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**Draft**

**SC&A'S ISSUES MATRIX FOR THE BROOKHAVEN NATIONAL LABORATORY  
SITE PROFILE TECHNICAL BASIS DOCUMENT**

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## Brookhaven National Laboratory Site Profile Issues Matrix

This matrix contains a list of the issues (formally titled Findings in the site profile review) that SC&A identified in Rev. 00 of the Brookhaven National Laboratory (BNL) technical basis document (TBD) ORAUT-TKBS-0048 (ORAUT 2006), with some status updating against the recent Rev. 01 edition of ORAUT-TKBS-0048 (ORAUT 2010). As of January 2012, SC&A has not performed a complete re-evaluation of the site profile issues in view of the recent Rev. 01 edition, or the two NIOSH Special Exposure Cohort (SEC) evaluation reports (NIOSH 2009 and NIOSH 2012), awaiting Work Group direction. Two SECs presently exist for BNL; one for the period January 1, 1947, through December 31, 1979, and one for the period January 1, 1980, through December 31, 1993.

This site profile issues matrix is based on preliminary assessments of the following:

- The BNL TBD ORAUT-TKBS-0048, Rev. 00, August 30, 2006 (ORAUT 2006)
- SC&A's September 2009 review of the BNL site profile ORAUT-TKBS-0048, Rev. 00, August 30, 2006 (SC&A 2009)
- The NIOSH SEC-00113 Evaluation Report dated September 29, 2009 (NIOSH 2009)
- The BNL TBD ORAUT-TKBS-0048, Rev. 01, April 26, 2010 (ORAUT 2010)
- The NIOSH SEC-00196 Evaluation Report dated January 5, 2012 (NIOSH 2012)

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<b>Finding 1: Bioassay Monitoring Not Adequately Established</b>
ORAUT-TKBS-0048 (ORAUT 2006) does not provide sufficient information to determine which workers were monitored for what radionuclides and what criteria were used to select workers for special, routine, and spot bioassay monitoring. To perform an adequate dose reconstruction, the dose reconstructor needs to know who, when, and why workers were bioassayed at a given DOE site. This information allows the dose reconstructor to determine if the worker should have been monitored, and prompts the dose reconstructor to search for such records, if applicable (especially important because of the lack of a centralized record system at BNL). Although bioassays for some radionuclides were conducted for some workers at BNL throughout the laboratory's operating history, sufficient documentation of written procedures and requirements for bioassays is not apparent before the 1990s; this leaves 40 years of uncertainty concerning bioassay requirements.
<b>SC&amp;A's February 2012 update:</b> The SECs negate this concern through 1993. <i>SC&amp;A needs to determine if this issue is still applicable after 1993.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 2: Records of Bioassay Monitoring Not Centralized or Knowingly Complete</b>
The site profile does not address the issue of the completeness and accessibility of the bioassay records. There were numerous bioassay data recording systems and filing methods at BNL. Many of these earlier records are still located in various departments, making it difficult (as confirmed by current BNL health physics personnel) for BNL to properly and completely respond to NIOSH requests for bioassay records to be used for dose reconstruction. It is not currently known by BNL health physics personnel if all the hardcopy records have been located, are legible, and are accessible for dose reconstruction. As various departments were formed and supplanted, and as department heads came and left BNL, the hardcopy records may have survived, or they may have been destroyed or removed from the site. There is presently no method available to determine if all the records for a given employee are available for dose reconstruction purposes, particularly before the records were centrally stored in electronic databases.
<b>SC&amp;A's February 2012 update:</b> The SECs negate this concern through 1993. <i>SC&amp;A needs to determine if this issue is still applicable after 1993.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 3: Minimum Detectable Activity and Uncertainty Values Not Sufficiently Defined</b>
Minimum detectable activity (MDA) is mentioned several times in Section 5 of the site profile (ORAUT 2006), and a list of whole-body counter (WBC) MDA values is provided in Table 5-3, pp. 78–79) for the years 1999 through 2005. Additionally, urinalysis MDA values for some of the common radioisotopes found at BNL are listed in Table 5-3, pg. 80), mainly for 1999–2006. Therefore, a reasonable amount of MDA information for common radioisotopes is provided for 1999–2006. However, what is lacking is a comprehensive listing of urinalysis and WBC MDA values for the 1940s–1990s, such as is found in other NIOSH site profiles. Additionally, uncertainty values are not provided, and are apparently not available, for most of the bioassay reporting period from the 1950s–1990s.
<b>SC&amp;A’s February 2012 update:</b> The SECs negate this concern through 1993. <i>However, this issue is still pertinent for the period 1994–1998 for many of the radioisotopes.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Meeting:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 4: Radionuclide Characteristics Not Sufficiently Known</b>
Unfortunately, as stated in Section 5.10 of the site profile (ORAUT 2006), specific <i>solubility data</i> , <i>particle size</i> , and <i>activity fractions</i> are not known, or are not available, for most facilities at BNL. Table 5-5 lists a few of the activity fractions, presumed to have come from stack emission data. However, stack emissions are not always a good indicator of the types of radioisotopes present, or their concentrations, in the worker's breathing zone (this also applies to Table 2-2). Interviews with BNL workers indicate that Tables 2-2 and 2-3 do not correctly reflect the historic radioisotopes present at some of the BNL facilities. Without appropriate characterization of workplace exposures, the adequacy and completeness of the internal and external monitoring programs come into question and may result in a less than favorable organ dose reconstruction. In addition, workplace specific <i>monitoring data</i> and/or <i>source term data</i> do not appear to be available.
<b>SC&amp;A's February 2012 update:</b> The SECs negate this concern through 1993. <i>However, this issue is still pertinent after 1993.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Action:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 5: No Internal Coworker Dose Database Available</b>
The site profile (ORAUT 2006) does not address internal coworker dose data. In view of the issues with the lack of a coordinated, consistent bioassay program and the problems with the availability of historic bioassay records, it would be advantageous to have a viable coworker database to use to assign unmonitored dose. Unfortunately, the lack of a routine and comprehensive bioassay program before the 1990s may make it difficult to create an adequate coworker internal dose table for the dose reconstructor to bridge monitoring or recordkeeping gaps for sporadically monitored workers, monitored workers whose complete records are not available, and for unmonitored workers who should have been monitored.
<b>SC&amp;A's February 2012 update:</b> The SECs negate this concern through 1993. <i>However, this issue is still pertinent after 1993.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 6: NTA Threshold Response Not Sufficiently Investigated</b>
The threshold energy of NTA film and the amount of dose not registered due to this limitation is important in neutron dosimetry. NTA film decreases in response starting at neutron energies below 1 MeV, and is almost completely insensitive to neutrons below 0.5 MeV; therefore, radiation fields containing an appreciable percentage of the total dose equivalent due to neutrons below 1 MeV must be evaluated carefully, with attention given to the missed dose resulting from this threshold affect. The site profile does not specifically address the subject of the NTA film threshold. The site profile should address this issue and make clear and technically sound recommendations to compensate for the incomplete neutron doses as recorded by NTA film and contained in the dose of record.
<i>SC&amp;A's February 2012 update: SC&amp;A needs to determine if the revised TBD provides additional information that could be applied to this issue.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 7: NTA Track Fading Not Covered in the Site Profile (ORAUT 2006)</b>
The magnitude of the proton recoil tracks in NTA film resulting from neutron interactions depends on the energy of the interacting neutron. Lower-energy neutrons cause less dense proton recoil tracks; these tracks fade more rapidly with time than heavier tracks caused by more energetic recoil protons resulting from energetic neutrons (i.e., 0.5–1.0 MeV neutrons in the workplace versus 4 MeV neutrons from a calibration source). The site profile did not directly address NTA film track fading, provide evidence that it was not a problem at BNL, or describe any procedure necessary to compensate for it.
<b>SC&amp;A's February 2012 update:</b> <i>SC&amp;A needs to determine if the revised TBD provides additional information that could be applied to this issue.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 8: NTA/TLD/Lexan/CR-39 Problems</b>
The problems associated with the NTA film threshold and track fading initiated a search for other neutron dosimeters; among those tested and selected for use at BNL were the TLD, CR-39, and Lexan neutron dosimeters. However, these neutron dosimeters were not without their own shortcomings. There were issues with NTA film, CR-39, and Lexan neutron dose readings, and even the gamma-muon readings. None of the detectors appeared to establish a long-term “gold standard” to which results could be compared. During the 1980s and 1990s, a number of issues were ongoing between BNL and their dosimetry vendor, Landauer. The BNL site profile does not cite these dosimetry problems, if they were solved, or make any recommendations on the use of the neutron dose records, given the concerns and uncertainties associated with these issues.
<i>SC&amp;A’s February 2012 update: SC&amp;A needs to determine if the revised TBD provides additional information that could be applied to this issue.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 9: Potential Exposures at Accelerators Not Sufficiently Covered</b>
High-energy accelerators, such as the many diverse types operated at BNL during its 60-year history, present the standard health physics problems, as well as emergent new challenges, typically unique to each type of new accelerator. There are many situations at high-energy accelerators that have the potential for unconventional exposures leading to unrecorded or under-recorded doses. The present BNL site profile does not address the unique dosimetry problems associated with high-energy accelerators, if the dosimetry systems were adequate during the startup periods, or if the dosimetry systems were sufficiently encompassing to accommodate operational changes. Nor does the site profile discuss adjustment factors for neutron doses, and if they are needed to compensate for the limitations of the dosimetry systems used as a function of time at different accelerator facilities.
<i>SC&amp;A's February 2012 update: SC&amp;A needs to determine if the revised TBD provides additional information that could be applied to this issue.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 10: External Coworker Dose Data Not Addressed</b>
Section 6 of the site profile (ORAUT 2006) does not address or provide any coworker data for use in assigning doses to workers who should have been monitored, but were not. Coworker data are needed in cases where the worker had the potential to receive greater than environmental doses, but by the criteria at the time, the individual was not considered a radiation worker and, therefore, was not badged, or the monitoring results cannot be located.
<b>SC&amp;A's February 2012 update:</b> Although some of the information has changed in the revised TBD, there appears to be no significant changes concerning this issue; <i>therefore, this issue is still pertinent.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 11: Incidents and Unanticipated Events Not Addressed</b>
The site profile (ORAUT 2006) does not sufficiently address incidents or unusual events that could affect external dose reconstruction. Some examples of incidents were found in the BNL documents; however, the site profile itself did not address such incidents for their implications to dose reconstruction, and whether the doses of record were correct under these exposure conditions. Likewise, specific environmental-related incidents and releases and their impact on onsite occupational doses to unmonitored workers are not addressed.
<b>SC&amp;A's February 2012 update:</b> Although some of the information has changed in the revised TBD, there appears to be no significant changes concerning this issue; <i>therefore, this issue is still pertinent.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<b>Finding 12: Potential Environment Exposures from Igloo Area Not Addressed</b>
Nothing is mentioned in Section 4 of the site profile (ORAUT 2006) concerning the Igloo storage area in the Hazardous Waste Management Facility and its impact on localized environmental doses. Averaged site parameter yearly readings, and other readings inside the BNL site, may not reflect the true environmental doses received by unmonitored workers who spent any significant time in the areas outside the Igloo or other hazardous waste facility areas.
<b>SC&amp;A's February 2012 update:</b> Although some of the information has changed in the revised TBD, there appears to be no significant changes concerning this issue; <i>therefore, this issue is still pertinent.</i>
<b>NIOSH Response:</b>
<b>SC&amp;A Reply:</b>
<b>Work Group Actions:</b>
<b>Board Action:</b>

## Brookhaven National Laboratory Site Profile Issues Matrix

<p><b>Finding 13: The Site Profile has Inadequately Characterized the Number and Types of X-rays Received by BNL Employees in Early Years</b></p> <p>The site profile (pg. 50) (ORAUT 2006) states that BNL had machines capable of photofluoroscopic/ fluoroscopic exams in 1951 and 1960, but on page 50, it is concluded that only the diagnostic unit was used for routine exams, and on page 52, it is stated that it seems unlikely that the greater dose units were used for routine exams. These potential exposures were not further addressed in the site profile. It references Brodsky 1964 as one of its reasons to conclude that only the diagnostic unit was used routinely for examinations. However, Sunderman (1947) summarized the health program used for BNL employees in September 1947. Sunderman recommended that employees of BNL be observed medically (1) upon hire at BNL, (2) routinely for employees requiring health maintenance, (3) when employees become sick or injured, and (4) when employees terminated. Candidates for employment were to receive “fluororoentgenograms of the chest, AP and LAT roentgenograms of the spine, and roentgenogram of one forearm.” During Health Maintenance exams of employees, an annual fluororoentgenogram of the chest was completed.</p>
<p><b>SC&amp;A’s February 2012 update:</b> There have been some changes in this area in the revised TBD (ORAUT 2010); therefore, SC&amp;A needs to determine if the revised TBD provides additional information that could be applied to this issue.</p>
<p><b>NIOSH Response:</b></p>
<p><b>SC&amp;A Reply:</b></p>
<p><b>Work Group Actions:</b></p>
<p><b>Board Action:</b></p>

## Brookhaven National Laboratory Site Profile Issues Matrix

### References:

Brodsky, A., 1964. Minutes of a meeting (no title) held on June 29, 1964 between A. Brodsky of BNL and Paul Klevin of the Atomic Energy Commission. Brookhaven National Laboratory, Upton, New York. Ref ID 17344.

NIOSH 2009. *SEC Petition Evaluation Report, Petition SEC-00113*, Rev. 0. National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio. September 29, 2009.

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Sunderman, F.W., M.D., 1947. *Health Program for Employees of the Brookhaven National Laboratory*, Brookhaven National Laboratory, Upton, New York. August 27, 1947.