

CITY OF CAMBRIDGE

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EMERGENCY MANAGEMENT DEPARTMENT

David B. O'Connor
Director

Mr. Robert Healy
City Manager
City Hall
Cambridge, Mass.

Subject: Study of the MIT Reactor

Dear Mr. Healy:

As you know, some time ago you requested that the Health and Hospitals, Police, Fire, and Emergency Management departments study and report back to you as to the safety of the MIT research reactor (referred to as MITR-II). You requested that we address the safety issues presented in the November issue of Boston magazine in particular. The article in Boston was based, to a large degree on recent articles and papers by Prof. Daniel Hirsch of Adlai Stevenson College, University of California at Santa Cruz. Because the major emphasis of the papers and articles was the threat of nuclear terrorism; we concentrated on the risks presented by an external assault on the reactor containment structure and the associated buildings, armed assault leading to entry of the reactor building, and the risks presented by theft of the reactor fuel and other radionuclides present.

As we explained in the memo of January 8, 1986, much of the information relating to the physical security of reactors is classified by Nuclear Regulatory Commission (NRC) regulations (10 CFR 73.21) and we had to obtain the appropriate waivers from the NRC before we could examine the relevant documents and perform a site visit at MITR-II to examine the physical security facilities. In the interim, we examined a number of documents provided to us by Professor Hirsch, MIT, and the NRC at our request as well as documents sent to us by a number of special interest groups that are interested in nuclear issues. Many of the documents were circulated among the individuals involved and all documents were read by at least one of us. A list of these documents is annexed.

On March 4th, a site visit was made by Dr. Chalfen, Chief Scott, David B. O'Connor, Kevin Doherty of the Health Department and Captain Henry Gallagher of the Police Department. The tour and presentation covered all aspects of the reactor operations and the security procedures that are routinely in effect, as well as the special procedures that apply to a variety of events that could involve the safety and security of the facility.

To understand the MITR-II reactor safety situation it is important to realize that the reactor is very different than the power reactors that are often described in the media. Power reactors are designed to produce vast quantities of heat to generate steam and operate turbines. In order to do this, a power reactor uses coolant at very high temperatures and pressures. If the pressure were released the coolant would turn into steam and dissipate and the uncooled core could melt. The MIT reactor is designed to produce the minimum amount of heat, but instead is designed to produce a large number of energetic neutrons to irradiate samples, test materials, produce radiopharmaceuticals and to irradiate medical patients. Because of this, the reactor operates at close to atmospheric pressure and at a temperature of about 140 degrees Fahrenheit. The coolant is fed into the reactor vessel from the top and removed from the top and loss of coolant over the core could not result from breakage of coolant pipes.

The reactor is described as a light water cooled, heavy water reflected, tank type reactor. The fuel is Highly Enriched Uranium (HEU). This fuel, at delivery, contains 6% U_{238} , 93% U_{235} , and 1% U_{234} . The facility is licensed to possess 29 Kilograms of irradiated HEU in the reactor and 3 unirradiated fuel elements may be kept for refueling. The amount of contained Uranium in the unirradiated elements totals approximately 1.5 kilograms which is substantially below the "formula quantity" as defined by the NRC 1. All shipments of fuel to MITR-II are less than formula quantity and at any given time within the United States there is never more than one formula quantity in transit.

It is important, in discussing the security of the facility, to understand the concept of "self protection". The NRC establishes different security standards for fuel that causes an external dose rate in excess of 100 rems/hour at a distance of three feet. The theory behind this is that this material cannot be easily stolen as the persons stealing the fuel would, in the time it would take to remove the fuel, get a dose of radiation that would cause either serious radiation sickness or death. Recently, a number of authors have criticized this policy as the thieves would not become ill for a period of time and, if ignorant of the effects of radiation or if of a suicidal bent, could complete a theft before the onset of illness.

1 cf 10 CFR 73.2(bb)- formula quantity means strategic special nuclear material in any combination in a quantity of 5000 grams or more, computed by the formula $\text{grams} = \text{grams contained } U_{235} + 2.5(\text{grams } U_{233} + \text{grams plutonium})$ while the regulations do not so state, it appears implicit to authors in the field that the formula quantity is the absolute minimum needed to make a nuclear device using sophisticated technology and substantial economic resources.

The MITR-II reactor is used nearly continuously and at higher power levels than the typical research reactor. As a result of this use, the fuel in the reactor would produce a dose rate in the range of 1000 rem/hour to 10,000 rem/hour. At these rates, any persons attempting to steal the fuel would, before completing the removal, be either dead or seriously ill, unconscious, convulsing, bleeding internally and dying. This fact would make MITR-II a remarkably unattractive target for nuclear terrorists.

Among the documents examined were the NRC physical security inspection reports for the past several years. The minimum security standards for MITR-II are defined by 10 CFR 73.67 . The facility has passed all inspections and was found to be satisfactory by the NRC inspectors.

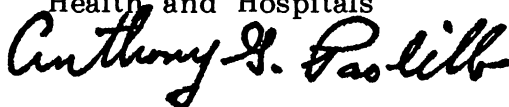
During our site inspection we found the physical security, access control, material storage, and fire suppression and safety to be satisfactory in both physical equipment and procedures. The armed response personnel are appropriately equipped and trained. Captain Gallagher did make one suggestion, not in correction of a deficiency but to enhance the security procedure for a specific situation. All agreed that this enhancement was appropriate and it has now been implemented.

It is our opinion that the security of the MIT research reactor is satisfactory. The structure and equipment are in excellent condition. The procedures are sound, closely followed and in full compliance with NRC regulations. The fuel far exceeds the NRC self protection level. In conclusion, all these factors combine to make a successful attack on the facility quite improbable.

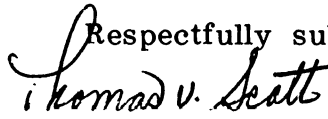
If you have any questions, or wish to examine any of the documents, please let us know.

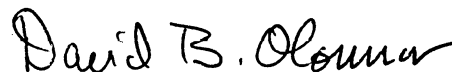


Melvin Chalfen
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Health and Hospitals



Anthony Paolillo
Chief
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Respectfully submitted,

Thomas V. Scott
Chief
Fire Department


David B. O'Connor
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BIBLIOGRAPHY

- 1) "Use and Development of Low and Medium Flux Research Reactors", Proceedings of an International Symposium, Cambridge, Massachusetts, U.S.A., Atomickern-Energie Kerntechnik, suppl. to Vol.44 (1984) (Book)
- 2) "The Effects of Nuclear Weapons" Samuel Glasstone and Phillip J. Dolan, eds., U.S. Dept. of Defense, 1977
- 3) "Preparedness and Response in Radiation Accidents" U.S. Dept. of Health and Human services, FDA-83-8211
- 4) "Protecting Reactors from Terrorists" Daniel Hirsch, Stephanie Murphy, and Bennett Ramberg, Bulletin of the Atomic Scientists, March, 1986, pp.22-25
- 5) "Weapons Grade Uranium on Campus" Daniel Hirsch, Univ. of Calif. , Santa Cruz, 1984
- 6) "Resolving the Safeguards and Proliferation Risks Associated with Presence of Weapons-Grade Uranium at Research Reactors", Daniel Hirsch, Univ. of Calif., Santa Cruz, 1984
- 7) "Nuclear Terrorism- A Growing Threat", Daniel Hirsch, Stephanie Murphy, Bennett Ramberg, Univ. of Cal. , Santa Cruz, 1984
- 8) Memo from Daniel Hirsch to David B. O'Connor, Subject "Emergency Planning and Security Considerations for Urban Based Research Reactors" Feb. 28, 1986
- 9) NRC Docket No. 50-142 , in the matter of (UCLA Reactor) the declarations of, a) Dr. Theodore B. Taylor, b) Dr. Herbert Scoville, c) Mr. David Hafemeister.
- 10) "MIT Research Reactor, 25 Years, 1958-1983" MIT, Cambridge, Mass., (1983)
- 11) "Physical Security Plan for the MIT Research Reactor Facility" NRC lic. no. R-37, amendment no.19, appendix 13B, classified as SAFEGUARDS information by 10 CFR 73.21
- 12) The Nuclear Control Institute provided an untitled brochure on their group and the text of the statements made by Dr. Theodore B. Taylor, Mr. Paul Leventhal, and Prof. Daniel Hirsch before the NRC, at a hearing concerning the conversion of research reactors from HEU to LEU.
- 13) "Use of Highly Enriched Uranium in Research Reactors" NRC policy statement. 47 FR 37007, Aug. 24, 1982

- 14) "Assessment of the Implications of the Conversion of University Research and Training Reactors to Low Enrichment Uranium Fuel", NUREG / CR-3666, Feb. 1984
- 15) "Criteria for the Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Non-Power Reactors" NUREG / CR-2174
- 16) "Safeguards Summary Event List" NRC, NUREG / 0525, Revisions 4-11
- 17) "Potential Threat to Licensed Nuclear Activities from Insiders (the Insider Study) NRC, NUREG /- 0703
- 18) "Standard Review Plan for the Review and Evaluation of Emergency Plans for Research and Test Reactors" NRC, NUREG-/-0849
- 19) "NRC/FEMA Operational Response Procedures to a Commercial Nuclear Reactor Accident" NRC, NUREG-0981, FEMA-51
- 20) NRC show cause order dated Sept. 27, 1985, limiting MIT's inventory of unirradiated fuel to three elements
- 21) NRC regulations, Code of Federal Regulations, Title 10; especially parts 50, 70, and 73
- 22) "Nuclear Plants-Military Hostages?" , Bennett Ramberg, Bulletin of the Atomic Scientists, March, 1986, pp.18-21
- 23) "Analysis of the Risks of Diversion of Plutonium or Highly Enriched Uranium" a paper presented by Dr. Edwin L. Zebroski to the Society for Risk Analysis in Knoxville, Tenn. on Oct. 1st, 1984.
- 24) " Perspective on the Possible Significance of Diversion of Uranium from Research Reactors" Dr. Edwin L. Zebroski, Electric Power Research Institute, Palo Alto, Cal. (1984)
- 25) "Relative Diversion Exposures of High Enrichment Uranium: Relation to University Research Reactors" a paper presented by Dr. Edwin L. Zebroski to the American Nuclear Society in New Orleans on June 4, 1984.



CITY OF CAMBRIDGE

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EXECUTIVE DEPARTMENT
ROBERT W. HEALY
City Manager

RICHARD C. ROSSI
Deputy City Manager

May 19, 1986

To the Honorable, the City Council:

Enclosed as per City Council request is a copy of a study of the
M.I.T. Reactor which was prepared by David B. O'Connor, Director of the
Emergency Management Department.

Very truly yours,

Robert W. Healy
City Manager

RWH/mbf
Enc.

Agenda Item No. 9 S-367A

Re: enclosed study of the M.I.T. Reactor,
prepared by the Director of the Emergency
Management Dept.

In City Council,

May 19, 1986

*Referred to Hearing
Scheduled 6/2/86*