ISSUE RESOLUTION MATRIX FOR FINDINGS AND KEY OBSERVATIONS

Issue Resolution Matrix for INL Findings and Key Observations

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.	NIOSH Response	Variance/Status
1	ORAUT-TKBS-0007-4	5	Issue 1: (5.1.1.1) Routine Airborne Releases - Source terms provided require improvement for use in determining the worker intake from airborne releases at different INL facilities. The data NIOSH uses do not take into account the deficiencies in the environmental monitoring equipment and their locations, and, in addition, NIOSH does not assess the uncertainties associated with the meteorological dispersion model used for the INL site. Most importantly, the source terms do not account for worker inhalation of resuspended contaminated soils and materials around the INL facilities.	45	The SC&A comments are directly related to the Tiger Team report (DOE/EN-0178, 1991). That report cites 40 CFR 50 and 40 CFR 58, both of which are EPA regulations concerning primary ambient air quality standards. The equipment type, location requirements, and uncertainties referred to in those standards are designed for purposes other than what NIOSH is using this data. The dose calculations made by NIOSH are independent of the requirements in those standards. NIOSH requests the reference SC&A used to determine that the uncertainties not accounted for in the meteorological dispersion model. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has revisited the meteorological dispersion model that was used to calculate the environmental intakes in ORAUT-TKBS-0007-4. The focus of that revisitation involved investigating SC&A's concerns about the model not being appropriate for evaluating	

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					dispersion coefficients at distances <20 km from the release point, and the source terms not accounting for worker inhalations of resuspended contaminated soils and materials. The results of that investigation have been provided to the INL working group in a white paper.	
2	ORAUT-TKBS-0007-4	6	Issue 2: (5.1.1.2) Episodic Airborne Release - The airborne releases associated with several of the Initial Engine Tests of the Aircraft Nuclear Propulsion (ANP) Program were likely to have been underestimated by factors ranging from **2 to 16**. Also, NIOSH did not evaluate the uncertainties associated with the deficiencies in air monitoring equipment.	55	Please provide a basis for the "factors ranging from 2 to 16." Please see response to number 1 regarding uncertainties. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has reviewed the SC&A report (*Critical Review of Source Terms for Select Initial Engine Tests Associated with the Aircraft Nuclear Propulsion Program at INEL*) on the Risk Assessment Corporation (RAC) modeling approach that was used for the INL site. The results of that review have been provided to the INL working group in a white paper.	

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3	ORAUT-TKBS-0007-4	7	Issue 3: (5.1.1.3) Direct Gamma Exposures – The fence-line TLD measurements are not adequate for reconstructing direct gamma doses to personnel working outdoors at and around a specific INL facility inside the fence-line boundary, because they do not take into account the most bounding scenarios.	57	Personnel within the various facilities were monitored and access was controlled. Dosimetry was required to enter the various "fenced" facilities on site. TLDs were placed on the fences enclosing the various facilities. The dose from these TLDs represents the bounding condition at the closest point an unmonitored individual could get to a facility.	Closed
4	ORAUT-TKBS-0007-5	8	Issue 4: (5.1.2.1) Completeness and Quality of INL Internal Dosimetry Programs - The identification and determination of missed internal dose for workers are heavily influenced by the assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker internal doses.	73	The default table for missed dose (5-24) does not have a basis in the "confidence" of the INL radiological program. The table is based on monitoring results, favorable ratios, and other claimant favorable assumptions. However, in resolving issue associated SC&A's Finding 3.5-1, for the ANL-W Site Profile, the previous approaches used to calculate missed and unmonitored internal doses have been completely replaced. The missed and unmonitored doses for activation and fission products are now based on the approach described in OTIB-0054. The unmonitored actinide doses are now being calculated using a new site-specific approach based on source term information and a	SC&A recommends closing

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					broader list of radionuclides.	
5	ORAUT-TKBS-0007-5	9	Issue 5: (5.1.2.2) High-Risk Jobs (Internal Exposure) - NIOSH did not evaluate comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker internal exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant's file are not complete.	77	NIOSH has monitoring records for internal dose and NIOSH feels the records are fairly comprehensive for "high-risk" jobs. The TBD contains requirements for reconstructing internal doses and for missed doses.	SC&A recommends that this finding remain open for further discussion.
6	ORAUT-TKBS-0007-5	O	Issue 6: (5.1.2.3) Calibration of Internal Dosimetry Analytical and Monitoring Equipment - The TBD does not provide any information on the calibration procedures, sensitivities, and standards of the internal dosimetry analytical equipment and monitoring instrumentation. The 1991 DOE Tiger Team findings show the deficiencies in these areas. NIOSH should evaluate the uncertainties and impacts on the internal dose assessment results associated with the deficient calibration programs at INL.	78	The references cited in the TBD provide information on the analytical equipment maintenance. Other facility audits find the program adequate. The equipment type, location requirements, and uncertainties referred to in the Tiger Team report are designed for purposes other than what NIOSH is using this data. The dose calculations made by NIOSH are independent of the issues discussed in an old Tiger Team report. NIOSH did account for uncertainties associated with the radiological model.	SC&A recommends that this finding remain open for further discussion.
7	ORAUT-TKBS-0007-5	O	Issue 7: (5.1.2.4) Changes of Internal Dose Limits - Inconsistent work practices were prevalent in the early years of the INL operation and may have led to significant missed dose to workers. NIOSH should evaluate the impacts of these dose limit	78	Dose limits have no impact on missed doses, since missed doses are solely the doses that would have gone undetected by a particular monitoring method	Closed

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			changes over the operating history of INL to see whether there were missed doses in the early years when the radiation protection policy was less protective and inconsistently implemented.		because of the limit of detection. Whereas, unmonitored dose is that for which no monitoring was performed. Therefore, NIOSH's response assumed that this comment was applicable to the potential unmonitored doses, since the dose limits influenced when internal dose monitoring was performed. A review of 90,515 urine sample results indicates that over 98% of the gross beta (GB) and gross gamma (GG) in urine results were below the MDA values provided in this TBD. In addition, a significant number of those positive bioassay measurements were follow-up measurements to previously identified intakes. Given that an overwhelming majority of the GB and GG in urine bioassay results, which constitutes most of the bioassay data in the early year of the INL's operations, were below the MDAs for those measurement methods, it is unlikely that the alleged inconsistent practices led to significant unmonitored internal doses.	

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8	ORAUT-TKBS-0007-5	10	Issue 8: (5.1.2.5) High-Fired Plutonium and Uranium Intakes - The TBD did not evaluate the hazard associated with high-fired plutonium and uranium at the INTEC (ICPP) and RWMC facilities. High-fired Pu-238, Pu-239, and uranium are not easily dissolvable, nor do they readily break into very small particles. They also emit some gamma rays and neutrons. Similar to the treatment of recycled uranium, NIOSH should evaluate the lung dose for intake of high-fired uranium and plutonium oxide particulates (alveolar deposition).	78	The INL internal TBD has been revised to include super-S Pu as a potential material type at the INL. Please define what you mean by high-fired uranium intakes.	SC&A recommends closing
9	ORAUT-TKBS-0007-5	O	Issue 9: (5.1.2.6) Skin and Facial Contamination – This TBD does not consider incidents with workers having skin contamination, facial contamination, and positive nasal swipes in the INL facilities. These kinds of problems would be compounded by the deficiencies in air sampling systems and ineffective respiratory protection programs. Guidance should be provided to a dose reconstructor to account for the missed dose due to the unaccounted uptake.	79	All versions of the internal TBD have indicated that the monitoring and analytical programs were designed to initiate, through *in vitro* and/or *in vivo* bioassay analysis, an investigation of any potential internal intake as indicated by positive air sampling, personnel contamination, etc… As a result, the skin and facial contamination incidents would have follow-up *in vitro* and/or *in vivo* bioassay measurement data when an intake was suspected. Therefore, the alleged deficiencies are of no consequence in NIOSH's dose reconstruction methods, since urine, fecal, whole body count, and lung count data would take precedence over air monitoring, contamination survey, and nasal smear data.	SC&A recommendation is pending a review of NIOSH's response to its WG action item.

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					03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has conducted additional research on INL practices to monitor and control skin contamination. The results of that investigation have been provided to the INL working group in a white paper.	
10	ORAUT-TKBS-0007-5	O	Issue 10: (5.1.2.7) Breathing Rates – The TBD assumption appears less claimant favorable than the ICRP or NCRP assumptions.	79	Based on the Section 5.1.2.7 of SCA-TR-TASK1-0005, this comment is actually being made for ORAUT-TKBS-0007-4. NIOSH was only able to find breathing rate information in Footnote c of Table 1 in ICRP 68, which also indicates that the information being provided was obtained from Table 6 of ICRP 66. The breathing rates in ICRP Reports 23, 66, and 68 for 8 hr of light work activity are all 9.6 m^3/workday. The INL Environmental TBD used an intake rate of 2,400 m^3/yr, which is equivalent to 9.6 m^3/workday times 250 workdays/yr. Therefore, the breathing rate used in the INL Environmental TBD is equivalent to the breathing rates recommended in ICRP Reports 23, 66, and 68.	Closed

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11	ORAUT-TKBS-0007-5	11	Issue 11: (5.1.2.8) Non-Occupational Worker Elimination of DU Background – The derivation of the background value of 0.16 µg/L used for subtraction from each urinalysis result of uranium prior to assessment of occupational internal dose for SMC radiation workers is not technically sound. The baseline background (population) intake value was determined by a study of urine samples submitted by non-radiation workers at the SMC facility. A better approach would be to use the urine excretion samples by non-INL people in the Idaho Falls areas. NIOSH should consider this subtraction from urinalysis results as a missed internal dose.	79	The idea to collect background samples from non-INL personnel is not feasible and is unreasonable. ICRP 23, lists the daily intake of naturally occurring uranium as 1.9 µg per day. Assuming equilibrium, the daily excretion of uranium through urine would also be 1.9µg. Applying the excretion volume for Reference Man of 1.4 liters per day, this results in a range of typical urinary concentration of 0.04 to 0.5 µg/L. Therefore, the INL's adjustment value of 0.16 µg/L is consistent with ICRP reference values for natural uranium. Reference: King, V. A., 2001, Technical Basis for Internal Dosimetry at SMC, EDF No. SMC-2001-02, Rev. 3, Idaho National Environmental and Engineering Laboratory, Idaho Falls, Idaho, May 31. [SRDB Ref ID: 8479, p. 67]	Closed
12	ORAUT-TKBS-0007-5	O	Issue 12: (5.1.2.9) Unmonitored Workers - The potential missed doses for unmonitored workers would be from inhaling resuspended contaminated soils and ingesting contaminated materials while eating in a contaminated, previously considered uncontaminated, area (such as office and cafeteria). NIOSH should evaluate these potential missed doses.	80	These scenarios are considered in the development of unmonitored doses.	Closed

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13	ORAUT-TKBS-0007-4/5/6	O	Issue 13: (5.1.2.10) Naval Reactor Facility Workers - As the internal dose TBD indicates, "some workers' internal dose could have resulted from their support work at the NRF." NIOSH should evaluate the potential missed dose at the NRF for these workers.	80	Workers assigned to the NRF are not covered as required by EEOICPA. However, doses received by NRF workers while responding to the Stationary Low-Power Reactor Number One (SL-1) accident are covered.	Closed
14	ORAUT-TKBS-0007-5	O	Issue 14: (5.1.2.11) Plutonium Monitoring - The TBD does not provide any historical information on the plutonium analysis methods used at INL. It is entirely possible that selective plutonium monitoring on workers was used at INL until 1980, but without this information, the dose reconstructors would not be able to assign missed internal dose due to plutonium intakes in the time period before 1980. NIOSH should provide information on plutonium monitoring.	80	Because plutonium was not separated from the spent nuclear fuel at the INL, the plutonium was always present with the more readily detectable mixed fission products that were also in the spent nuclear fuel. Therefore, in the vast majority of the plutonium exposure scenarios, the plutonium would have been present with the product and waste streams containing mixed fission products, and any intakes of radioactivity would have been more readily detectable by performing bioassay measurements for mixed fission products. Exceptions to these exposure scenarios may have included exposures to laboratory workers that may have separated and/or handled laboratory quantities of plutonium and the limited number of workers that may have somehow received a plutonium intake from the plutonium that was plated out on the surfaces inside a	SC&A recommends closing

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					decontaminated hot cell at the ICPP. Performing bioassay measurements for these few types of scenarios and possibly just as experimental bioassay procedures, would explain the sporadic plutonium bioassay data. Because the INL appears to have routinely performed bioassay measurements for mixed fission products when it thought there was any potential for exposure, and because the intakes of mixed fission products can be correlated to intakes of plutonium, the dose reconstruction process for the INL involves assigning missed plutonium doses based on either Pu:Sr-90 or Pu:Cs-137 ratios that get applied to intakes that were estimated for those fission products.	

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15	ORAUT-TKBS-0007-4/5/6	1	Issue 15: (5.1.3) SL-1 Accident Dose Reconstructions - The TBDs do not evaluate the potential missed internal and external doses or the associated uncertainties for the over 1,000 rescue and cleanup workers involved with the SL-1 accident that occurred in January 1961. There was a high potential for significant exposures, because the equipment used and the radiological control policies in place in that era were not as advanced and protective as those in current use. The TBDs should develop adjustment factors related to stay time, dose field estimates, internal dose results, external dose readings, and contamination level estimates.	80	NIOSH has a significant dosimetry history for first-responder and recovery workers at the SL-1 facility. The dosimetric records provide enough data to accurately reconstruct doses. In some instances SL-1 specific coworker dose is used. SL-1 dose reconstruction data is addressed in the TBD.	SC&A recommends that this finding remain open for further discussion.
16	ORAUT-TKBS-0007-6	8	Issue 16: (5.1.4.1.1) Completeness and Quality of INL Beta/Gamma Dosimetry and Record Keeping Programs - The identification and determination of missed external dose for workers are heavily influenced by this assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker external doses.	96	Please provide the reports of "significant deficiencies and inconsistencies in radiation work practices" and provide how the NIOSH-derived missed dose calculations are subject to the results of the Tiger Team report. NIOSH has no plans to develop an external coworker dose model.	SC&A recommends that the WG keep this issue open pending receipt and review of the INL-specific coworker model.
17	ORAUT-TKBS-0007-6	4	Issue 17: (5.1.4.1.2) Penetrating and Non-Penetrating Doses - NIOSH should re-evaluate the missed gamma dose, due to the deficiencies in the procedures and algorithms.	96	The under-reporting of the penetrating photon doses, due to the two-element film dosimeter's limitation for measuring low energy photon doses, at the INL is	SC&A recommends closing

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					much less of a significant situation for the majority of exposure scenarios than what is being indicated by SC&A. INL Health Physics personnel have been aware of the dosimeter response issues associated with low energy photons for many years, including at least some of the years when the two-element film dosimeters were being used. However, there were ways for the dosimetry personnel to determine whether a non-penetrating dose was likely attributable to beta or low energy photon radiation. One such way was noting the ratio of the OW and S readings from the dosimeter, since this ratio should be relatively consistent for similar radiation fields (i.e., in terms of radiation type and energy distribution). Because the OW reading for the two-element film dosimeters being used at the INL had a significant over-response to low-energy photons, an unusual amount of blackening on the OW film would be observed when the dosimeter was exposed to low energy photons. Therefore, an OW to S reading ratio that was significantly higher than usual	

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					would be an indication that the worker's non-penetrating dose contained a significant contribution from low-energy photon exposure. Also, using such dosimeter readings as is would potentially result in a significant overestimate of the non-penetrating dose that was being reported and could potentially have resulted in a dose limit being exceeded. Therefore, it was in the INL's best interest to at least be somewhat familiar with the OW to S reading ratios and the photon energy distributions for the various exposure scenarios and to adjust any doses that were too high because of the dosimeter's over-response to low energy photons. In addition to the unusual amount blackening that would have been observed on the OW dosimeter, the survey instrument readings would have indicated to the INL Health Physics personnel that the "beta" doses based on the dosimeter results were being significantly over-reported and that they were likely seeing the effect of the dosimeter's over-response to low energy photon radiation, since the hand held survey instruments that were	

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					carried during most hot jobs did not over-respond to the low energy photons.	
18	ORAUT-TKBS-0007-6	O	Issue 18: (5.1.4.1.3) Correction For Beta Doses – NIOSH should develop a method to consistently account for uncertainties in dosimetry readings. Claimant-favorable correction factors should be developed for beta dose reconstruction.	97	Table 6-9 in the TBD provides correction factors for under-reporting. Comment 18 quotes the following statement along with several others from OCAS-IG-001, which are quotes from Revision 1 (OCAS 2002) versus Revision 3 (OCAS 2007) of the OCAS-IG-001 and some of which is no longer in OCAS-IG-001. "If individual energy distribution information is not available for two-element film badges, the open window dose should be used as a claimant friendly estimate of the 30 to 250 keV dose." However, the comment didn't quote some statements that were in between the quoted statements. One such statement was, "When monitoring data do not indicate the relative energy distribution, the distribution can be estimated based upon either the site radionuclide inventory or the relative energy distribution which can be estimated for most facilities based upon a review of historical operations," which is still a statement in Revision 3 of OCAS-IG-001 (OCAS 2007) and is what	SC&A recommends closing

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					was used for the INL TBD. The photon energy distribution of 25% 30–250 keV photons and 75% >250 keV photons in the INL TBD is claimant-favorable for the majority of exposure scenarios at the INL, based on the radioactivity in The Materials Test Reactor's (MTR's) spent reactor and the waste stream for the ICPP (see attached file). MicroShield calculations indicate that 88.9% of the photons in the spent MTR reactor fuel have an energy greater than 300 keV, and that percentage increases to 98.8% for the ICPP's waste stream that contains all of the fission products and transuranics. It should also be noted that these energy distributions do not account for the effect from any minimal shielding that would have been in place for most exposure scenarios and would have further reduced the amount of low-energy photons that the workers were being exposed to. In addition, the potential under-reporting of the penetrating photon doses would have only been able to have occurred when the reported non-penetrating dose was	

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					significantly greater than the dosimeter's limit of detection, since the OW reading for the dosimeter would have been capable of detecting the low-energy photons and would have significantly over-responded to them. Therefore, this issue is only potentially applicable to the instances when a significant non-penetrating dose is reported for a specific dosimeter. Because reviews of the dosimetry data for a significant number of cases indicate that the majority of non-penetrating doses reported for most INL workers were either zero or insignificant, NIOSH expects that the number of potentially under-reported penetrating photon doses would have been very small. If SC&A has encountered any specific examples where an INL worker's penetrating dose was likely under-reported, NIOSH would be willing to investigate this potential issue further. It should also be noted in Comment 18 that the reference to the correction factor used at the SRS (i.e., the factor of 1.119) is not applicable to other sites.	

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19	ORAUT-TKBS-0007-6	O	Issue 19: (5.1.4.1.4) Angular Dependence Correction Factor for Gamma Dose - NIOSH should provide angular dependence (anatomic geometry) correction factors for external gamma doses, particularly for low-photon energies, where the angular dependence of the sensitivity of the dosimeter is most pronounced. These correction factors are used to account for, for example, the bias introduced by a dosimeter worn at the neck level and the higher doses received by tissues/organs below the waist.	99	***Revised Response for WG Review:*** When appropriate, the *Technical Information Bulletin: Best Estimate External Dose Reconstruction for Glovebox Workers* (DCAS-TIB-0010) allows the dose reconstructors to apply a special geometry correction factor to the doses to organs in the lower torso to account for the angular dependence associated with working with radioactive materials in gloveboxes or other benchtop work environments (referred to as just glovebox work after this point) (DCAS 2010). The use of the approach described in DCAS-TIB-0010 to adjust the doses to the organs in the lower torso when glovebox work was performed has since been approved by the Procedures Subcommittee. Even though the ***external TBD*** does not refer to DCAS-TIB-0010, the ***external TBD*** does refer to *External Dose Reconstruction Implementation Guideline* (OCAS-IG-001), which allows dose reconstructors to adjust organ doses to account for non-uniform exposure geometries (NIOSH 2007).	Awaiting SC&A/Board review of updated response

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					Although the higher level guidance in OCAS-IG-001 already permits the dose reconstructors to use DCAS-TIB-0010 to adjust the doses for organs in the lower torso when the circumstances are appropriate, NIOSH will add the following to Section 6.4 of ORAUT-TKBS-0007-6 as additional guidance for the dose reconstructors. An underestimation of external dose can occur for organs in the lower torso when workers spend a significant amount of their time working with radioactive materials in gloveboxes or other benchtop work environments (referred to as just glovebox work after this point). At the INL site, glovebox work involving radioactive materials was predominately performed in laboratory settings, uranium processing areas, some settings requiring work in an inert atmosphere, certain maintenance applications, and at sample collection stations. In general, DCAS-TIB-0010	

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					adjustments to the measured and missed external photon and neutron doses should be considered for cancer organs in the lower torso when glovebox work is indicated in claim documents (e.g. the computer assisted telephone interview) and when the identified places of work or work activities would have included glovebox work.	
20	ORAUT-TKBS-0007-6	O	Issue 20: (5.1.4.1.5) Restating Beta Dose As Gamma Dose - It is not claimant favorable to state that the entire dose measured in the open window is due to the beta dose.	99	Open window beta dose is discussed in OCAS-IG-001. Please provide a basis for these opinions – where has SC&A found data supporting <30 keV photons?	SC&A recommends closing
21	ORAUT-TKBS-0007-6	O	Issue 21: (5.1.4.1.6) Photon Spectrum Split – NIOSH should provide guidance assigning dose values for the 30 keV<E<250 keV and E>250 keV regions.	99	Photon energy ranges are based upon the predominant radionuclides found in the workplace. Scenarios, like those discussed in the SC&A report would be reconstructed on a case-by-case basis. Please provide a basis for these statements and for the SC&A opinion that a 50/50 energy range is more appropriate.	SC&A recommends closing
22	ORAUT-TKBS-0007-6	O	Issue 22: (5.1.4.1.7) Immersion Dose - The dose recorded on a dosimeter due to a semi-infinite cloud irradiation would be approximately half of the actual dose received. NIOSH should, therefore, consider a weighting factor of 2 for immersion dose.	100	NIOSH does not use personnel whole-body or extremity dosimeter data to estimate internal doses. The comment listed in this matrix does not appear to coincide with the discussion in the SC&A	Closed

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					review report. This comment may be an error because there is no mention of semi-infinite cloud exposures in the TBD.	
23	ORAUT-TKBS-0007-6	9	Issue 23: (5.1.4.1.8) High-Risk Jobs (Beta/Gamma Exposure) - Site experts interviewed by SC&A classified INL as an "acute dose" site, with a significant number of facilities, operations, experiments, and occurrences providing the possibility of personnel receiving dangerous levels of radiation. NIOSH did not evaluate comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker external exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant's file are not complete.	100	Please provide a basis for these statements regarding NIOSH evaluation of facility and field data. The referenced section of the SC&A report does not appear to relate to the comment provided. The report discusses beta dose and hot particles. NIOSH would only perform dose reconstruction for hot particles or unreported skin contamination that were documented. There is no reasonable way to estimate hot particle doses without monitoring data. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has conducted additional research on INL practices to monitor and control skin contamination. The results of that investigation have been provided to the INL working group in a white paper.	SC&A recommends that this finding remain open for further discussion.
24	ORAUT-TKBS-0007-6	O	Issue 24: (5.1.4.1.9) Extremity Dose - NISOH should evaluate the potential for missed extremity dose for workers working in facilities where highly contaminated equipment, piping, instruments, valves, and systems resulted in	100	NIOSH is currently pursuing development of formal project (TIB) guidance to address this issue. Refer to the submitted paper for background information	SC&A recommendation is pending a review of NIOSH's response to its WG

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			exposures in confined spaces to hands.		on this issue. INL assigned extremity dosimetry when needed. For other workers, NIOSH will address this on a case-by-case basis – we routinely use multiplication factors to account for geometry differences for cancer on extremities when the EE was a "hands-on" worker. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has conducted a review of INL/ANL-W claims with extremity cancers. The results of the review have been provided to the INL working group.	action item.
25	ORAUT-TKBS-0007-6	O	Issue 25: (5.1.4.1.10) Discrepancies between PIC and Film Reading – NIOSH should compare PIC versus film badge data (i.e., shallow and deep), and ensure that all the dose has been captured by the film badge. It is important to note that some PICs were worn for only the length of the job, so the discrepancy between readings of the two-dosimeter systems cannot be explained by drifting. **Expanded:** Many difficulties in comparing PIC readings and film results make agreement within a factor of two the best that can be expected.	100	The PIC is not a legal record and is a lower-preference for reconstructing dose. The PIC typically over-responded to site photon energies and was sensitive to shock. They are designed for use in the field to get a real-time exposure reading until the dosimeter could be read at a later time.	Closed
26	ORAUT-TKBS-0007-6	O	Minimum Detection Limit – NIOSH should re-evaluate the approach in determining the MDL of the dosimetry system by taking into account the	101	This observation is similar to finding 3 listed below (Comment 27). The response to the finding	SC&A recommends closing

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			system uncertainties. **Expanded:** The selection of 10 mrem as the MDL [minimum detection limit] for high energy gamma is questionable. Even for modern densitometers and film, it is a challenge to achieve this level, as a single density "click" can correspond to greater than 10 mrem for high-energy gamma radiation; this is not a problem, however, for intermediate and low-energy x-rays. Rather, one click of the densitometry system may correspond to 15 or 20 mrem for 660 keV or 1.2 MeV gammas, for example. If the claim is made that 10 mrem is a valid choice for the MDL, then supporting materials should be provided, such as film dose-to-density curves and densitometer calibration data. Other sites (e.g., Savannah River Site - SRS) have adopted 40 mrem as the high-energy gamma MDL for early film.		also satisfies this observation.	
27	ORAUT-TKBS-0007-6	3	Issue 27: (5.1.4.1.12) Minimum Reporting Level (Beta/Gamma) - NIOSH does not provide adequate information supporting the use of chosen detection threshold levels to represent the MRL values for gamma film badges and TLDs. The use of MRL/2 as the missed external dose for dose reconstruction per OCAS-IG-001 is not claimant favorable for claims where the probability of causation value is close to 50%. In addition, NIOSH should re-evaluate the MRL values used and provide more supportable default values.	103	The MRLs used in the INL TBD are based on peer-reviewed and published, scientific documents as referenced in table 6-15 (see footnote b in Rev. 2 of the TBD). Comments on OCAS-IG-001 are usually more programmatic in nature and not part of a specific site. In this case, the reviewer's comment is not accurate. MRL/2 is assigned a lognormal distribution as required in OCAS-IG-001 and discussion of uncertainty may be found therein.	SC&A recommends that this issue remain open.

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					Additionally, when the PoC is between 45 and 52%, the IREP sample size increases from 2,000 to 10,000, the random seed (which is normally 99) is selected by chance, and IREP is run 30 times at the 99th percentile versus the 50th percentile. These methods provide a more claimant favorable dose reconstruction and ensure that the PoC is not underestimated.	
28	ORAUT-TKBS-0007-6	3	Issue 28: (5.1.4.2.1) Minimum Reporting Level (Neutron) - NIOSH's approach for determining the MRL values for NTA emulsion film is not thorough or supported. For example, NIOSH uses 10 neutron readings in one data sheet from March 1958 to determine the MRL values for the period between 1951 and 1957, and 6 neutron readings to represent all neutron measurements between 1959 and 1976. Furthermore, the use of MRL/2 as the missed external dose for dose reconstruction per OCAS-IG-001 is not claimant favorable for claims where the probability of causation value is close to 50%. In addition, NIOSH's MRL values of 14 mrem and 20 mrem appear low and are inconsistent with generic values given for NTA dosimeters, as well as values cited by other DOE facilities with similar neutron source terms and detectors. NIOSH should re-evaluate the MRL values used and provide more supportable default values.	108	***Data capture needed to close this issue out*** Comments on OCAS-IG-001 are usually more programmatic in nature and not part of a specific site. In this case, the reviewer's comment is not accurate. MRL/2 is assigned a lognormal distribution as required in OCAS-IG-001 and discussion of uncertainty may be found therein. The MRLs used in the INL TBD are based on peer-reviewed and published, scientific documents as referenced on page 22. The MRL of 14 is cited on page 6 of Cipperly 1958. Additionally, when the PoC is between 45 and 52%, the IREP sample size increases from 2,000 to 10,000, the random seed (which is normally 99) is selected by	SC&A is waiting for NIOSH white paper.

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					chance, and IREP is run 30 times at the 99th percentile versus the 50th percentile. These methods provide a more claimant favorable dose reconstruction and ensure that the PoC is not underestimated. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH is revisiting its response about detection limits. NIOSH's response to address the NTA film dosimeter detection limits will be in the form of a white paper. Completion of the white paper is pending additional data capture at the INL.	
29	ORAUT-TKBS-0007-6	2	Issue 29: (5.1.4.2.2) Failure to Properly Address Neutron Exposures - INL had a total of 52 reactors, most of which were experimental/ prototype in design, which typically operated with high-power densities and with minimum shielding and neutron moderation. It is unjustified to presume that there are no missed neutron doses. In addition, there are deficiencies associated with neutron calibrations. Due to the use of the PoBe source for neutron calibration, dosimeters would significantly under-measure neutron doses from sources with lower-energy spectra. NIOSH should re-evaluate the entire approach in the TBD to account for potential missed neutron doses.	109	The inappropriate instructions to discount an INEL worker's missed neutron doses has been eliminated from the Missed Neutron Dose Section of the external dosimetry TBD. Because it was impossible to determine who a worker's coworkers were from the redacted dosimetry records, the guidance in Rev 02 of that TBD was not being used to eliminate missed neutron doses. However, it should be noted that ORAUT-OTIB-0023 is still considered an appropriate basis for eliminating unreasonably	SC&A recommends closing

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			Expanded: The method presented in the TBD of determining who needs to be assigned a missed neutron dose is circular: Section 6.5.4 states: *"If no neutron dose was assigned to the worker or coworkers for several months, the dose reconstructor should assume that the person was not exposed to neutrons."* Clearly this does not allow for individual workers having temporary or varying assignments. Also, if the program failed to correctly identify that they should have been monitored, the record will show no assigned neutron dose. In addition, the TBD makes the assumption that high Z materials, such as iron and lead, were never used (e.g., for shield penetrations) in place of hydrogenous materials, such as water and concrete. However, no attempt is made to validate or qualify this assumption. ORAUT-OTIB-0051, *Effect of Threshold Energy and Angular Response of NTA Film on Missed Neutron Dose at the Oak Ridge Y-12 Facility*, was issued after the 2004 Site Profile and has a bearing on neutron dosimetry issues; hence, it should be considered in this TBD.		high missed neutron doses for some INEL claims. In addition, neutron dosimeters at the INEL were only assigned and read when there was a potential for exposure. Given that most of the reported neutron dosimeter results were reported as zero, the INEL's process to determine who had the potential to receive neutron exposures appears to have been appropriate and adequate. The guidance provided in Rev 03 of the external TBD now requires missed neutron doses to be assessed for every worker using the reported neutron dosimeter results, unless the missed neutron doses are unreasonably high per the guidance in ORAUT-OTIB-0023. NIOSH is not clear what SC&A's issue is regarding the potential under-measurement of neutron doses to lower energy neutrons, since Rev 00 through Rev 03 of the INEL's external dosimetry TBD has included facility specific adjustments to the reported neutron doses to account for the dosimeters' poor energy response to lower energy neutrons. The NTA film corrections for energy response in the INEL TBD are	

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					comparable to the energy response corrections in ORAUT-OTIB-0051, which range from 1.0 to 2.2. Because the need to apply a correction to NTA film results to account for angular response is still being debated on a complex wide level, no angular response corrections were added in the latest revision of this TBD. Also, the assumption of AP geometry would negate the need to adjust for angular response.	
30	ORAUT-TKBS-0007-6	2	Issue 30: (5.1.4.2.3) Neutron Calibration Deficiencies - Due to the use of the PoBe source for neutron calibration, dosimeters would significantly under-measure neutron doses from sources with lower energy spectra. NIOSH should re-evaluate the approach in the TBD to account for potential missed neutron doses.	110	Section 6.3.3.2 indicates that the recorded dose is 11% high based on this calibration.	SC&A recommends closing

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31	ORAUT-TKBS-0007-6	8	Issue 31: (5.1.4.2.4) Completeness and Quality of INL Neutron Dosimetry and Record Keeping Programs - The identification and determination of missed neutron dose for workers are heavily influenced by this assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker neutron doses.	110	Please provide the reports of "significant deficiencies and inconsistencies in radiation work practices" and provide how the NIOSH-derived missed dose calculations are subject to the results of the Tiger Team report.	SC&A recommends that the WG keep this issue open pending receipt and review of the INL-specific coworker model.
32	ORAUT-TKBS-0007-6	O	Issue 32: (5.1.4.2.5) Uncertainty Estimation for Neutron Doses – NIOSH should explain how the FNCFs were obtained and provide instruction to dose reconstructors on how to apply them.	110	The latest revision to the TBD appears to adequately explain the FCNFs. The text indicates that this is a correction that INEL applied to the dosimeter results to generate the reported dose (pg.23 of TBD). Also, several references are cited in the TBD text to indicate how these FNCFs were obtained. The references also provide additional information on the methodology used.	SC&A recommends closing
33	ORAUT-TKBS-0007-6	O	Issue 33: (5.1.4.2.6) Neutron Organ Dose – NIOSH should provide neutron spectrum information and guidance for organ dose reconstruction for workers at ZPPR and TREAT.	110	Guidance provided in Section 6.4, spectrum data in Table 6-14 of Rev 03.	SC&A recommends closing
34	ORAUT-TKBS-0007-6	9	Issue 34: (5.1.4.2.7) High-Risk Jobs (Neutron Exposure) - NIOSH did not evaluate	111	Please provide a basis for these statements regarding NIOSH	SC&A recommends that

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			comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker neutron exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant's file are not complete.		evaluation of facility and field data. The report discusses that there were potential higher dose neutron activities conducted but no details are provided. NIOSH would only perform dose reconstruction for such activities if they were documented. These types of reconstructions would be done on a case-by-case basis. 03/12/14 Update: As tasked during the 2011 INL Working Group meeting, NIOSH has looked at the interviews appearing in SC&A's site profile review and elsewhere for relevant anecdotal discussions on neutron exposures. The results of that review have been provided to the INL working group in a separate response document.	this finding remain open for further discussion.
35	ORAUT-TKBS-0007-6	O	Issue 35: (5.1.4.2.8) Multiplying Factors for Missed Neutron Dose – NIOSH should provide data to support the two multiplying factors (1.25 and 2) and the fixed missed neutron dose default value of 50 mrem. **Expanded:** See ORAUT-OTIB-0051 and Issue No. 29.	111	These values are based on weighting neutron spectra with dose conversion factors to determine the fraction of the dose below 0.8 MeV as referenced in footnote 37 of Revision 02. It should also be noted that the upper-bound for the factor of 2 ± 0.3 is being used (i.e., a factor of 2.3). In regards to the 50 mrem of	SC&A recommends closing

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					neutron dose, the TBD was not recommending that the dose reconstructors assign 50 mrem of unmonitored neutron doses to the affected workers. The TBD was merely describing an instance where unmonitored neutron doses were received by INL workers. The earlier versions of the external TBD neglected to indicate that the INL has already assigned unmonitored neutron doses for those workers based on the area dosimeter results, such that the dose reconstructors do not need to assign unmonitored neutron doses to the affected TAN workers. An additional clarifying statement was since added to Revision 02 of the external TBD that still subsists in Revision 03.	

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36	ORAUT-TKBS-0007-6	13	**Issue 36:** (6.3.2.2) Missed Low Energy Beta Dose - Section 6.3.2.2 of the TBD discusses the 100mg/cm^2 plastic dosimeter holder and the fact that betas of less than 360 keV will not penetrate the holder. (It is unclear if this density includes the film wrapper.) However, the TBD does not discuss allowance for or consideration of the possibility of the complete failure to detect these betas. The general, averaging approach to missed beta is questionable. The concern is that beta exposure is always assumed to be due to a mix of energies and thus the dose component from low energies is known and can be corrected. Clearly this is not the case, as is stated in the attribution. A specific concern is the Rare Gas Processing Facility (CPP-604), which harvested Kr-85. This nuclide is a pure beta emitter, with an endpoint energy of 670 keV. The film badges in use at the time were far from ideal for betas and failed to see any below 360 keV. NIOSH should determine if the maximum modifier recommended for betas of 2.8 is sufficient for this environment.	NA	The current revision to the TBD (i.e., Rev. 03) appears to address these concerns regarding the INEL dosimeter responses to low-energy betas.	SC&A recommends closing
37	ORAUT-TKBS-0007-6	O	**Issue 37:** (6.5.4) Error in Reference - The second paragraph of page 41 of the External Dose TBD (ORAUT 2007f) references Table 6-16 for IREP groups; it should refer to Table 6-14 instead.	NA	Corrected in latest TBD rev.	Closed

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38	ORAUT-TKBS-0007-6	O	**Issue 38:** Shallow Dose - NIOSH should consider making use of ORAUT-OTIB-0017, *Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose*, where appropriate. Additionally, contrary to the OTIB's claim (p. 15) that the assumption of undergarment and pants thicknesses of 2 mm each is claimant favorable, SC&A believes that measured thicknesses are about half that and, hence, the OTIB assumptions are not claimant favorable.	NA	This is a complex-wide issue and not specific to INEL.	Closed

Note: O-Observation