Insoluble Particulate Tritium Example Dose Reconstruction for the Pinellas Plant

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National Institute for Occupational Safety and Health

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Pinellas Plant
Insoluble Tritium Example Dose Reconstruction for Advisory Board

Employee Information

Cancer Description: Lung (ICD-9: 162); diagnosed 12/31/2015
Liver (ICD-9: 155); diagnosed 12/31/2015
Prostate (ICD-9: 185); diagnosed 12/31/2015
BCC (ICD-9: 173); diagnosed 12/31/2015
SCC (ICD-9: 173); diagnosed 12/31/2015

Year of birth: 1932
Gender: Male
Smoking: Never Smoked
Ethnicity: "White, non-Hispanic"

Employment Information

Start date: 01/01/1957
End date: 12/31/1997
Occupation: Unknown
Dosimetry Data: None

Organ Dose Assessed [1]

Cancer	External Organ Used	Internal Organ Used
Lung	Lung	Lung
Liver	Liver	Liver
Prostate	Urinary Bladder	Heart Wall[2]
Skin	Skin	Skin

1. ORAUT-OTIB-0005
2. Non-metabolic organ with the highest dose.

External Dose

Not applicable for tritium exposures.

Internal Dose

At the Pinellas Plant, insoluble particulate tritium [i.e., metal tritides (MT) and certain more insoluble forms of organically bound tritium compounds (insoluble OBT)] were handled in areas where the more dispersible and soluble forms of tritium [i.e., elemental tritium (HT), tritiated water (HTO), and certain more soluble forms of organically bound tritium compounds (soluble OBT)] were present. A review of the available dosimetry records indicates that the Pinellas Plant routinely monitored workers with any potential for exposure to tritium with bioassay (i.e. urinalysis) due to the potential exposure to the more soluble forms. This means that workers

with potential exposure to insoluble particulate tritium can be identified by the fact that they would have been included in the standard tritium bioassay program. Therefore, the insoluble particulate tritium intake rates below are applied only to the periods that workers were monitored for tritium via bioassay.

Contamination Levels

The available information on the Pinellas Plant indicates that only a relatively small portion of the Pinellas Plant's workforce had the potential to be exposed to dispersible forms of insoluble particulate tritium, and those scenarios were typically limited to accidents. The available incident information in the monthly health physics reports (SRDB 13358, 27095, 133577, 133579, 133580, 133581, 133583, 133586, and 133591) indicate that when the contamination levels exceeded the control level, the affected areas were cleaned up immediately. These monthly health physics reports indicate that as early as 1959, areas greater than 2×10^{-5} μCi/in^2 (688 dpm/100 cm^2) were recommended for decontamination. In 1969, the control limit was reported as 440 dpm/100 cm^2. This indicates that a routine contamination control program was in place throughout the history of the site and that it would be unlikely to see high contamination levels for extended periods of time. This was confirmed in an interview of a former radiological control employee (SRDB 127111) who indicated that metal tritide contamination was cleaned up fairly quickly. They indicated that radiological control personnel would take wipes in the morning and, if contamination was identified, they would then mop up the area and re-survey. The likelihood of routine high surface contamination level should be considered unusual and short in duration.

The source of the contamination indicated in these reported incidents are generally not associated with insoluble particulate tritium. Rather, they are associated with loaded glass tubes of tritiated gas (HT) that were dropped releasing the tritium gas or from maintenance activities (which would likely be associated with soluble OBT). Exposures associated with these types of releases would be captured in the assessment of the individual's tritium bioassay.

The monthly health physics reports also provide information on the maximum tritium surface contamination levels. Between 1957 and 1973, the highest surface contamination level identified in the health physics reports was in 1970, 4.4×10^6 dpm/100 cm^2 (10,000 times the control limit). This incident was actually associated with maintenance activities and not insoluble particulate tritium. There were three other instances where contamination levels were reported as greater than 1×10^6 dpm/100 cm^2. None of these instances were associated with insoluble particulate tritium. The majority of the rest of the maximum surface contamination levels reported in the monthly health physics reports are at least an order of magnitude or more lower than these.

The Mound Plant was a facility that performed insoluble particulate tritium work similar to the Pinellas Plant. The highest annual 95th percentile surface contamination level associated with SW-8 and R-108 at the Mound Plant was less than 3×10^5 dpm/100 cm^2. This is about an order of magnitude lower than the maximum surface contamination level identified at the Pinellas Plant.

Therefore, the use of a constant contamination level of 4.4×10^{6} dpm/100 cm^2 at the Pinellas Plant is considered bounding and favorable to the claimant.

Resuspension Factors

Based on a review of various methodologies for other sites, a resuspension factor of 1×10^{-6} $m^{-1}$is generally used for decontaminated undisturbed areas; whereas, a resuspension factor of 1×10^{-5} m^{-1} or greater is generally used for areas with ongoing operations in areas with a significant amount of loose contamination. The assumption for the Mound Plant is a resuspension factor of 5×10^{-5} m^{-1}. The Pinellas Plant was aware of the impact of contaminated areas and worked to maintain a clean work environment when contamination was identified, therefore a resuspension factor of 1×10^{-6} to 1×10^{-5} m^{-1} is probably more consistent with the conditions at the Pinellas Plant. However, given that the type of tritium work and facilities at Pinellas are similar to those at Mound, the more favorable to the claimant resuspension factor of 5×10^{-5} m^{-1} will be used.

Intake Analysis

Based on the information above, the bounding potential unmonitored insoluble particulate tritium exposure will be based on:

- Constant surface contamination level of 4.4×10^{6} dpm/100 cm^2 (4.4×10^{8} dpm/m^2)
- Resuspension factor of 5×10^{-5} m^{-1}

This resulted in a calculated particulate tritium air concentration of 24,200 dpm/m^3. Applying a breathing rate of 1.2 m^3/hour and an exposure time assumption of 50-hour weeks (based on a review of telephone interviews provided by former workers) for 52 weeks per year (2,600 hours total per year), the annual inhalation and ingestion intake rates for insoluble particulate tritium were calculated and are provided in the table below. Ingestion rates are based on guidance from OCAS-TIB-0009.

Inhalation	Ingestion
3.09×10^{7} pCi/year 8.47×10^{5} pCi/calendar day	5.80×10^{5} pCi/year 1.59×10^{3} pCi/calendar day

These values account for only potential insoluble particulate tritium intakes. Exposure to soluble forms of tritium (HT, HTO, and soluble OBT) will be assessed based on the worker's tritium bioassay data. The assessment of tritium bioassay (i.e., soluble forms of tritium) is not covered in this example dose reconstruction.

Solubility Types M and S tritiated compounds were present at the Pinellas Plant. There is limited information to clearly indicate which form of insoluble tritiated compound(s) a worker might have been exposed to, the potential exposures are based on the more favorable to the claimant solubility type.

Uncertainty

Because the assigned intakes represent an upper-bound for the energy employee's potential unmonitored insoluble particulate tritium intakes, all doses are applied as a constant distribution.

Summary

The assessment methods presented in this report define the methods by which a dose estimate can be determined for the evaluated worker class. These methods support NIOSH's conclusion that the operationally-related internal dose for the evaluated worker class can be bounded. A summary of the doses and probability of causations are provided below.

Cancer	External (rem)	Internal (rem)	Total (rem)	Probability of Causation
Lung	n/a	4.632	4.632	22.12%
Liver		0.009	0.009	0.12%
Prostate		0.009	0.009	0.02%
Skin BCC		0.009	0.009	0.04%
Skin SCC		0.009	0.009	0.01%