

General Steel Industries (GSI) Special Exposure Cohort

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Background

- **General Steel Industries (GSI) was classified as an Atomic Weapons Employer (AWE) facility from 1953 to 1966**
- **Residual contamination period through 1993**
- **Performed radiography examinations of uranium metal using betatrons**
- **No correction of defects or other manipulation of uranium metal was reported**

Sources of Radiation: Internal

- **Dust from uranium corrosion**
- **Dust from activated steel**

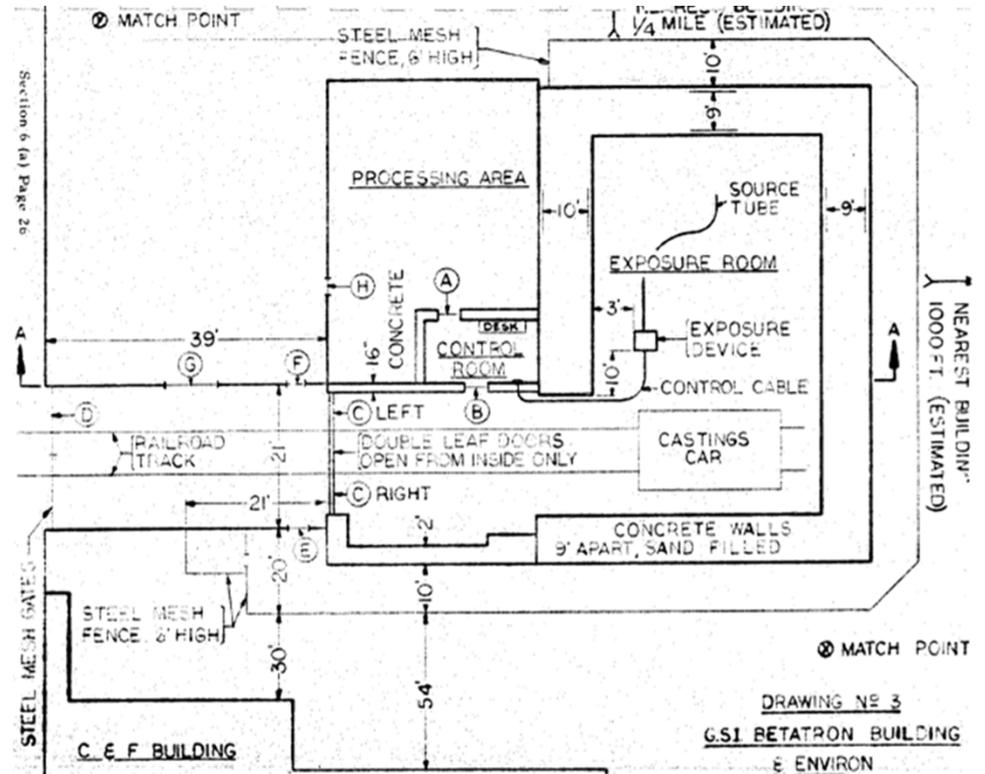
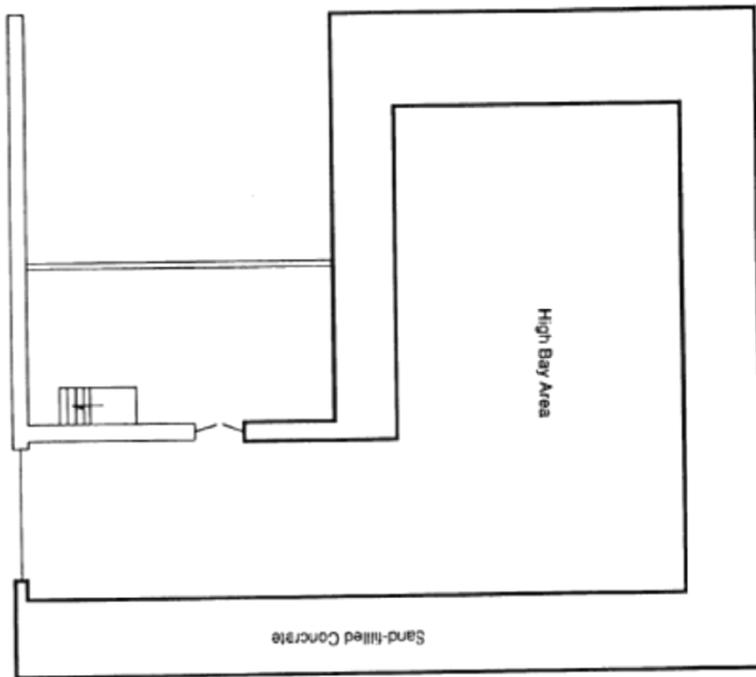
Sources of Radiation: External

- **Direct radiation from betatrons**
- **Activated steel**
- **Uranium**
- **Radiography with isotopic sources**
- **Portable x-ray machines**

Betatrons

- **Two betatron buildings on site, new and old**
 - **Old betatron was built in 1952 and was reported to have a maximum energy of 24 MeV**
 - **New betatron was moved from Eddystone, Pennsylvania, to Granite City in 1963 and was reported to have a maximum energy of 25 MeV**
- **Photon energy was high enough to cause activation**

Betatron Buildings



Activated Steel

- **Betatron energy was high enough to cause activation of steel castings**
- **MCNP, a computer program, was used to model this activation using favorable scenarios**
 - **Reported intensity**
 - **Drawings of the aluminum compensator and ion chamber**
 - **Maximum electron energy**
 - **Reported distances between betatron and castings**

Isotopic Sources

- **Two 500 mg Ra-226 sources until 1962**
 - **Used fishing pole technique to place sources**
 - **Interview with former operator described technique details**
 - **Sources used both inside a radiography room in 6 building and throughout the plant**

Isotopic Sources—cont.

- **Purchased two Co-60 sources in 1962**
 - **Discontinued use of Ra-226 at the request of the state of Illinois**
 - **Purchased two Co-60 sources in 1962**
 - **Sources were 260 mCi and 280 mCi**
 - **Sources were to be used in the radiography room**
 - **Workers reported sources also used throughout the plant**

Isotopic Sources—cont.

- **St. Louis Testing**
 - **Contracted to perform some radiography as well as provide other services (instrument calibration)**
 - **Used 50 Ci Ir-192 source and 10 Ci Co-60 source on site at various times**
 - **GSI employees were not involved with radiography performed by St. Louis Testing**

Other Sources of Radiation

- **GSI owned two portable x-ray machines**
 - **GE OX-250**
 - **Andrex**
- **Reports of the frequency and location of use are conflicting**
 - **The few memories of machines indicate infrequent use**
 - **Former supervisor indicated machine was tested when bought and not used again**

Data Sources: Film Badges

- **Film badge dosimetry from Landauer**
 - **Covers November 1963 through 1972**
 - **Only those associated with radiography were issued film badges**
 - **Weekly exchange**
 - **Reporting level of 10 mrem**
 - **99.7% of readings less than reporting level**

Data Sources: Film Badges—cont.

- **Prior to 1963, film badges were worn**
 - **Unable to locate reports of film badges**
 - **Information from interviews and pictures of former workers show film badges being worn**
 - **One former worker provided a film badge summary report**

Data Sources: NRC

- **Co-petitioner obtained GSI documents from Nuclear Regulatory Commission (NRC) via a Freedom of Information Act (FOIA) request**
- **Documents mainly licenses and applications for licenses and renewals**
- **License first granted in 1962 prior to purchase of Co-60 sources**

Data Sources: NRC—cont.

- **Information includes:**
 - **Drawing and radiation surveys of radiography room**
 - **Type and strength of isotopic sources (Ra-226 and Co-60)**
 - **Sparse information on source utilization and previous exposures**
 - **Detail drawing of new betatron building**
 - **Survey outside new betatron shooting room with 80 Ci Co-60 source exposed**

Data Sources: Former Workers

- Many workers were interviewed at various times by various people (Co-petitioner, NIOSH, SC&A)
- Some interviews were group settings and some individual

Data Sources: Former Workers—cont.

- **Information includes:**
 - **Work practices when using source outside radiography room**
 - **Violations of practices both routine and abnormal**
 - **Frequency and duration of x-rays using the betatrons**
 - **Badge practices including removing film badge when working outside betatron building**

Dose Estimate: Internal

- **Uranium modeled using uranium slug production values from Battelle-TBD-6000**
 - **Slug production involved some abrasive work while GSI did not perform any destructive work on the uranium metal**
- **Dose from uranium fission and activation products were included in the estimate**
- **Internal dose from activated castings was considered by assuming an individual continuously ground on a freshly activated casting**

Dose Estimate: External (Betatrons)

- **New Betatron building was modeled in MCNP**
- **Model was checked against a 1971 80 Ci Co-60 source survey**
- **Building model was then used to determine dose rates outside the building when betatron was operating at various locations and orientations**

Dose Estimate: External—cont.

(Betatrons)

- **Dose rate at the film badge storage location was determined for each orientation**
- **Orientations were chosen based on weekly dose rate at badge rack for each orientation consistent with the utilization described by the operators**

Dose Estimate: External—cont.

(Betatrons)

- **Hours per week of each orientation was then used to determine dose at various locations while betatron was operating**
- **Dose from steel and uranium after operations was determined and added to this dose**

Dose Estimate: External—cont.

(Betatrons)

- **Typical durations for x-rays of steel and uranium were assessed from worker interviews**
- **Separate dose estimates were derived for each**
- **The two dose estimates were combined using uranium work frequencies derived from purchase orders**

Dose Estimate: External

(Layout man)

- **Operators often marked castings for upcoming shots outside the betatron building**
- **When performing this work, film badges were not worn (kept in the betatron building)**
- **Exposed to betatron radiation while it was operating and to activated steel**

Dose Estimate: External—cont.

(Layout man)

- **Dose from betatron determined using worst-case location and orientation frequencies previously determined**
- **Dose from activated steel determined using worst-case scenario for moving castings into and out of the betatron building.**

Dose Estimate: External

(Co-60 sources)

- **A 1962 survey around the radiography room was used in combination with source utilization reported by the Atomic Energy Commission (AEC)**
- **Source strength and reported work practices outside the radiography room were used to determine that dose**
- **Highest of the two scenarios to be used**

Dose Estimate: External

(Ra-226 sources)

- **Source strength and reported work practices outside the radiography room were used to determine that dose**
- **Assumed radiography room did not exist before 1962**
- **Information since then indicates it did exist and was routinely used**
- **Estimate for radiography room was done by SC&A**

Dose Estimate: External

(St. Louis Testing Sources)

- **Reported that GSI radiographers did not help St. Louis Testing perform radiography**
- **Estimate based on continuous occupancy at the boundary**

Dose Estimate: External

(Portable X-rays)

- Reported frequency of use was very low
- Qualitative estimate used to estimate dose would be lower than other potential sources