that define an URSQ. This is shown below:

- No increase in probability or consequences of an analyzed accident because the new program does not affect the reactor's design or operating procedures. It concerns only the use made of the medical therapy facility beam.

- No new type of accidents are created.

- No margin of safety is reduced, again because the change is only to establish a quality management program for generation of the medical therapy facility's neutron beam for patient use.

Safety Review No. 0-92-3

Quality Management Program for Generation of Medical Therapy Beam for Human Therapy

Description of Change

A quality management program for generation of MITR-II medical therapy facility beam for human therapy is established pursuant to 10 CFR 35.32(f)(1). The structure of the program conforms to 10 CFR 35.32(a)-(e).

Safety Analysis

The establishment of this quality management program has no effect on reactor safety because it applies solely to generation of the medical therapy facility beam for patient use.

Quality Management Program

for

Generation of Medical Therapy Facility Beam for Human Therapy

at the

Massachusetts Institute of Technology Research Reactor

SR#-0-92-3

MAR 06 1992

Quality Management Program: Generation of MITR-II Medical Therapy Facility Beam for Human Therapy

1. Purpose: The objective of this quality management program is to ensure that radiation treatments provided by the MIT Research Reactor's (MITR-II) Medical Therapy Facility beam will be administered as directed by an authorized user.

2. Authorized Users: Use of the MIT Research Reactor's Medical Therapy Facility beam for the treatment of human subjects, is limited to the following

NRC Medical Use Licensee No. 20-03857-06.

Any other medical use licensee that has been similarly authorized by NRC to utilize the MIT Research Reactor's Medical Therapy Facility beam for human therapy.

3 Program Requirements: The following requirements are established as part of this quality management program:

(a) A written directive will, except as noted in subparagraph (iv) below, be prepared by an authorized user prior to the administration of any radiation therapy. This directive shall include the following information:

(i) Name and other means of identifying the patient.

(ii) Name of the licensed physician and certified medical physicist in charge of the therapy.

(iii) The total radiation fluence to be administered, the radiation fluence per fraction, the treatment site, and the overall treatment period.

(iv) If, because of the patient's condition, a delay in order to provide a written revision to an existing written directive would jeopardize the patient's health, an oral revision to an existing written directive will be acceptable, provided the oral revision is documented immediately in the patient's record and a revised written directive is signed by an authorized user witnin 48 hours of the oral revision.

Also, a written revision to an existing written directive may be made for any diagnostic or therapeutic procedure provided that the revision is dated and signed by an authorized user prior to the administration of the next fraction.

If, because of the emergent nature of the patient's condition, a delay in order to provide a written directive would jeopardize the patient's health, an oral directive will be acceptable, provided that the information contained in the oral directive is documented immediately in the patient's record and a written directive is prepared within 24 hours of the oral directive.

(b) Prior to each administration of any radiation, the patient's identity will be verified by more than one method as the individual named in the written

directive. Acceptable methods of identification include, but are not limited to:

(i) Self-identification by patients who are conscious upon arrival at the MIT Research Reactor. Information provided shall include name, address, date of birth and/or social security number.

(ii) Hospital wrist band identification.

(iii) Visual identification against photographs provided with the written directive.

(iv) Identification by attending medical personnel.

(c) The patient treatment plan is certified by the medical physicist to be in accordance with the written directive.

(d) Each administration of radiation is in accordance with the written directive subject to tolerances of 20% in total radiation fluence and 30% for any given fraction.

(e) Any unintended deviations from the written directive shall be identified and evaluated, and appropriate action taken.

4. Program Implementation: The following practices shall be observed in order to ensure proper implementation of the quality management program:

(a) A review shall be conducted of the quality management program. This review shall include, since the last review, an evaluation of:

(i) A representative sample of patient administrations,

(ii) All recordable events, and

(iii) All misadministrations.

The objective of this review is to verify compliance with all aspects of the quality management program.

(b) The procedure for conducting the above review is as follows:

(i) The review shall be performed by the Director of the MIT Radiation Protection Program or his designate.

(ii) The review shall be performed annually.

(iii) Patient administrations selected for review shall be audited to determine compliance with each of the requirements listed in paragraph (3) above.

(iv) The review shall be written and any items that require further action shall be so designated. Copies of the review shall be provided to the NRL Director and to the MIT Reactor Safeguards Committee who will evaluate each review and, if required, recommend modifications

in this quality management program to meet the requirements of paragraph (3) above.

(c) Records of each review, including the evaluations and findings of the review, shall be retained in an auditable form for three years.

5. Response to Recordable Event: Within thirty days after the discovery of a recordable event, the event shall be evaluated and a response made that includes:

(a) Assembling the relevant facts, including the cause;

(b) Identifying what, if any, corrective action is required to prevent recurrence; and

(c) Retaining a record, in an auditable form, for three years, of the relevant facts and what corrective action, if any, was taken.

6. Records Retention: The following records shall be retained:

(a) Each written directive; and

(b) A record of each administered radiation therapy where a written directive is required in paragraph (3(a)) above, in an auditable form, for three years after the date of administration.

7. Program Modification: Modifications may be made to this quality management program to increase the program's efficiency provided that the program's effectiveness is not decreased. The licensee shall furnish the modification to the NRC (Region I) within 30 days after the modification has been made.