SAFE HANDLING GUIDE

Iron-59 Handling Precautions

This document contains general information designed to provide a basic understanding of radiation safety. While we believe the information to be accurate, regulatory requirements may change and information contained herein is not tailored to individual needs. A radiation protection specialist should be consulted for specific applications.

^{59}Fe
44.6 y
ß⁻ 0.466
0.273
γ 1.10
1.29
E 1.565

Physical data

Principal radiation emissions[1]
Maximum beta energies: 0.466 MeV (53.1%)
0.273 MeV (45.2%)
0.131 MeV (1.4%)

Gammas: 1.292 MeV (43.2%)
1.099 MeV (56.5%)
0.192 MeV (3.1%)
0.143 MeV (1.0%)

Maximum range of beta in air: 115 cm (45 in)[2]
Unshielded exposure rate at 1 cm from a 1 mCi point source: 6.18 R/h[3]
Unshielded exposure rate at 1 m from a 1 MBq point source: 4.31 nC/kg/h[3]
Half-value layer for lead shielding: 9.7 mm (0.38 in)[3]

Occupational limits[2]

Annual limit on intake: 800 µCi (30 MBq) for oral ingestion and 300 µCi (11 MBq) for inhalation
Derived air concentration: 1 x 10-7 µCi/ml (3.7 kBq/m^3)

Dosimetry

Gamma emissions from ^{59}Fe present a significant penetrating and shallow external exposure hazard. In adult man about 70% of total body iron is bound in hemoglobin[5]. It may be assumed that 80% and 1.3% of ^{59}Fe uptakes transfer to the liver and spleen respectively. The rest is assumed to be uniformly distributed to all other organs and tissues of the body[5]. Iron is retained in organs and tissues with a biological half-life of 2000 days[5]. One or two percent of an uptake of ^{59}Fe is eliminated via urine during the first 24 hours, the rest of the uptake is eliminated in feces[5]. The dose committed is reduced by the short physical half-life of ^{59}Fe.

Decay table

Physical half-life: 46.6 days[1].

To use the decay table, find the number of days in the top and left hand columns of the chart, then find the corresponding decay factor. To obtain a precalibration number, divide by the decay factor. For a postcalibration number, multiply by the decay factor. Visit **www.perkinelmer.com/toolkit** to use our online Radioactive Decay Calculator.

Days	0	1	2	3	4	5	6	7	8	9
0	1.000	0.985	0.969	0.954	0.940	0.925	0.911	0.897	0.883	0.869
10	0.856	0.843	0.830	0.817	0.804	0.792	0.780	0.768	0.756	0.744
20	0.733	0.722	0.710	0.699	0.689	0.678	0.668	0.657	0.647	0.637
30	0.627	0.618	0.608	0.599	0.590	0.580	0.571	0.563	0.554	0.545
40	0.537	0.529	0.521	0.513	0.505	0.497	0.489	0.482	0.474	0.467

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PerkinElmer has developed the following suggestions for handling Iron-59 after years of experience working with this beta and high-energy gamma emitter.

General handling precautions for Iron-59

1. Designate area for handling ^{59}Fe and clearly label all containers.
2. Store ^{59}Fe behind lead shields.
3. Wear extremity and whole body dosimeters while handling mCi (37 MBq) quantities.
4. Use shielding to minimize exposure while handling ^{59}Fe.
5. Do not work over open containers.
6. Use tools to indirectly handle unshielded sources and potentially contaminated vessels.
7. Practice routine operations to improve dexterity and speed before using ^{59}Fe.
8. Prohibit eating, drinking, smoking and mouth pipetting in room where ^{59}Fe is handled.
9. Use transfer pipets, spill trays and absorbent coverings to confine contamination.
10. Handle ^{59}Fe compounds that are potentially volatile or in powder form in ventilated enclosures.
11. Sample exhausted effluent and room air by continuously drawing a known volume through membrane filters.
12. Wear lab coat, wrist guards and gloves for secondary protection.
13. Maintain contamination and exposure control by regularly monitoring and promptly decontaminating gloves and surfaces.
14. Use end-window Geiger-Mueller detector, NaI(Tl) detector or liquid scintillation counter to detect ^{59}Fe.
15. Submit periodic urine sample for bioassay from 4 to 24 hours after handling ^{59}Fe to indicate uptake by personnel.
16. Isolate waste in sealed, clearly labeled shielded containers and hold for decay.
17. Establish surface contamination, air concentration and urinalysis action levels below regulatory limits. Investigate and correct any conditions which may cause these levels to be exceeded.
18. On completing an operation, secure all 59Fe; remove and dispose of protective clothing and coverings; monitor and decontaminate self and surfaces; wash hands and monitor them again.

Near an unshielded ^{59}Fe source, dose rates from beta radiation can be much higher than dose rates due to gamma radiation. Avoid direct eye exposure by interposing transparent shields or indirect viewing. Avoid skin exposure by indirect handling and prompt removal of contaminated protective clothing. Urinalysis to determine uptake is only effective during the first 24 hours after handling ^{59}Fe. Whole body counting is the most sensitive method for determining ^{59}Fe body burdens[6]. This and fecal analysis may be used to determine uptake for weeks or months after handling ^{59}Fe.

References

1. Kocher, David C., Radioactive Decay Data Tables, Springfield: National Technical Information Service, 1981 DOE/TIC-11026.
2. Kaplan, Irving, Nuclear Physics, New York: Addison-Wesley, 1964.
3. Calculated with computer code "Gamma" utilizing decay scheme data from Kocher[1] and mass attenuation coefficients for lead and mass energy absorption coefficients for air from the Radiological Health Handbook, Washington: Bureau of Radiological Health, 1970. The HVL reported here is the initial HVL for narrow beam geometry.
4. U.S. Nuclear Regulatory Commission. 10 CFR 20 Appendix B – Standards for Protection Against Radiation, 1994.
5. ICRP Publication 30, Part 2, Limits for Intakes of Radionuclides by Workers. Pergamon Press, Oxford, 1980.
6. ICRP Publication 10, Evaluation of Radiation Doses to Body Tissues from Internal Contamination Due to Occu-pational Exposure. Pergamon Press, London, 1968.

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