X-IRRADIATION FACILITY DESIGN REQUIREMENTS

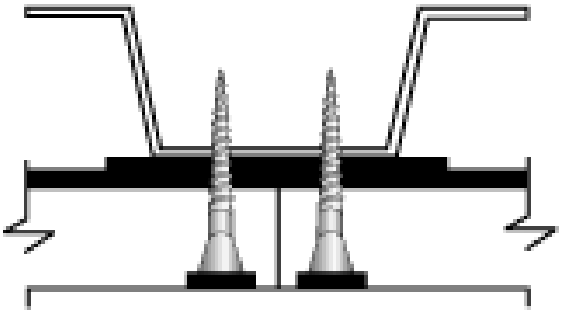
INTRODUCTION

1) This document outlines the design recommendations for erecting x-irradiation enclosures, and supplements specific details on shielding considerations (shielding materials and the thickness of shielding barriers) that will be determined according to the proposed erection.
2) The terms *shall* and *should* have specific meanings:
   - *shall* is a recommendation based on a statutory or University requirement and the recommendation must not be subject to 'lean engineering',
   - *should* is a recommendation that may be varied subject to further discussion and prior approval by the client and University Radiation Protection Service ('The Service').
3) Mandatory University requirements relating to the design and construction of radiation facilities can be found at http://www.leeds.ac.uk/rps/ionising/HoSInfo.htm under the heading 'The University Standard' ['Standard for the Management of Sources of Ionising Radiation' and the associated guidance document 'Heads of Schools Guidance Note']: clients, Estate Services and their contractors and architects shall follow these requirements, which are summarised here http://www.leeds.ac.uk/rps/construction.html.
4) No changes to submitted designs shall be made without the written agreement of the client and The Service, i.e. lean engineering (where projects are subject to cost saving changes that are then not brought to the attention of clients or The Service) is not permitted.

DESIGN SPECIFICATIONS

Shielding

5) The Service shall calculate shielding thicknesses for all barriers using BS 4094-1:1966 and BS 4094-2:1971 as appropriate. Normally the calculated values will be expressed in mm lead, although concrete equivalents may be included if required by architects and facility designers.
6) The Service will specify the materials and thicknesses and these shall be used in the design and erection.
7) Unless otherwise agreed in writing, lead shielding shall be resin bonded onto plywood and nailed or screwed into place. The lead shall face inwards into the enclosure.
8) Screw or nail heads should be covered with lead strips or counters.

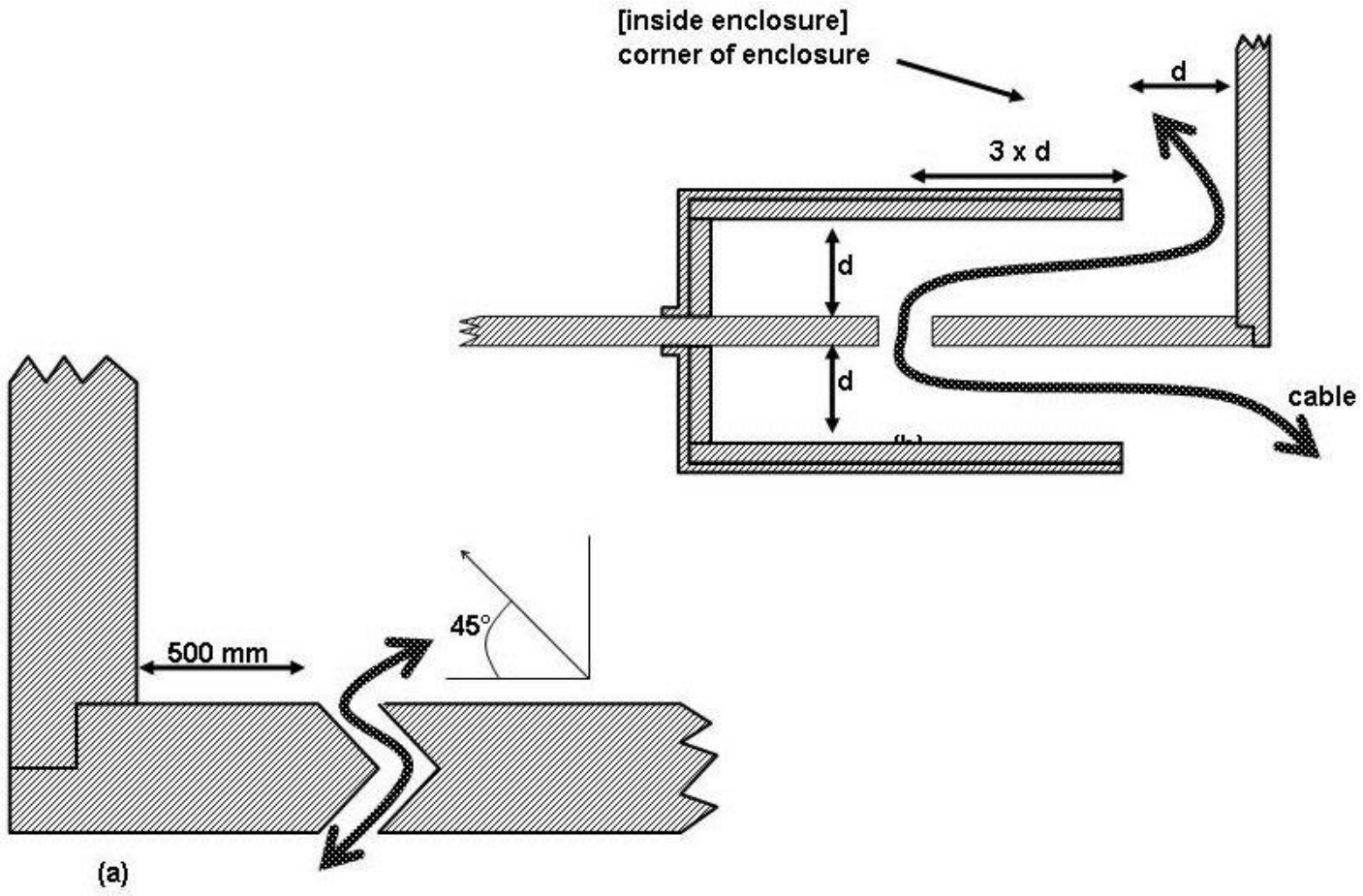


3/8" LEAD DISC

9) Joints between lead sheets shall be covered by overlapping lead strips of an equal thickness of lead. The overlap should be 15 mm either side of the joint.

10) Abutments shall be coved with lead of the calculated thickness and the coving shall extend to a distance of 150 mm, and lead-lead joints shall be formed from chevroned or butt joints as shown in the diagram below.

11) Cable entries shall be protected by mazes of the calculated thickness of lead as shown below, and to the dimensions given. Orifices should take account of the thickness and degree of flex in the cable(s) they are to carry:



Shielded cable entry points; a - simple chevron facing the corner of the enclosure, b - box design

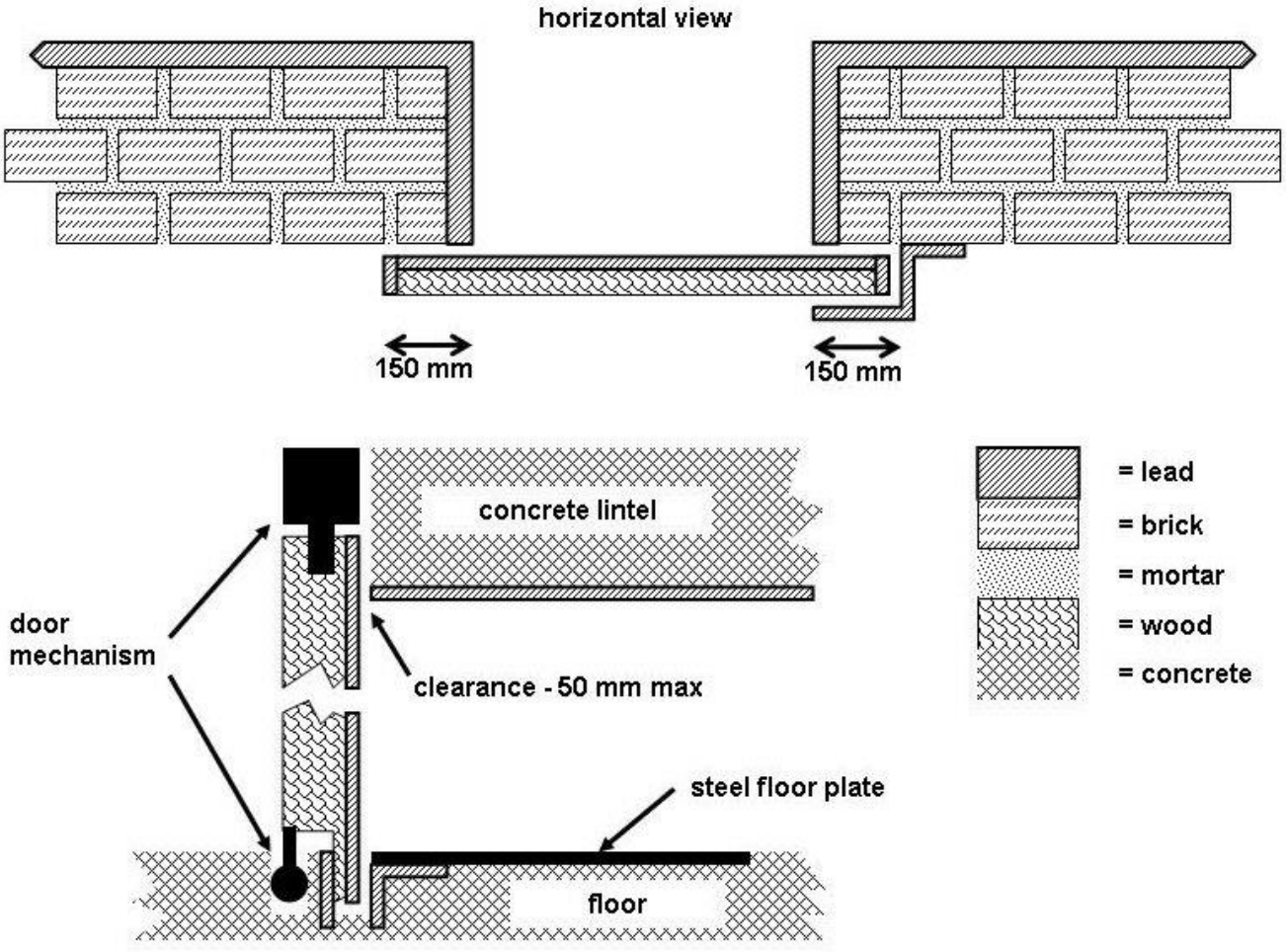
Facias

12) The internal surfaces of an enclosure shall be finished in an appropriate plastic / synthetic lining that is sealed at the joints and contains no horizontal (dust collecting) surfaces. The nature of the material shall be agreed by the client and The Service in writing. The agreement shall not be subject to lean engineering.

13) All external faces shall be finished with specified materials in a manner agreed in writing by the client and The Service. The agreement shall not be subject to lean engineering.

Doors

14) Doors will usually be sufficiently heavy as to require hanging and be of a sliding design, and should be powered by devices or mechanisms that facilitate ease of movement. Safety devices or design considerations shall ensure that it is not possible to trap or crush limbs.



Example of door design

15) A minimum of two failsafe interlocks or actuators that operate in opposing modes shall be fitted to doors and access panels.

16) The selection of appropriate devices and guards shall be made after consideration of the guidance provided in PD 5304:2005 ‘guidance on safe use of machinery’ and BS EN 1088:1995 + A2:2008 ‘safety of machinery – interlocking devices associated with guards – principles for design and selection’.

Safety features

17) The enclosure shall be fitted with annunciators that indicate when the x-ray unit is in a state of readiness and when a useful beam is being emitted. One annunciator shall be position outside the enclosure adjacent to the enclosure door and another in a visible position inside the enclosure.

18) A suitable number of twist-lock type emergency stop devices shall be fitted inside the enclosure. Normally one will be sited close to the exit and the other on an opposite wall. Annunciators should be of an LED type.

19) All safety features shall be interlocked in series to the control panel responsible for energising the unit in such a manner that failure of one device will prevent the set being energised. Obtaining an electrical feedback from LED devices may be difficult, in which case a written justification of why it is not possible to include these in the safety circuitry should be submitted to The Service.

Other features for consideration

20) X-ray coolant systems may emit heat and could cause a significant increase in room temperature. It is advised that discussions are held with ventilation experts who may be able to make recommendations on air handling / conditioning.

21) Most x-ray sets will require the installation of a 3-phase supply. Competent electrical engineers should be contracted to advise on monitoring the electrical demand and on the installation of an appropriate supply. X-ray sets are sensitive to current spikes.

Constructing and erecting x-ray enclosures

22) **Enclosures shall only be designed, constructed and erected by specialist contractors who have a <u>proven track record</u> in the construction and installation of x-ray enclosures and can submit written evidence or testimonials to The Service to support this.**

Contractor requirements

23) The contractor shall submit to The Service, for written acceptance by The Service, a definitive list of the proposed structures, systems and components (SSCs) that perform a safety function.

24) The SSCs shall be substantiated.

25) Details of the SSCs that define performance (e.g. power rating, current power, operating voltages, model type and numbers, pre-settable parameters) shall be provided to The Service for written acceptance by The Service. The contractor will identify any redundancy and comment on the guaranteed lifespan of the devices.

26) The contractor shall demonstrate, in writing to The Service, compliance against BS EN 61508:2010 ‘functional safety of electrical/electronic/ programmable electronic safety-related systems’.

27) The contractor shall provide a HAZOP plan, in writing to The Service’ that defines any potential operational and safety threats and state how any threats are (to be) protected against.

Critical examination

28) A pre-commissioning critical examination shall be undertaken by The Service that shall assess the functionality of the x-ray unit and enclosure, shall determine that the enclosure has been installed in accordance with and provided with SSCs identified in written statements provided by the contractor, determine that no ‘lean engineering’ has been carried out. The enclosure will not be received by the University or client until a satisfactory critical examination has been completed.