DEPARTMENT OF MECHANICAL ENGINEERING
THE UNIVERSITY OF TEXAS AT AUSTIN

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June 21, 1995

United States Nuclear Regulatory Commission
ATTN: Seymour H. Weiss, Director
Non-Power Reactors and Decommissioning
Project Directorate
Division of Project Support
Office of Nuclear Reactor Regulation
Washington, D.C. 20555-0001

SUBJECT: Control of Access to Radiation in Beams
Docket No. 50-602

Dear Mr. Weiss:

The Nuclear Engineering Teaching Laboratory (NETL) submits the following in response to your letter of June 5, 1995. We currently have several neutron beam port experiments operating, and planning is underway for other experiments which will utilize additional neutron beam ports in the near future.

Measurements of the dose rates/fluences encountered from the various beam lines indicated that these beams, although small in area, had dose rates which could be deemed High or Very High Radiation Areas. Hence the facility management imposed the access controls and posting requirements of 10 CFR 20.1601, 20.1602, and 20.1902. These requirements are incorporated into the shielding design criteria for each experimental setup utilizing a beam port. The imposition of these requirements adds proportionately to the time (man hours) required to get an experiment "up and running," and also increases the overall cost of an experimental setup (i.e., door interlocks and alarms). Notwithstanding, NETL does not regard these requirements as unduly burdensome to our operations.

With reference to your request for detailed suggestions on how to assure worker safety around radiation beams, we can offer specifics relating to one of our permanent beam experiments as an example. This is not to suggest that our measures would suffice for every facility (not a "one size fits all" situation). However, the exchange of information is oftentimes very useful. We plan to submit a paper for the April 1996 Radiation Protection and Shielding Division Topical Meeting, *Advancements and Applications in Radiation Protection and Shielding*, which would provide further details and a broader forum for dissemination of this information.

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Information on the measures we undertook for control of access to the beam port utilized for experiments in Neutron Depth Profiling is enclosed as attachment 1.

Should you have any questions on this matter, please feel free to call me at (512) 471-5787.

Cordially,

Bernard W. Wehring

Bernard W. Wehring
Director of the Nuclear Engineering Teaching Laboratory
Professor, Mechanical Engineering

enclosure: Attachment 1

Attachment 1

Control of Access to Radiation Beams

A Case Study: Neutron Depth Profiling at the
Nuclear Engineering Teaching Laboratory,
The University of Texas at Austin

Prepared for: Seymour H. Weiss, Director
Non-Power Reactors and Decommissioning
Project Directorate

The nondestructive technique of Neutron Depth Profiling (NDP) is used to determine the concentration versus depth for specific impurity elements in various substrates of a host sample. The NETL-NDP utilizes thermal neutrons from a tangential beam port of the 1-MW TRIGA Mark II research reactor. This report presents a brief overview of the engineered controls and administrative procedures in effect at NETL for the NDP experimental area as relates to personnel access to the neutron beam. For detailed information on the NDP experimental setup, i.e., design aspects of the thermal neutron beam and NDP sample chamber, see references [1] and [2].

The NDP experimental area described herein is considered a routine, permanent neutron beam experiment. A neutron beam experiment is an experiment utilizing an open beam port with the sample located outside the biological shield. A routine neutron beam experiment is a neutron beam experiment which uses a standard collimator/filter assembly or an empty beam port. A permanent neutron beam experiment is a neutron beam experiment which has a concrete shielding wall (or equivalent) surrounding the sample. The operation requirements of the NDP facility comply with the general limitations and procedures of the Permanent Neutron Beam Experiment (Experiment Review and Authorization documents). These limitations and procedures are as follows:

1. A concrete shielding wall (or equivalent) shall be built around the sample such that no individual can receive an effective dose equivalent of 5 mrem in 1 hour for a reactor power of 1 MW if that individual stays outside the concrete shielding wall.

2. The concrete shielding wall shall have entryways that are locked, except during periods when access to the sample is required. An RWP [Radiation Work Permit] shall be required to authorize personnel to enter the shielding-wall area. All limitations on personnel movement inside the shielding wall shall be given in the RWP.

3. The entryways shall have interlocks that energize a conspicuous visible or audible alarm a) when an entryway is unlocked with the reactor key switch on, or b) when the reactor key switch is turned on with an entryway unlocked. The alarm shall inform both the individual in the confines of the concrete shielding wall and the reactor operator.

4. The reactor shall be shut down at the time of an unanticipated alarm.

5. In place of the controls required by 1., 2., 3., and 4., direct supervision by the reactor health physicist shall be required for the initial setup of the experiment, any changes in boundaries or shielding, and any significant changes to the sample. Dose rate measurements will be taken, recorded, and filed by the reactor health physicist in order to verify that the limitations in 1., 2., and 3. are satisfied.

6. At the conclusion of a permanent routine neutron beam experiment, i.e., shielding wall removed, the special beam port shielding, i.e., inner plug, outer plug, etc., shall be replaced and secured.

The limitations on personnel movement inside the shielding wall are given in *Requirements for Operation of NDP Facility*, which is a part of the Radiation Work Permit (RWP). Under Area Access, the RWP states, "No personnel shall be inside the area when the reactor control rods are up and the shutter is open and the steel rod plug is out. The key to the access point is in control of the Senior Reactor Operator (SRO) or the Beam Port Manager." The RWP also requires that the beam stop must be secured in place any time the control rods are up. Temporary removal of the beam stop is allowed if conditions 1) and 2) of the Area Entry requirements given below are met, and either the Health Physicist or the SRO and Beam Port Manager are notified of and approve the relocation.

The Area Entry provisions allow the experimenter to enter the enclosed area after the control rods are down, with the knowledge of the SRO and the Beam Port Manager. Sample changes or target chamber or component removal requires the following:

1) Dose rate must be less than 100 mrem/hr in any accessible area.
2) Steel rod plug in place at the aperture of the beam.
3) Shutter closed.

Access Requirements During Reactor Operations allows the experimenter access during other reactor operations if conditions 1), 2), and 3) in Area Entry above are met, the RO and Beam Port Manager acknowledge the entry, a ß-γ and neutron survey instrument(s) are used during the entry, and the dose rate is less than 100 mrem/hr in the accessed areas. However, the RWP explicitly states, "UNDER NO CIRCUMSTANCES SHALL ANY PERSON, AT ANY TIME, WALK THROUGH THE BEAN LINE IN FRONT OF THE BEAM CATCHER WHEN THE REACTOR IS OPERATING ABOVE 1 kW." This restriction applies even in the case of shutter closed, steel rod plug inserted.

A photograph of the Neutron Depth Profiling experimental area is presented in figure 1. Figure 2 is a line drawing of a top view of the NDP area. That is, if one stood on the biological shield (area behind the blue fence at the far left, figure 1) and looked down, the arrangement in figure 2 would be observed. The view shown in figure 1 is identical to that which is observed by the control room personnel using closed-circuit television for visual surveillance of the beam port experimental areas during reactor operations. Note the location of the Very High Radiation - Neutron Beam sign between the sample chamber and the inner concrete shield wall in figure 1. This sign is required to be in place during reactor operations.

Supplementing the camera surveillance, a magnetic read switch is wired to a digital input scanner which provides visual and audible warnings on the reactor control console panel upon entry. To provide the experimenter with an audible entry alarm, the gate is fitted with a door motion sensor (Radio Shack Safe House® Model Cat. No. 49-419) which cannot be switched off from the fence exterior. The chain link fence gate is also placarded [RWP Required for Entry].

The exterior concrete block walls are 39.5 cm (15.6 inches) thick and 188 cm (74 inches) in height; the chain link fence and gate are 182.8 cm (72 inches) in height. The beam stop is a standard 55 gallon drum comprised of 400 pounds of paraffin, 20 pounds of boric acid, boral and lead.

An area radiation monitor is mounted on the exterior perimeter of the chain link fence to continuously monitor the dose rate in the vicinity of the NDP area. Dose rates (combined neutron and gamma) outside the enclosed NDP area are at or less than 5 mrem/hr during 1 MW operations.

REFERENCES

[1] K. Unlu and B. Wehring, "Neutron Depth Profiling at the University of Texas," Nucl. Instr. and Meth, Phys. Res. A 353, 402-405 (1994).

[2] K. Unlu and B. Wehring, "Neutron Depth Profiling at the University of Texas Research Reactor," Trans. Am. Nucl. Soc. 68, 163 (1994).

Texas Cold
Neutron Source

Neutron Depth
Profiling

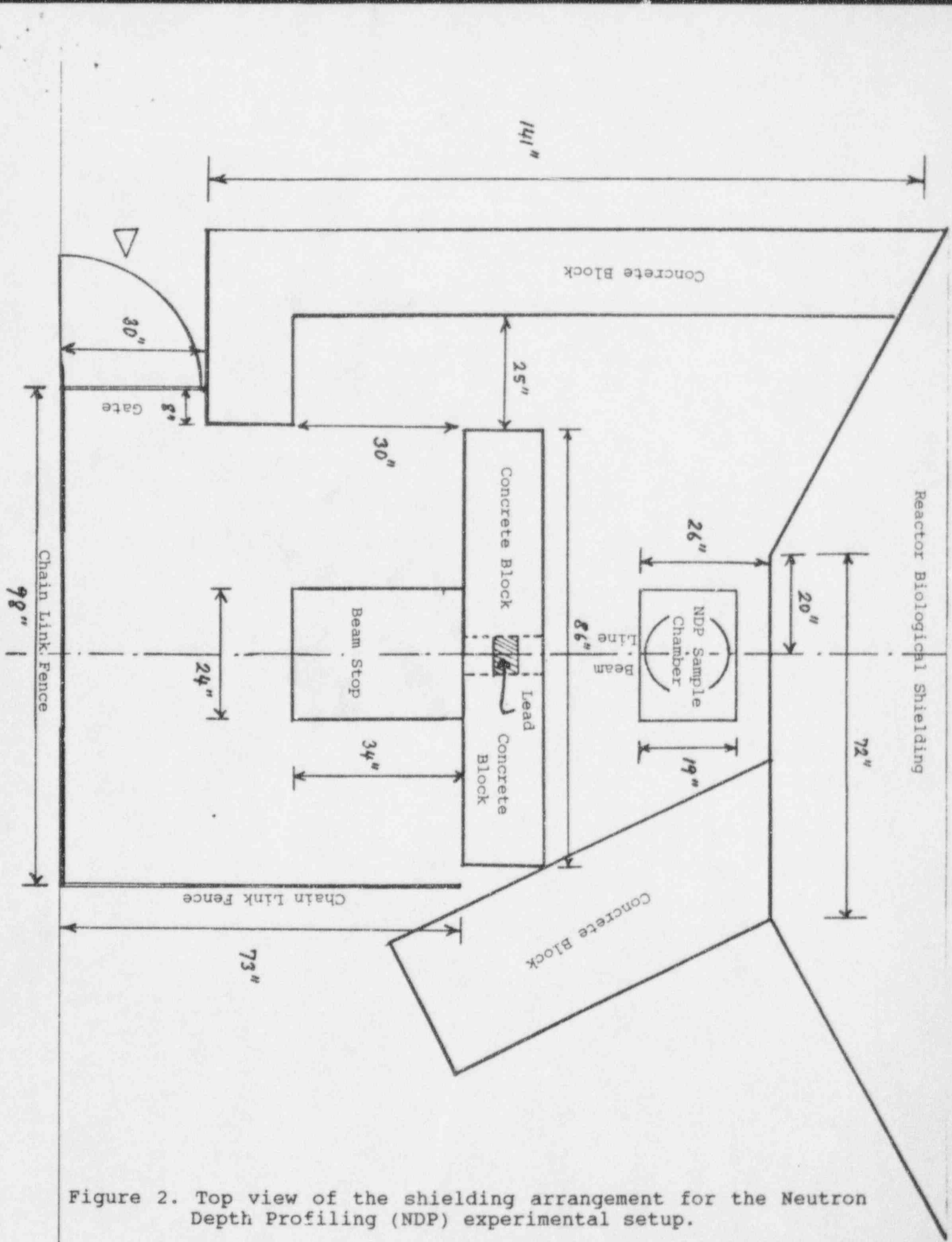

Figure 2. Top view of the shielding arrangement for the Neutron Depth Profiling (NDP) experimental setup.