INTRODUCTION

This is an assessment of the risks from exposure to ionising radiation for work involving a GE Lunar iDXA. This assessment does not assess the risks from planned medical exposures to patients or volunteers undergoing scans and this is subject to a separate dose and risk assessment (see IRMER procedures).

The GE Lunar iDXA Bone Densitometer is an x-ray scanner used to measure bone density and body composition. It consists of an x-ray head mounted underneath a scanner table with the x-ray beam directed upwards to a detector arm above the patient.

The x-ray tube operates at 100kV with a maximum 2.5mA current and a filter splits the x-ray output into high and low energy components at 70keV and 38keV. The resulting x-rays are output as a fan beam (4.5°) that is 18.4 mm x 3.3 mm at the table top and oriented across the table axis whilst the x-ray head/beam and detector arm are moved along the table to traverse the scan area required. The tube assembly has integral lead shielding.
to reduce leakage and no further shielding is used within the room.

Manufacturer’s (GE) data give estimated patient skin entrance doses ranging from <10µGy for hand, forearm or total body scans to 329µGy for spine or femur scans \(^\text{ref 1}\). Calculations of the effective dose to the patient based on phantom measurements \(^\text{ref 2}\) are 1-10µSv per scan.

Isodose plots of the scatter dose were measured by the manufacturer using a 25x25x15 cm water phantom at 100kV, 2.5mA \(^\text{ref 1}\). The reported scatter dose at 2m from the centre of the scanner table at these settings is 2µGy/h and this has been confirmed by measurement \(^\text{ref 3}\).

Manufacturer’s safety specifications are that “To avoid scatter radiation, the operator should remain … at least 6 feet (1.83 m) away from the center of the scanner on iDXA” \(^\text{ref 1}\).

The restricted area that the operator should not enter whilst x-rays are being emitted has therefore been set at 2m from the scanner table and is designated as a Radiation Controlled Area during scanner operation.

**DOSE ASSESSMENT**

Estimated doses should be compared with:

- University of Leeds dose constraint for radiation workers = 1mSv/year \(^\text{ref 4}\)
- Dose constraint for exposures to the public from any new source of radiation = 0.3mSv/year \(^\text{ref 5}\)
- Average radiation dose to the public in the UK = 2.7mSv/year \(^\text{ref 6}\)

The projected maximum usage of the scanner is estimated at a maximum of 20 scans a week using either standard or thick total body scans and for the purposes of this assessment a maximum of 20 thick body scans per week has been used to give a ‘worst case’ dose estimate.

Scan conditions for thick total body scans are 0.188mA for 796 seconds, i.e. 59.9 secs (2.5mA equivalent)

Therefore 20 scans = 1198 seconds (2.5mA equivalent) = 0.33 hours / week = 17.3 hours / year.
Doses to operator

Maximum radiation dose per year to an operator at an operator position 2m from the scanner would be:

\[ 2 \mu Sv/h \times 17.3 \text{ hours} = 35 \mu Sv / \text{ year}. \]

The maximum estimated dose to an operator is therefore 3.5% of the university’s dose constraint and 1.3% of the average UK public exposure to radiation.

Doses external to the room

1. The adjacent office (6.88) wall has 50mm plaster board plus one layer of Knauf Safeboard (attenuation at 100kV = \text{1E-2}). Measured doses in this office are less than 0.02\mu Sv/h \text{ ref } 3 = 0.35\mu Sv/\text{year}

2. Other adjacent external areas are corridors and an occupancy factor of 0.2 can therefore be applied \text{ ref } 7. These positions outside the room would be at least 2m from the table and at most points are much more than this and the shielding effect of building materials would also reduce the dose further.

Doses to staff and visitors outside the room would therefore be less than 0.2 \times 35 = 7\mu Sv/\text{year}.

The estimated dose to staff, visitors, and the public is therefore less than 2.3% of the public dose constraint and less than 0.3% of the average UK public exposure to radiation (equivalent to less than 1 day of background radiation exposure).
<table>
<thead>
<tr>
<th>Condition</th>
<th>Persons exposed</th>
<th>Radiation exposure</th>
<th>Level of risk</th>
<th>Risk reduction measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure to x-rays</td>
<td>Operators</td>
<td>x-rays; scatter dose rate &lt;2µSv h(^{-1}) at 2m. Estimated annual dose (see calculations above) &lt;0.035mSv/y.</td>
<td>Low</td>
<td>Operator training. Demarcation of a controlled area within 2m of scanner. Access restrictions for scanner room. Local rules include instructions for operator to keep out of controlled area whilst scan in progress. Daily QA procedures. Critical Examination before the x-ray tube is first used; if repaired, altered or moved; and annually. Dose levels confirmed by environmental dose monitoring.</td>
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<td>Exposure to scatter radiation within the scanner room during normal operation: <strong>outside controlled area.</strong></td>
<td>Operators</td>
<td>Penetrating x-rays; scatter dose rate up to 50µSv/h at edge of scanner table. Estimated annual dose 6.25mSv/y.</td>
<td>Medium</td>
<td>Operator training. Demarcation of a controlled area within 2m of scanner. Local rules include instructions for an operator to keep out of the controlled area.</td>
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<td>Exposure to scatter radiation within the scanner room during normal operation: <strong>inside controlled area.</strong></td>
<td>Operators</td>
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<td>Exposure to scatter radiation outside the scanner room during normal operation.</td>
<td>Staff, visitors, public</td>
<td>x-rays; scatter dose rate &lt;2µSv h(^{-1}) at 2m. Estimated annual dose (see above) &lt;&lt;0.007mSv/(\text{y.})</td>
<td><strong>Negligible</strong>&lt;br&gt;The estimated annual dose is less than 0.3% of the annual UK natural background level.&lt;br&gt;Estimated annual dose is well below the dose constraint of 0.3mSv for members of the public.</td>
<td>Access restrictions for the scanner room.&lt;br&gt;Critical Examination before the x-ray tube is first used; if repaired, altered or moved; and annually.&lt;br&gt;Dose levels confirmed by environmental dose monitoring.</td>
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**Damage to equipment**

| Damage to the equipment by impact or fire. | All persons entering the scanner room. | Penetrating x-rays; potential dose rate – several Sv h\(^{-1}\). | **High**<br>If the equipment were subject to damage it is possible that the x-ray shielding might be compromised although this is unlikely.<br>If the equipment was damaged but still operable radiation exposure could exceed the University annual dose constraint of 1mSv in seconds.<br>Dose rate could exceed dose constraint and legal dose limits; potential for legislative infraction. | If the equipment has been damaged in any way the user should:<br>- switch the power off and<br>- inform the RPS and seek advice before using the equipment. |
## Condition

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<td><strong>Maintenance / servicing</strong></td>
<td>All persons entering the scanner room.</td>
<td>Penetrating x-rays; potential dose rate – several Sv h(^{-1}).</td>
<td><strong>High</strong></td>
<td>Removal of panels or shielding could give access to areas where there is a high dose rate. Radiation exposure could exceed the university’s annual dose constraint of 1mSv in seconds. Dose rate could exceed dose constraint and legal dose limits; potential for legislative infraction. There must be a service and maintenance contract for the equipment and all repairs and modifications to the equipment must only be carried out by a qualified service engineer. The service engineer must have sole use of the room if servicing requires the removal of shielding or overriding of safety features.</td>
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### REFERENCES:

Ref 3: UoL Critical Exam report, CRIT 1822 XRID41 FBS.