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April 16, 2015 & May 13, 2015

Charles Barnett, M.D.
Radiation Safety Officer
VANCHCS

Subject: X-ray shielding specifications – Revision 2a (typo correction)
Nuclear Medicine Department
Veteran's Affairs OPC, 150 Muir Road, Martinez, CA 94553
Rooms C156, C157, C158

Dear Dr. Barnett,

I am providing the following report for the above subject project. This radiation shielding report replaces prior reports dated April 1, 2014 and April 15, 2015.

The rooms of interest are located on the ground level of a two level building with unoccupied crawl space below and fully occupied space above. The shielding detailed in this document will protect individuals from unreasonable radiation exposure based on 10 CFR 20 requirements and satisfy your ALARA commitment. Please note that radiation levels around shielded X-ray rooms are not zero. Required shielding is based on workload, occupancy factors, inherent shielding, distance, and radiation type. I declare under penalty of perjury that in my professional opinion the radiation project conforms to the applicable provisions of Chapter 91, California Building Code (Title 14, CCR), relating to radiation protection. I am a certified radiological physicist by the American Board of Radiology.

There are several critical assumptions that are the basis of the shielding plan.

1. Symbia T2 scanner is for nuclear medicine, low mA, use only.
2. Symbia T2 will be located in east scanner room (C156)
3. DEXA scanning will be effected by CT scanning and substantial shielding is specified to protect the scanner. However, the scanner must be tested with the CT in operation to verify negligible interference.

The purpose of this shielding study was three fold.

1. Provide shielding specifications based on stated uses.
2. Ensure shielding will be adequate for future equipment changes.
3. Lower X-ray background for SPECT and DEXA scanners.

To satisfy the above needs the shielding varies from no added shielding material to 8 pound per square foot (nominal 1/8 inch thick) lead. Cost differences in shielding material in this range are negligible so I have tried to keep shielding as uniform as possible for ease of construction and to account for future changes in use, workload, and surrounding occupancy.

East Scanner Room (adjacent to hot lab)

Symbia T2

Room 156

Deck - assumed to be at least 2.5 inch thick normal density reinforced concrete. It does not require modification for the purpose of X-ray shielding. However, during construction, the deck must be inspected to verify the minimum concrete thickness and to certify it to be free of voids and large cracks.

All **perimeter walls and structures** in the walls, windows, frames, and doors require shielding. The specification for all structures is nominal 4 pound per square foot (1/16 inch thick) lead shielding applied from the level of the finished floor to a height of seven feet above the finished floor. Note that the leading of the south wall continues into the control room (C157) and is continuous with the leading of the south wall of room C158.

Control room wall for C156: This interior wall requires nominal 4 pound per square foot (1/16 inch thick) lead shielding applied from the level of the finished floor to a height of seven feet above the finished floor. Also, all other structures defining this barrier (windows, doors, and frames) require the same lead equivalency.

West Scanner Room (adjacent to DEXA)

Symbia T6

Room 158

Deck/Ceiling - assumed to be at least 2.5 inch thick normal density reinforced concrete. **Part of the ceiling requires an additional layer of 2 pound per square foot (nominal 1/32 inch thick) lead applied at the level of the drop ceiling.** The lead will begin at the intersection line of the west wall with the ceiling and continue for 15 feet in the direction of the operator's control area. It will be the full width of the room in this area. Also, during construction, the deck must be inspected to verify the minimum concrete thickness and to certify it to be free of voids and large cracks.

All **perimeter walls** (except control wall) and structures in the walls, windows, frames, and doors require shielding. The specification is nominal 4 pound per square foot (1/16 inch thick) lead shielding applied from the level of the finished floor to a height of seven feet above the finished floor for all areas **except an 8 foot wide section centered in the west wall that requires 8 pound per square foot lead (1/8 inch thick).**

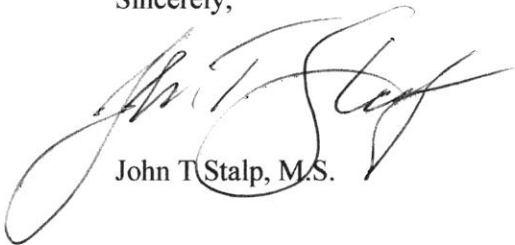
Control room wall for C158: This interior wall requires nominal 4 pound per square foot (1/16 inch thick) lead shielding applied from the level of the finished floor **to the height of the drop ceiling**. Also, all other structures defining this barrier (windows, doors, and frames) require the same lead equivalency.

Control Room
Room C157

South wall requires nominal 4 pound per square foot (1/16inch thick) lead shielding applied from the level of the finished floor to height of 7 feet.

A structural engineer will need to approve lead loading to structures of interest. Attached are detailing instructions, a floor plan, and a list of assumptions. Please contact me with your questions. Thank you for using our physics service.

Sincerely,

A handwritten signature in black ink, appearing to read "John T. Stalp", is written over the printed name.

John T Stalp, M.S.

Attachments -2

Shielding Assumptions

1. Workloads are for busy modern CT scanners – Siemens Symbia T6 and T2. T2 will be used only for low mA nuclear medicine work.
2. Location of adjacent buildings is not of interest.
3. Design is to keep annual doses below 100 mrem per year for nonradiation workers and less than 500 mrem per year for radiation workers.
4. The X-ray shielding plan is for X-rays less than 140 kVp.
5. Only CDRH approved X-ray equipment will be used.
6. Deck is minimum 2.5 inch thick normal density concrete.
7. T2 scanner is shielded for nuclear medicine use only.
8. T6 scanner is shielded for diagnostic radiology use.
9. NaI detectors (DEXA and SPECT) are extremely sensitive to background radiation levels.

DETAILING - LEAD SHIELDING INSTALLATION

1. National publications deal with detailing. They are, National Council on Radiation Protection # 147 and National Bureau of Standards # 76, entitled "Medical X-ray Protection".
2. Lead lined plywood/wallboard is commonly used to shield X-ray & gamma rays due to ease of installation. Steel screws or nails are commonly used to affix the board to the support members. **It is necessary to cover the screw or nail heads in the leaded wall areas with lead inserts only when more than 4 pound per square foot (1/16 inch thick) lead is installed on that segment of the shielding plan.**
3. Shielding of the radiation room shall be constructed so that the protection is not impaired by joints, by openings for ducts, pipes, etc. passing through the barriers, or by conduits, service boxes, etc. embedded in the barriers. The only exception is that cracks under doors are not considered a problem as long as the crack is less than 2 cm in height.
4. Shielding material can be applied to the inner or outer surface of the walls.
5. Scanner room doors (or other means to access the room) and observation windows also require special consideration to ensure adequate protection without sacrifice of operational efficiency.
6. Joints between lead sheets should be constructed so that their surfaces are in contact and with an overlap of not less than 1 cm or twice the thickness of the sheet, whichever is greater.
7. Openings in the protective barriers for ventilation ducts, pipes, and electrical outlets need to be backed with lead or fitted with radiation baffles to ensure that the required degree of overall protection is maintained. In many cases, where there are many openings in a wall, the opposite side of the wall is leaded.
8. While specific recommendations are given, alternate methods of shielding may prove equally satisfactory. From the point of view of radiation protection, the particular method used is not important provided that the radiation survey of the completed installation establishes that the structural shielding is adequate.
9. The adequacy and proper installation of radiation barriers should be verified by a qualified expert conducting a radiation protection survey using an anthropomorphic phantom after the radiation machine has been installed.
10. The locations of shielding material are designed for specific applications and for specific functions. Any change in these applications, location of equipment, traffic patterns, control functions, or occupancy factors should be reviewed by a qualified expert for possible changes in shielding requirements.



SCALE 1/4" = 1'-0"

- 156 needs to be moved slightly to allow door swing. Done

$$\frac{1}{32}'' \text{ Pb (216)}$$