Protective Garment Quality Assurance Program: General Information

Medical Physics Services

Sir Charles Gairdner Hospital

Medical Technology and Physics

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Department of Health
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Introduction

Western Australian legislation requires that lead equivalent protective garments of at least 0.25 mm of lead be worn by all staff carrying out X-ray procedures where there is no other protective barrier available (unless directed otherwise by a Qualified Expert[1]) [Radiation Safety (General) Regulations 1983 (Western Australia)]. Radiation Protection Series 14.1 requires that Interventional Radiology (and CathLabs) departments use lead equivalent protective garments of at least 0.5 mm of lead at the front of the garment. Full protective garments should be designed such that they cover the front part of the body (i.e. from the throat down to the knees and covering the entire shoulder), the entire back (down to the knees) and the sides of the body from not more than 10 cm below the armpit and to at least half way down the thighs [AS/NZS 4543.3:2000 *Protective devices against diagnostic medical X-radiation – Part 3: Protective clothing and protective devices for gonads*]. As these garments tend to be the primary source of protection against scatter radiation for radiation workers involved in procedures where no other protective barrier is available it is vital that the integrity of the shielding material be checked at routine intervals. The proceeding sections outline recommendations for the quality assurance of these protective garments along with practical rejection criteria that can be applied when assessing their shielding integrity.

Use of Protective Garments in Diagnostic X-Ray Facilities

The protective garments used in a modern-day diagnostic X-ray facility to protect wearers from scatter radiation tend to consist of a heavy metal (typically tin, antimony or barium) impregnated vinyl or rubber that provides a certain level of lead equivalent shielding and typically has a nylon fabric on the outer layer. This means that the garments are not only much lighter to wear, but they are flexible and more robust than earlier generation protective garments. Nonetheless, these garments are still subject to significant wear and tear (especially in busy X-ray facililities) and a number of studies have found that, depending on the care taken over the garments, their lifespan ranges from roughly 5–8 years [Lambert and McKeon 2001]. As these garments are quite expensive (~$800 per garment), it is vital that they be treated in a manner that will minimise the level of wear and tear and maximise the lifespan of the garment. This deterioration of the garment can be minimised by:

[1] A Qualified Expert, means an expert whose qualifications are approved by the Radiological Council.

- Hanging garments on suitable racks so that they are not folded or creased.
- Wearing correctly-sized garments so that the materials are not stretched.
- Repairing worn velcro fastenings or clips so that the garment is supported adequately and so that there are no points under undue stress.

Testing of Protective Garments

Protective garments, like any other product, should be tested on receipt to ensure that the manufacturer has provided an acceptable product that does not fall short of the stated specifications. This testing consists of a visual inspection (to check if straps and materials are in good condition) and a fluoroscopic inspection (to verify that there are no imperfections in the shielding material). Thereafter, the garments should be visually inspected at least every 6 months and fluoroscopically inspected at least once every 24 months. Table 1 below provides a summary of the testing requirements of lead aprons.

Table 1. Summary of the quality assurance (QA) requirements for protective garments.

Type of Inspection	Frequency	QA Requirements
Visual inspection	6 months	• Garments need to be checked to ensure that they are not overly dirty. • Straps, velcro fastenings and seams need to be checked thoroughly to verify that the garments are safe to wear and will not come apart during a procedure. • If any major straps or velcro fastenings are in poor condition then the garments should be removed from circulation and repaired (see Appendix A for details of repair company).
Fluoroscopic inspection	24 months	• Garments need to be placed individually on a floating table top and scanned methodically using a fluoroscopy machine. This will not provide quantitative information, but will identify holes, faults and general shielding material deterioration. • Should there be any doubts as to the safety of the garment then the garment should be removed from circulation and the local radiation safety office notified (details provided in Appendix A).

Criteria for Rejection

Based on the cost of replacing protective garments and the estimated radiation dose received due to the presence of a defect in the shielding material, Lambert and Mckeon (2001) have provided quantitative criteria for rejection. It is suggested that the protective garments be replaced if defects of greater than 15 mm^2 are identified near critical organs (e.g. breast, lungs, gonads, etc.) or if defects greater than 670 mm^2 are identified over non-critical areas (around seams or in overlapping areas). For thyroid collars, the criterion is slightly more stringent and any defects greater than 11 mm^2 should result in the replacement of the garment.

As the cost of replacing aprons is substantial (~$800 per apron) it is recommended that, wherever possible, the defects identified on the apron be measured and compared with the abovementioned rejection criteria. This method requires the fluoroscopic images of each defect to be saved and processed offline and can be a very time consuming task for large departments that have a high number of aprons in circulation. **It should be noted that many wearers are uncomfortable with the knowledge that they are wearing garments with defects present and as such, it is acceptable that maybe a more qualitative assessment of the defects be performed (budget allowing)**. That is, if the department performing the QA believes a defect to be unacceptable then they may replace the apron. Figures 1 to 3 below provide example images (with measurements) to assist with this qualitative assessment and Figure 4 provides an indication of some typical defects that can be observed during a fluoroscopic inspection of the garment.

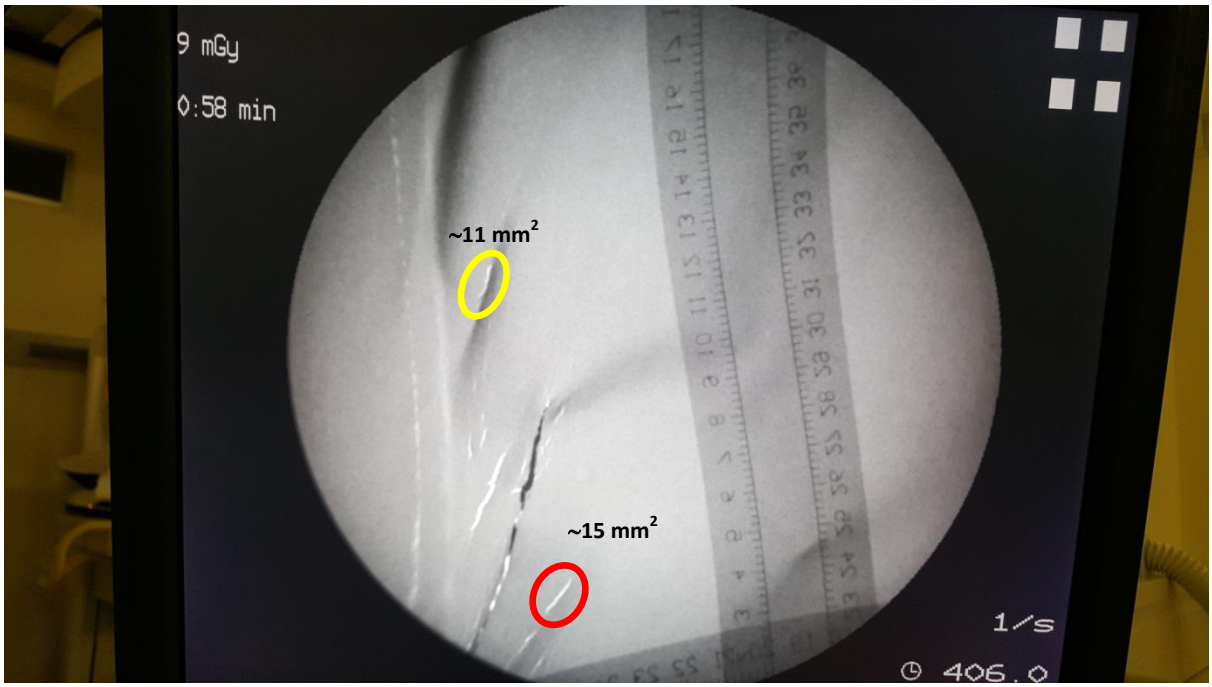

Figure 1. Defect of approximately 11 mm^2 (yellow) and 15 mm^2 (red) observed in a protective garment.

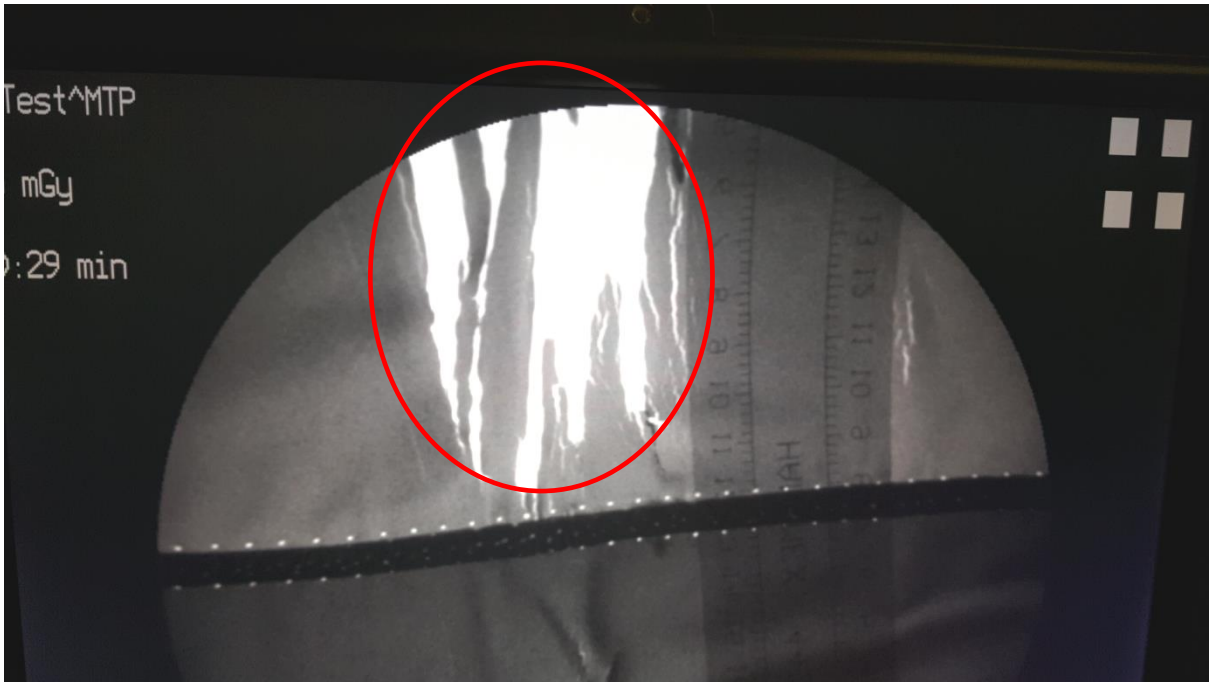

Figure 2. Defect of approximately >2000 mm^2 (red).

Figure 3. Multiple defects amounting to an exposed area of approximately 350 mm^2 (red).

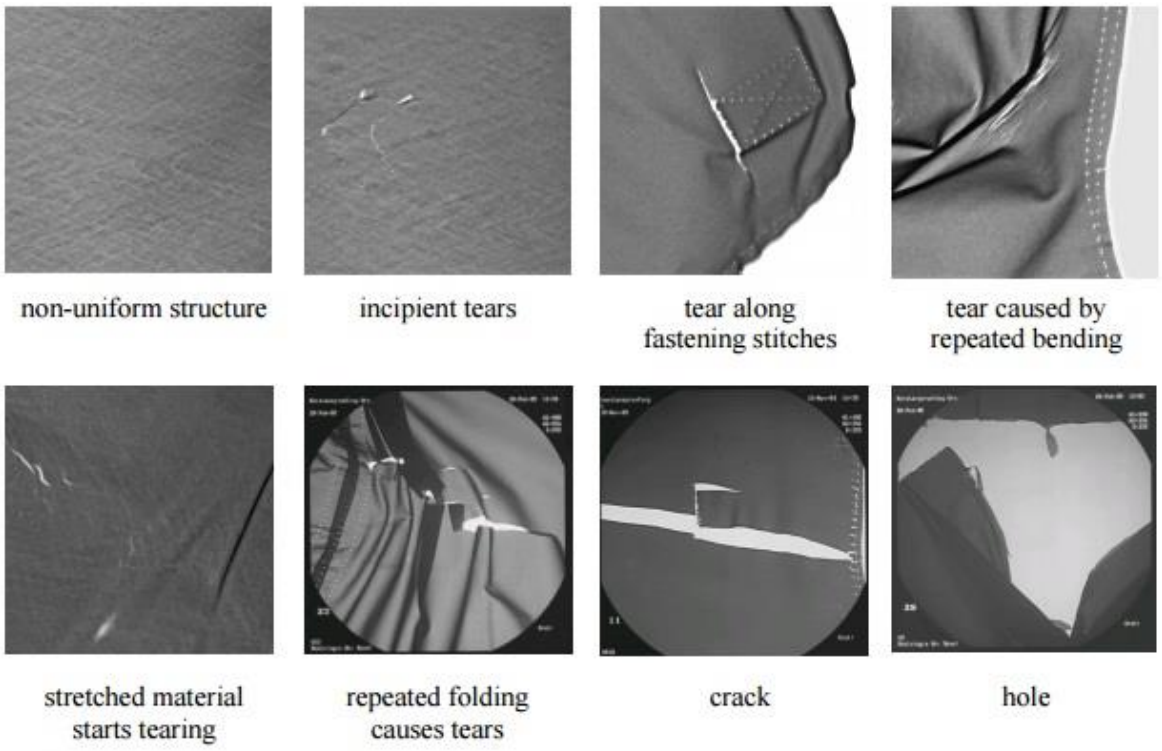

Figure 4. General appearance of protective garments with varying defects.

References

Lambert, K., Mckeon, T. 2001. “Inspection of Lead Aprons: Criteria and Rejection”, *Operational Radiation Safety*, Supplement to Health Physics, 80, suppl. 5, S67–S69.

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Standards Australia/Standards New Zealand. 2000. *Protective devices against diagnostic medical X-radiation – Part 3: Protective clothing and protective devices for gonads*, AS/NZS 4543.3:2000.

Appendix A

Radiation Safety Office Details:

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Sir Charles Gairdner Hospital

Hospital Avenue

Nedlands, WA 6009

Ph: 9346 2866

Garment Repair Company Details:

Alison Dodgson

AD Sewing

26 Lorikeet Loop

High Wycombe, WA 6057

Ph: 0439 945 887