



DEPARTMENT OF HEALTH & HUMAN SERVICES

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## Memorandum

**To:** Carborundum Work Group  
**From:** Thomas P. Tomes, DCAS Health Physicist  
**Subject:** Use of Surrogate Data at the Carborundum Company  
**Date:** 10/27/2016

The DCAS assessment of doses to workers at the Carborundum Company in the Evaluation Report (ER) for petition SEC-00223 included the use of data from Battelle-TBD-6000 (Battelle, 2011) to estimate internal and external doses to workers at Carborundum. This correspondence evaluates the applicability of the surrogate data in TBD-6000 against the criteria established by DCAS in OCAS-IG-004 (DCAS, 2008). The Advisory Board has a document with similar criteria for use of surrogate data (ABRWH, 2010).

The Carborundum Company in Buffalo, NY, is a covered AWE facility in June through September 1943, and from 1959 through 1967. The 1943 work was limited to the experimental grinding of uranium metal slugs. The 1959 through 1967 work involved developmental research, fabrication and study of the properties of refractory uranium compounds and mixed plutonium/uranium compounds. In addition to the developmental work, the compounds were synthesized into small pellets for fuel for experimental testing in a reactor (at another site).

The DCAS ER relies on surrogate data contained in TBD-6000 to estimate external and internal doses for the 1943 experimental work with uranium metal. It also relies on surrogate data for the reconstruction of external dose from uranium work in 1959 through 1967. External dose from the mixed uranium/plutonium compounds do not rely on surrogate data, nor do estimates of intakes for 1959 through 1967.

### **1943 Work**

As described in the ER, the 1943 work was limited to experimental centerless grinding of ten uranium slugs for the purpose of selecting an abrasive that could be used (by others) to finish grind uranium metal. Ten slugs totaling 30 pounds were used in the testing.

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There are no personal or area monitoring data, and none are known to exist, to estimate radiation doses. The source term for exposure is known: thirty pounds of natural uranium metal slugs. The ER refers to doses provided in *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*, Battelle-TBD-6000, as an appropriate surrogate. Although TBD-6000 was developed for the reconstruction of doses at AWE facilities in the absence of monitoring data, its applicability must be established on a case by case basis.

Implementation Guide 004 (IG-004) has a list of criteria that must be met for the use of surrogate data when the hierarchy of data indicates surrogate data can be considered. Each of the five criteria discussed in IG-004 were evaluated for the applicability of the data in TBD-6000 to the reconstruction of doses during the grinding of slugs in 1943.

### Source Term

As provided in the ER section 5.1.1, the source term for the 1943 work at Carborundum is well known. The work was limited to natural uranium metal slugs, which is included in the various shapes of metal evaluated TBD-6000. The source terms are similar.

### Facility and Process Similarities

Carborundum's 1943 work did not involve a production process, but they handled a few uranium metal slugs and experimented with different abrasives and machine settings with a centerless grinder. TBD-6000 external doses include specific evaluations of exposure to workers handling uranium metal, including slugs; it also includes estimates of airborne radioactivity and intakes by workers involved with the centerless grinding of uranium metal. The Carborundum centerless grinding was limited to a short period of time, but involved some repeated grinding of the same pieces. One of the considerations in IG-004 is size and ventilation of the work area, which is unknown at Carborundum for the 1943 work.

The values for centerless grinding in TBD-6000 are those reported for unventilated grinding, which very likely was the case for Carborundum in 1943. The 1943 work was not a production operation as compared to TBD-6000, yet could have had intermittent high concentration around the machine. Based on the operations described in the report from Carborundum, testing was done in June 1943 during which they made frequent changes of wheels and machine settings until they found an abrasive that worked. Once an effective abrasive and machine settings were determined experimentally, they ground the slugs on a number of passes. That was the extent of the work. The TBD-6000 centerless grinding intake rate is the daily weighted average for a centerless grinder operator in a facility that had no ventilation to mitigate airborne releases into the breathing zone of the operator. Those operators were exposed to very high airborne concentrations, with the average daily exposures provided in TBD-6000. The next section discusses the underlying data in TBD-6000 in more detail.

### Temporal Considerations

Building design and process changes are identified as issues that could impact intakes of workers doing the same work, but in facilities designed in different eras. There is no definitive information on design of the grinding operation at Carborundum, and efforts to obtain more information were unsuccessful. There is no reason to think any special engineered controls were in place at Carborundum. The bounding intakes for a centerless grinder operator at Carborundum is based on uranium air concentration released from the grinder into the breathing zone of the machine operator, which is the specific exposure scenario for centerless grinding evaluated by Harris and Kingsley (1959), the main reference for intakes in TBD-6000. Harris and Kingsley evaluated operators who were exposed to centerless grinding of uranium metal slugs in both unventilated and ventilated operations, providing maximum observed concentrations released into the breathing zone of an operator. They also provided average daily weighted air concentrations for facilities without designed controls and for those with ventilation on the grinder in the 1950s. The average daily air concentration for unventilated work is provided in TBD-6000. The average daily intakes from ventilated grinding are much lower than the intake rates provided in TBD-6000. The higher air concentration in TBD-6000 for unventilated exposure is appropriate for Carborundum. SC&A also evaluated the intakes specified by NIOSH for Carborundum and concluded it was sufficiently bounding and allows for the maximum observed (by Harris and Kingsley) air concentration released into the breathing zone of an operator (SC&A, 2016, section 5.2.1).

### Data Evaluation

The quality of the TBD-6000 data and the applied uncertainty has been reviewed previously by NIOSH and the Advisory Board. Therefore, it is not necessary to review the quality and validity of the TBD-6000 data.

### Review of Bounding Exposure Models

The plausibility of intakes at the levels provided in TBD-6000 was considered. The Carborundum work with uranium in 1943 was not a production operation, although the work could have had significant grinding for short periods of time. Carborundum reported the results of the experiments one month after receipt of the ten uranium slugs. However, the slugs were on site for about four months total. Although the intake value from TBD-6000 is appropriate for centerless grinding, it may be high based solely on quantity of materials in process at Carborundum. Carborundum experimented with the same slugs using different abrasives and machine settings. Once an effective abrasive and machine settings were determined experimentally, they ground the slugs on a number of passes. Based on the amount of work performed, the centerless grinder operator was likely exposed for a significant amount of time for a relatively short period. NIOSH currently has no definitive information to adjust the number of hours exposed to allow for the actual time uranium was ground during the four months in 1943. Therefore, the

doses and intakes from TBD-6000 for the period “up to 12/31/1950” are applied for the four month AWE period. Those are considered plausible bounding dose rates.

### **1959 through 1967 Work**

The ER relies on surrogate data for external dose estimates for workers exposed to uranium during developmental research, fabrication and study of the properties of refractory uranium compounds. NIOSH does not use surrogate data to estimate external dose for exposure to mixed uranium/plutonium carbide, nor is surrogate data used for internal dose estimates for the 1959 through 1967 period.

There are no available dosimeter data or area monitoring data. Efforts to locate data were unsuccessful. The source term for uranium exposure are the uranium compounds: uranium nitride (UN), uranium carbide (UC), and uranium silicide ( $U_3Si_2$ ), and the source compounds used to synthesize them. The ER Table 5-2 entries for contract AT-(40-1)-2558 identifies the source uranium compounds used:  $UO_2$ ,  $U_3O_8$ , and uranium shot. That table also provides the SRDB Ref ID numbers for various reports describing the processes and work with uranium.

The ER uses external doses provided in *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*, Battelle-TBD-6000. That has been used by NIOSH as surrogate data for work at other uranium processing facilities.

IG-004 has a list of criteria to be met for surrogate data use when the hierarchy of data indicates surrogate data can be considered; each criteria is discussed below.

### **Source Term**

Records indicate the uranium work under contract AT-(40-1)-2558 involved normal and depleted uranium. TBD-6000 provides dose rates for exposure to uranium metal, and has a table of beta dose rates from various uranium compounds and natural uranium metal.  $UO_2$  and  $U_3O_8$  are listed and are marginally lower than dose from metal. The refractory compounds synthesized at Carborundum (noted above) are not listed in the table, but those compounds should also be marginally lower than the more dense uranium metal. Records indicate some limited work with other uranium compounds as well, such as ammonium diuranate. Therefore, the dose rates from uranium metal should provide a sufficient and favorable estimate of dose rates from the compounds produced at Carborundum.

### **Facility and Process Similarities**

The design of the facility and details of the processes at Carborundum have limited impact on estimates of the external doses provided in TBD-6000. The TBD-6000 bounding doses to an operator are based on the assumption an operator spent 50% of the workday at a distance of 1 foot from the surface of

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uranium metal. So, the principle issue is the assumption of number of workhours a Carborundum worker spent in close proximity to the pieces of uranium being fabricated.

That time of exposure appears sufficient for Carborundum given the various steps involved in synthesizing and studying the materials. That work included small batch processing of the source uranium in the laboratory equipped with gloveboxes, grinding mills, and furnaces. Batch work included holding times in mills and furnaces (many hours) in the preparation of the compounds and pressing them into shapes for testing and sintering. Small pellets and a couple other shaped pieces were made for different physical examination and testing of the pieces (AEC, 1961).

From a review of the various project progress reports, it appears that, on average, a significant amount of time would have been spent away from direct contact with the materials. Given that NIOSH has no personal dosimeters for those workers, the assumption of a one foot distance exposure 50% of the time, as provided for uranium metal in TBD-6000 should provide a favorable bounding dose rate.

### Temporal Considerations

The methods of external dose modeling do not rely on changes to facilities from one era to another. The Carborundum uranium work was experimental laboratory scale developmental work with limited production of product. The discussion in the *Facility and Process Similarities* section above regarding time and distance is the primary issue in use of the surrogate data.

### Data Evaluation

The quality of the TBD-6000 data and the applied uncertainty has been reviewed previously by NIOSH and the Board. Therefore, it is not necessary to review the quality and validity of the TBD-6000 data.

### Review of Bounding Exposure Models

The dose rates in TBD-6000 are considered reasonable estimates for the uranium compounds and pieces of uranium refractory compounds synthesized at Carborundum. The 50% workday exposure model at one foot is a reasonable bounding estimate.

### Conclusion

NIOSH reviewed the use of surrogate data in the reconstruction of doses for workers at the Carborundum Company against the criteria contained in OCAS-IG-004. Based on the evaluation provided above, NIOSH concludes that the use of surrogate data in TBD-6000 is appropriate for bounding: 1) internal and external exposure to uranium in 1943; and 2) external exposure to uranium compounds from 1959 to 1967.

## References

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