1. IDENTIFICATION


Working ID: DS545

Proposed Title: Radiation Safety of Gamma, X Ray and Electron Beam Irradiation Facilities


Review Committee(s) or Group: RASSC (Lead), WASSC, TRANSSC, EPRSeSC, NSGC

Technical Officer(s): Haridasan PAPPINISSELI, RSM-NSRW

2. BACKGROUND

IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, establishes requirements for the protection of people and the environment from the harmful effects of ionizing radiation and for the safety of radiation sources. The implementation of these requirements helps to ensure that the number of people exposed to radiation and their doses are kept as low as reasonably achievable and helps to prevent emergencies or to mitigate their consequences.

IAEA Safety Standards Series No. SSG-8, Radiation Safety of Gamma, Electron and X Ray Irradiation Facilities, is intended to implement the requirements of GSR Part 3 in respect of the radiation sources used in irradiation facilities. However, the publication, issued in 2010, predates GSR Part 3 and several other relevant safety standards.

As proposed during a consultancy meeting in August 2022, the revised publication will alter the current title, for better reflecting the content and industrial practice. The meeting noted several gaps or updating certain contents to that will represent the actual industrial practice being ongoing in Member States. The table of contents will be updated by including additional sections on Duties and Responsibilities, Safety Assessment, Radiation Protection Programme, Qualification and Training, and Protection of public and the environment. This Safety Guide will have an expanded scope to include all Categories of gamma, X ray and electron beam (eBeam) irradiators.

3. JUSTIFICATION FOR THE PRODUCTION OF THE PUBLICATION

The revision of SSG-8 is necessary as it predates the current safety requirements established in GSR Part 1 (Rev.1), GSR Part 2, GSR Part 3, GSR Part 4, GSR Part 7 and SSR-6 (Rev. 1) and
recommendations in supporting Safety Guides. A revision is needed to ensure consistency with the current safety requirements and with the terminology of the IAEA Safety Glossary (2018 Edition).

Since the development of SSG-8, the application of ionising radiation technologies has expanded. The use of eBeam and X ray technologies are increasing in industrial and research settings. To meet this increasing demand new technologies are emerging. For example, low energy eBeam and X ray irradiation is gaining increased commercial attention. Since the publication of SGG-8 in 2010 more experience in safely handling of these technologies has been gained. The revised Safety Guide will capture this expanded knowledge.

Although SSG-8 continues to be used widely it is in need of revision. IAEA Radiation Safety Standard Committee (RASSC) eight term 2021–2023, assigned the revision of SSG-8 as high priority. The Committee considered several extant safety guides in need of revision, and this was identified as priority one.

4. OBJECTIVE

The objective of the proposed revision of SSG-8 is to provide recommendations and guidance on meeting the requirements established in GSR Part 3 concerning the design and use of ionizing technology-based irradiation facilities. This includes gamma, X ray and electron beam (eBeam) irradiation facilities.

The recommendations in this revised publication will also address SSR-6 (Rev. 1) and other relevant IAEA safety standards, Nuclear Security Series publications, and the Code of Conduct on the Safety and Security of Radioactive Sources in relation to ionizing technology based irradiation practices.

The recommendations in the proposed publication are targeted primarily at regulatory bodies and current and future operating organizations of industrial and research irradiation facilities, as well as their employees and radiation protection officers. This safety guide will also be of interest to qualified experts, equipment designers and manufacturers, and equipment service providers. The guidance will also be of interest to those who are utilizing industrial irradiation services.

5. SCOPE

This Safety Guide provides recommendations on how to meet the requirements of GSR Part 3 with regard to the safe design and operation of irradiation facilities [gamma irradiators (Categories I to IV), X ray irradiators (Categories I and II)] and electron beams irradiators (Categories I and II) that are used for the blood and blood component irradiation, industrial radiation processing and research and development.

This Safety Guide will not include the X ray generators and other radiation sources used for security inspection purpose and for non-medical human imaging (addressed in SSG-55). It will not include the use of ionizing radiation for medical diagnosis and therapeutic applications, industrial radiography, heavy ions and cyclotrons, as these may be found in other IAEA safety guides. This Safety Guide will not duplicate the guidance in GSG-7 and GSG-8.

6. PLACE IN THE OVERALL STRUCTURE OF THE RELEVANT SERIES AND INTERFACES WITH EXISTING AND/OR PLANNED PUBLICATIONS
This Safety Guide will interface with at least the following IAEA Safety Standards Series and other publications (the list is not intended to be final or exhaustive):

- GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, 2014
- GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities, 2016
- GSR Part 6, Decommissioning of Facilities, 2014
- GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency, 2015
- SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018
- NSS No. 11-G (Rev. 1), Security of Radioactive Material in Use and Storage and of Associated Facilities, 2019
- NSS No. 9-G (Rev. 1), Security of Radioactive Material in Transport, 2020
- RS-G-1.9, Categorization of Radioactive Sources, 2005
- Code of Conduct on the Safety and Security of Radioactive Sources and supplementary guidance, 2004
- GSG-7 Occupational Radiation Protection, 2018
- GSG-8 Radiation Protection of the Public and the Environment, 2018
- SSG-45 Pre-disposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education, 2019
- SSG-46 Radiation Protection and Safety in Medical Uses of Ionizing Radiation, 2018
- SSG-49 Decommissioning of Medical, Industrial and Research Facilities, 2019

All relevant sections in the IAEA’s Department of Nuclear Safety and Security will be consulted, as appropriate, throughout the drafting and review process.

7. OVERVIEW

A consultancy meeting in August 2022 reviewed the current structure and content of SSG-8 and concluded that some changes in a revised version is needed, though the majority of the current structure has to be retained. The outline of the publication will be similar to that of the publication that is being revised. For the comparison of previous and proposed table of content please see the table below.

Moreover:

- All figures need update.
- The main title and some section titles have been modified.
- Some new sections and subsections have been added.
- The current table of contents has been extended to cover Category I gamma irradiators, self-shielded low energy eBeam and X Ray irradiators
Three new Annexes are proposed.


Proposed table of contents:

1. INTRODUCTION
   Background
   Objective
   Scope
   Structure

2. TYPES OF IRRADIATORS
   Introduction of the categories of irradiators
   Gamma irradiators – Category I to IV
   Low energy electron beam and x-ray irradiators – Category I
   High energy electron beam and x-ray irradiators – Category II

3. DUTIES AND RESPONSIBILITIES
   Radiation protection principles
   The government and the regulatory body
   The operating organization
   Radiation protection officers
   Qualified experts
   Workers
Clients
Suppliers and service providers
Safety culture
Management of disused radioactive sources

4. SAFETY ASSESSMENT
General
Methodology for the safety assessment –* by the category of an irradiator*
Outcomes of the safety assessment
Reviews of the safety assessment
Record of the safety assessment

5. RADIATION PROTECTION PROGRAMME
Objectives and scope
Structure and content
Management structure and policies
Education and training
Local rules and supervision
Designation of controlled/supervised areas
Workplace monitoring
Personal Protective Equipment
Individual monitoring
Health surveillance programme
Radiation protection officer
Periodic reviews and audits - management system and process improvement

6. QUALIFICATION AND TRAINING
General
Design of a training programme
Structure and content
Refresher training
Training assessments and certification

7. INDIVIDUAL MONITORING OF WORKERS
General
Dosimetry (equipment, measurement, testing, calibration and maintenance)
Dose limits/constraints for occupational radiation protection
Individual dose assessment
Investigation of doses
Record keeping

8. WORKPLACE MONITORING
Workplace monitoring equipment (radiation survey meters and radiation monitors)
Maintenance and calibration
Radiation monitoring and contamination measurement
Record keeping
9. PROTECTION OF PUBLIC AND ENVIRONMENT
   General
   Dose limits/constraints for protection of the public
   Dose assessment
   Visitors
   Public engagement

10. RADIOACTIVE SOURCES CONTROL AND INTERFACE WITH NUCLEAR SECURITY
    General
    Source control
    Nuclear security considerations
    Decommissioning of equipment

11. IRRADIATOR DESIGN AND OPERATION
    GENERAL
    Siting requirements for high powered irradiators including to buildings and
    their load-bearing structures
    Source assembly moving system
    Shielding
    Gamma (all categories)
    X-ray – high and low energy
    eBeam – high and low energy

    Access to the radiation source and safety interlock systems
    Safety interlock for the personnel access door
    Backup access control – Personnel entry
    Safety interlocks for product entry and exit ports
    Backup access control – Product entry and exit ports
    Removable radiation room shield plugs
    Fixed radiation monitor with alarms

    Control console
    Access key
    Emergency stop device at the control console
    Disabling the radiation source

    Internal design
    Radiation resistant components
    Product positioning systems
    Gamma (all categories)
    X-ray – high and low energy
    eBeam – high and low energy

    Product movement timer
    Irradiation chamber
Safety delay timer with alarms
Emergency stop device
Emergency exit
Ventilation
Notices and symbols
Audible and visual signals
Signage and posting
Irradiation source status indicators
Irradiation status indicator colors
Considerations with regard to external events

GAMMA IRRADIATORS
Design of sealed sources
Specific requirements for wet storage conditions
Certification and documentation
Internal design
Source holder and source rack
Source guard
Emergency source cooling system
Source travel timer
Emergency access ports
Source rack position indicators
Access to radioactive sources and safety interlock systems
Access to storage pools in Category III
Backup access control – product entry and exit ports
Removable radiation room shield plugs at gamma irradiators
Fixed radiation monitor with alarms
Backup system for bringing source back to the safe position
Product exit radiation monitor
Wet source storage irradiators
Radiation monitor of the water treatment system
Storage pool integrity
Materials of pool components
Water level monitoring and control
Water conditioning
Cooling of storage pool water
In-pool piping
Storage pool guard cover

Fire protection
Power failure
Electrical power
Non-electrical power

X-RAY IRRADIATORS AND ELECTRON BEAM IRRADIATORS
Safety considerations in the use of high energy X rays and electron accelerators
Shielding
Disabling mechanism for the main acceleration system
Built-in monitoring of machine parameters
Built-in remote machine diagnostics
Safety consideration in the use of low energy X-ray and electron beam systems

FACILITY MODIFICATIONS

12. TESTING AND MAINTENANCE OF EQUIPMENT
   Periodic tests
   Leak testing of radioactive sources
   Records
   Facility maintenance programme
   Ageing management

13. TRANSPORT, LOADING AND UNLOADING OF RADIOACTIVE SOURCES
   Transport
   Loading and unloading of sources

14. EMERGENCY PREPAREDNESS AND RESPONSE
   General
   Functions for Emergency Preparedness and Response
   Infrastructure for Emergency Preparedness and Response

REFERENCES

ANNEX I: Outline of an Example Training Course Organized by an Irradiation Facility

ANNEX II: Checklist of Periodic Tests at Irradiation Facilities

ANNEX III: Summary of Selected Past Emergencies at Irradiation Facilities

8. PRODUCTION SCHEDULE:

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<thead>
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<th>Step</th>
<th>Description</th>
<th>Timeline</th>
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<td>1</td>
<td>Preparing a DPP</td>
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<td>2</td>
<td>Internal review of the DPP (Approval by the Coordination Committee)</td>
<td>September 2022</td>
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<td>3</td>
<td>Review of the DPP by the review Committee(s) (Approval by review Committee(s))</td>
<td>November 2022</td>
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<td>4</td>
<td>Review of the DPP by the CSS (approval by CSS) or information of the CSS on the DPP</td>
<td>April 2023</td>
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<td>5</td>
<td>Preparing the draft publication</td>
<td>2023, 2024</td>
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<td>6</td>
<td>First internal review of the draft publication (Approval by the Coordination Committee)</td>
<td>August 2024</td>
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<td>7</td>
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<td>8</td>
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<td>9</td>
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<tr>
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<td>11</td>
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STEP 12: (For Safety Standards) Editing of the draft publication in MTCD and endorsement of the draft publication by the CSS (For nuclear security guidance) DDG’s decision on whether additional consultation is needed, establishment by the Publications Committee and editing

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<td>STEP 14: Target publication date</td>
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9. RESOURCES

Estimated resources involved:

Secretariat (person-weeks): 40 weeks

Member States (number and type of meetings): 4-5 CSs, HBAs as needed.
ANNEX - 1

Chairperson report RASSC 50.

Microsoft Word - RASSC 50 - draft report-Final With comments.docx (iaea.org)