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

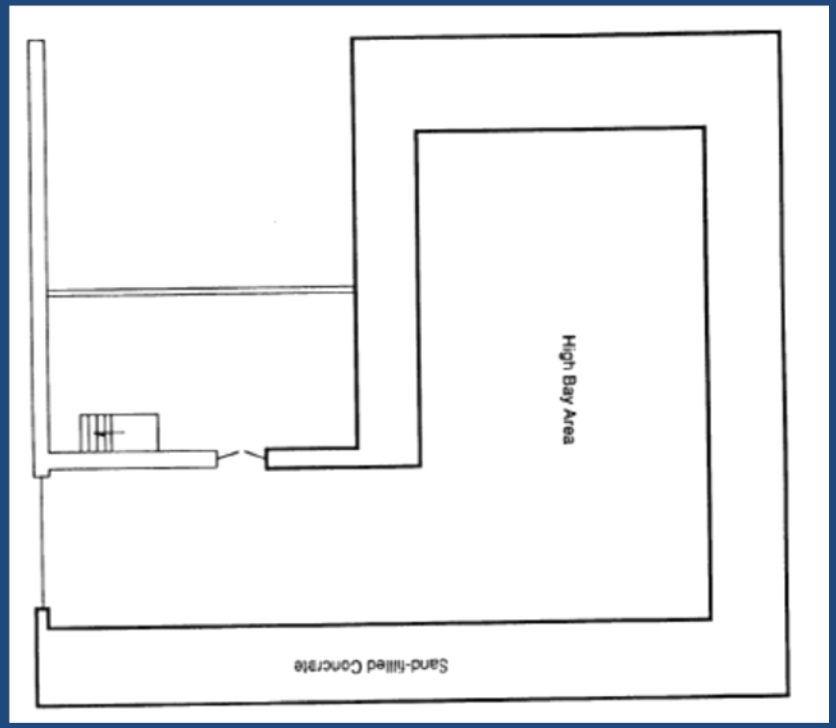
Sources of Radiation: External

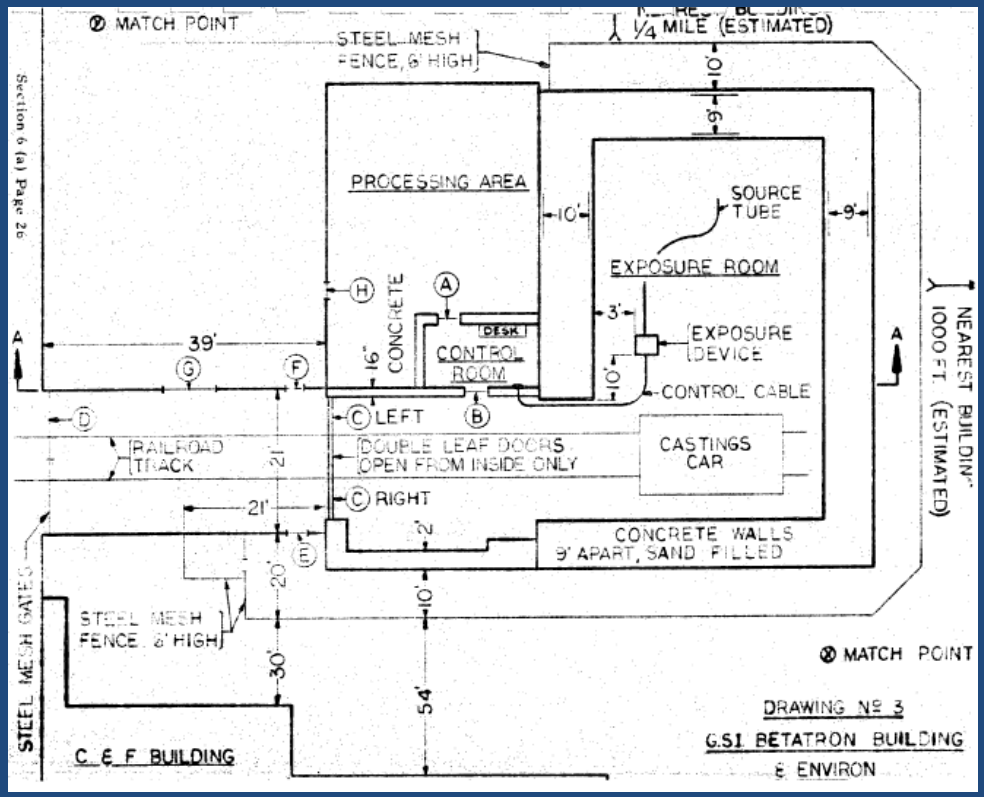
- Direct radiation from betatrons
- Activated steel
- Uranium
- Radiography with isotopic sources
- Portable x-ray machines

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

Use of TBD-6000

- All TBD-6000 tasks involve uranium metal
- All tasks inherently include moving uranium metal as well as other operations
- Moving the metal is the least airborne causing evolution
- All tasks in TBD-6000 are bounding for GSI
- The lowest task is most plausible

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

Residual Contamination

- Operational airborne assumed to deposit on surfaces
- Airborne assumed to be present when people were handling uranium
- Estimated the surface contamination then resuspended it
- External dose based on vacuum cleaner contact reading (higher than from surface contamination)