

DEFENSE THREAT REDUCTION AGENCY
NUCLEAR TEST PERSONNEL REVIEW PROGRAM
RADIATION DOSE ASSESSMENT

STANDARD OPERATING PROCEDURE
RA03 – Standardized Radiation Dose Assessment Reports and Dose
Calculation Worksheets

Revision 1.3

Key to SOP ID Codes

RA (Radiation Assessment - SOP)
ED (External Dose - Standard Methods)
ID (Internal Dose - Standard Methods)
UA (Uncertainty Analysis - Standard Methods)

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Standard Operating Procedure

RA03 – Standardized Radiation Dose Assessment Reports and Dose Calculation Worksheets

1 Purpose/Summary

This standard operating procedure (SOP) provides detailed guidance on preparing standardized RDA Reports and dose calculation worksheets for Nuclear Test Personnel Review (NTPR) Program participants (generally veterans). Templates of a standardized RDA Report and Mathcad calculation worksheet are provided as attachments. The standardized templates are intended to help streamline the preparation of NTPR RDA reports, provide consistently organized content and facilitate the review process. They are also intended to minimize repetition of information provided either in the Scenario of Participation and Radiation Exposure (SPARE) or in the NTPR Dose Assessment SOP Manual.

This SOP is written for qualified radiation dose analysts (“Analysts”) who develop RDA Reports and supporting dose calculation worksheets or perform detailed quality control of such, and for managers who oversee the entire dose assessment process to assure conformance with procedures, methods, quality standards of assessment products, and established NTPR policies and guidelines.

2 Scope

This SOP applies to all radiation dose assessments prepared according to SOP RA01 (found elsewhere in this SOP Manual). It provides guidance on the drafting of RDA Reports and stipulates a standard outline and format for calculation worksheets (currently developed using the Mathcad software) that guarantees the application of approved standard procedures and methods, and all documented data and information. It assures that all aspects of radiation dose calculations and reporting are addressed to satisfy the requirements of Title 32, Code of Federal Regulations (CFR), Part 218, *Guidance for the Determination and Reporting of Nuclear Radiation Dose for DoD Participants in the Atmospheric Nuclear Test Program*, and DTRA’s *NTPR Program - Quality Plan* (DTRA, 2009c), and DTRA’s *NTPR Program - Program Management Plan* (DTRA, 2009d).

3 Responsibilities

RDA Reports and accompanying calculation worksheets are prepared by Analysts and checked for quality and consistency by reviewers from the radiation dose assessment team and managers. Analysts draft RDA Reports and develop calculation worksheets that assist in determining radiation doses according to the standard operating procedures and standard methods described elsewhere in this procedures manual. Analysts are qualified technical staff experienced in carrying out radiation dose assessments and trained in all procedures and methods relevant to the cases they prepare.

4 Definitions

SPARE A document with detailed information on an NTPR participant's activity scenario during involvement in the U.S. atmospheric nuclear testing program.

Mathcad Desktop software for performing and documenting engineering and scientific calculations.

5 Procedure: Detailed Activity/Task Description

A dose assessment accomplishes the analyses needed to estimate all relevant radiation dose components. The final product of the dose assessment is the RDA Report, supporting calculation worksheets, and any additional analyst notes.

The primary Analyst drafts the RDA Report, which provides a summary of the participant's activities, sources of potential radiation exposures, description of exposure pathways, and resulting accrued mean and upper bound dose. The type of information included in the RDA Report and a standard RDA Report template are provided in this procedure. Also, the Analyst prepares calculations of radiation doses and upper bounds for all identified exposure scenario elements based on the SPARE (with consideration of any comments on the SPARE that the participant supplies). The Analyst uses a calculation worksheet that adheres to a standard outline and format described in this procedure.

5.1 Radiation Dose Assessment Reports

The RDA Report is the formal documentation of the results of the dose assessment process (DTRA, 2007). The completed RDA Report is intended for submission to the veteran, claimant, or the Department of Veteran Affairs. A template of a standard RDA Report is enclosed as Attachment 1. The RDA Report should include the following information:

- A complete assessment summary table of the mean and upper bound doses, including total external gamma and neutron doses, doses to organs from internally deposited radioactive materials (internal doses), and external doses to the skin as applicable.
- A summary of the veteran's participation and key activities relevant to potential exposure pathways and radiation environments.
- A discussion and documentation of material changes with respect to the SPARE process that stems from the veteran's verbal or written comments regarding his activities and radiation exposures.
- Summary descriptions of the component doses for each exposure situation that comprises the veteran's scenario for external and internal doses.

Additionally, the following conventions should be adhered to in preparing the RDA Report:

- If exposures occurred in different calendar years from more than one operation, the mean and upper bound doses are assigned for each year separately. When exposure occurred from participation in a single operation that spanned two calendar years, all doses in the overall summary table should be assigned to the first year of exposure, except in cases involving leukemia. In such cases, the NTPR Program Manager will provide specific guidance.
- Internal doses from alpha particles are reported separately from internal doses due to gamma and beta radiations, which are combined.
- In reporting skin doses, contributions from beta particles and gamma rays are combined.
- All reported doses (doses listed in the overall summary table) will be given to two significant figures, obtained by rounding up the third figure. Final calculated doses less than 1 millirem are reported as “<0.001 rem” when provided in tables, and as “less than 1 mrem” or “less than 0.001 rem” when reported in the text.

5.2 Decision Summary Sheet for the RDA Report

An RDA Report Decision Summary Sheet (DSS) should be prepared for each case requiring the development of a full RDA. The DSS should contain a header with at a minimum the following information (a template is provided as Attachment 2):

- Date prepared and name of preparer.
- Veteran’s name, rank, unit, duty station and dates of participation.
- Affected internal organs and surrogate organs if necessary
- Whether dosimetry records/film badges are available if they cover the entire or partial periods of participation.

The second section of the DSS should include the major decisions made to develop the dose assessment along with the rationale, assumptions and references related to each decision (Attachment 2).

5.3 Dose Calculation Worksheets

Dose calculation worksheets for specific veteran cases prepared using the Mathcad or other similar scientific software should be organized according to a standard outline and format (a template is provided as Attachment 3). Calculation worksheets should adhere to the following principles:

- Consistency among cases to include the same section headings (see Attachment 3).

- Sections that do not apply to a case are included with the annotation “Not applicable to this case” or a similar note.
- Identifying information for the veteran and case is presented on the first page of the worksheet.
- Only input, calculations, and results that are relevant to the case are included.
- Large data sets are read-in from external input files.
- Data input values are displayed at the end of worksheets in a Data Annex section and not in the input and calculations sections.
- All content has to fit on 1-page width throughout the worksheet; landscape or portrait orientation can be used.
- Content including equations and text do not overlap page breaks.

6 Data and Records Management

Official copies of final RDA Reports, the DSS, supporting dose calculations worksheets, and supporting information are maintained by the Enterprise Manager according to the NTPR Program Management SOP Manual (DTRA, 2009a).

7 Quality Control and Quality Assurance

This procedure assures that RDA Reports and dose calculation worksheets are prepared according to the standardized document organization and formats as specified in revisions of this Standard Procedures Manual. All RDA Reports and calculation worksheets undergo the internal review process specified in SOP RA05. This process ensures that the products of a dose assessment are prepared according to this procedure and adhere to the standards set forth in the NTPR Quality Assurance SOPs Manual (DTRA, 2009b).

8 Referenced SOPs and Standard Methods from this Manual

- (1) SOP RA01 - Radiation Dose Assessment for Cases Requiring Detailed Analysis
- (2) SOP RA04 - Internal RDA Reviews

9 Reference Materials

- (1) DTRA (Defense Threat Reduction Agency), 2009a. DTRA NTPR Program - Program Management Standard Operating Procedures Manual, Fort Belvoir, VA (October 31).
- (2) DTRA (Defense Threat Reduction Agency), 2009b. DTRA NTPR Program - Standard Operating Procedures for Quality Assurance, Fort Belvoir, VA (May 31).

- (3) DTRA (Defense Threat Reduction Agency), 2009c. DTRA NTPR Program - Quality Plan, Fort Belvoir, VA (February 28).
- (4) DTRA (Defense Threat Reduction Agency), 2009d. DTRA NTPR Program - Program Management Plan, Fort Belvoir, VA (April 30).

Attachment 1 Template of a Standard RDA Report

A copy of a template for a standard RDA Report is provided starting on the next page.

Review by: _____ Tech

Review by: _____ CHP

Review by: _____ Mgt

Radiation Dose Assessment Report
John Q. Veteran, Operation(s) [List each Operation (Year of each Operation)]

Summary

A radiation dose assessment (RDA) for the veteran was performed in accordance with the Nuclear Test Personnel Review (NTPR) Radiation Dose Assessment Standard Operating Procedures (SOP) Manual (DTRA, [year1]) using the standard procedures, standard methods, and scientific principles and studies described therein. Specific details of the dose assessment are provided in the body of this report; results are summarized in Table 1.

Table 1. Dose Summary

External Doses				
Radiation Type (by year/operation)	Dose (rem)		Upper Bound Dose (rem)	
<i>Neutron</i>				
Year (Operation)				
Year (Operation)				
<i>Gamma</i>				
Year (Operation)				
Year (Operation)				
Internal Doses				
Organ (by year/operation)	Dose (rem)		Upper Bound Dose (rem)	
	alpha	beta-gamma	alpha	beta-gamma
<i>[Organ name, for each organ]</i>				
Year (Operation)				
Year (Operation)				
Skin Doses from External Sources				
Skin Site (by year/operation)	Dose [beta-gamma] (rem)		Upper Bound Dose [beta-gamma] (rem)	
<i>[Skin site, for each site]</i>				
Year (Operation)				
Year (Operation)				

This RDA Report describes the evaluation of the external[,/ and] internal (*list organ names*)[, and skin (*list skin sites*)] doses that the veteran accrued as a result of his [/her] participation in atmospheric nuclear weapon testing during Operation(s) [*list names of operations*]. The veteran's radiation exposure potential is based on his [/her] recollections, service records, and operational documents and reports, as described in the attached Scenario of Participation and Radiation Exposure (SPARE) (DTRA, [year2]). The SPARE, which serves as a companion document to this report, includes details about the test series and unit and personal information for the veteran. The numerical values of the parameters used for determining his [/her] radiation doses are provided in the radiation dose calculation worksheets available in his [/her] case file (DTRA, [year3]).

OPERATION [Insert Operation Name]

[For each operation, include the following sections, as applicable]

Background Information

Operation [insert name of operation] consisted of a series of [insert number of nuclear tests] nuclear weapon tests, conducted at the [Pacific Proving Ground (PPG) or Nevada Test Site (NTS)] from [insert start date of the operation] to [insert end date of the operation]. A detailed discussion of the operation, including information about the detonations and test areas is given in Appendix X-# of the SOP Manual (DTRA, [year1]).

Unit and Personal Activities

During Operation [insert name of operation], the veteran served as [insert rank] ([insert rank abbreviation]) with [insert unit name]. He [/She] served at [insert location(s) where the veteran served] during the period [insert start date] to [insert end date]. [Insert a summary of unit and veteran’s activities most relevant to the scenario of his [/her] participation and exposures.]

More detailed discussions of his [/her] activities and those of his [/her] unit can be found in his [/her] SPARE (DTRA, [year2]) and in Appendix X-# of the SOP Manual (DTRA, [year1]).

[Here, discuss any additional pertinent activities not described in the SPARE and address any comments provided by the veteran or his [/her] representative]

External Dose Assessment

Available Dosimetry

Dosimetry records for the veteran (or reliable cohort dosimetry records) were found (/not found) during case research (DTRA, [year3]).

[a- If film badges were found, include the following text and table:]

Relevant data for his [/her] film badge records are provided in Table [Table#] and evaluated according to SOP RA02 and Standard Method (SM) ED01 (DTRA, [year1]). External gamma doses accrued during the veteran’s participation in Operation [insert name of operation] outside of the time periods covered by film badges are reconstructed using SOP RA02 and the methods described in SM ED02 (DTRA, [year1]).

Table #. Veteran’s [/Cohort] Film Badge Record for Operation [insert operation name]

Badge Number	Issue Date	Turn-in Date	Dose (rem)
<i>[For each film badge, enter badge number]</i>	<i>[date]</i>	<i>[date]</i>	<i>[dose]</i>
<i>[Footnotes: enter clarifying information, as necessary]</i>			

[b- If dosimetry records were found for periods during which the veteran served in the operation and an evaluation of the reliability of the readings was performed, include a discussion of the findings here and conclude with one of the following three statements:]

[b.1- If all dosimetry records were found to be reliable, include the following:]

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During the period(s) [enter date(s) covered by reliable film badge(s)], the veteran accrued [a dose/doses] of [enter dose(s), in rem] while he [she] [insert the veteran's activities and locations] as recorded by his [/her] film badge(s) [enter film badge number(s)], respectively. These dose(s) are included in Table ##.

[b.2- If dosimetry records are found and are all unreliable, include the following:]

Because dosimetry records for the veteran were determined to be unreliable, i.e., do not represent true doses due to [include reason(s) for unreliability, such as environmental damage], his [/her] external gamma doses are reconstructed using SOP RA02 and the methods described in SM ED02 (DTRA, [year1]).

[b.3- If dosimetry records are found and only some are unreliable, include the following:]

Because dosimetry records from film badge number(s) [specify film badge number(s) with unreliable readings] for the veteran were determined to be unreliable due to [include reason(s) for unreliability, such as environmental damage], the external gamma doses corresponding to the periods and activities covered by these film badges are reconstructed using SOP RA02 and the methods described in SM ED02 (DTRA, [year1]).

[c- If no dosimetry records were found, continue with the following:]

As a result, his [/her] external gamma doses are reconstructed using SOP RA02 and the methods described in SM ED02 (DTRA, [year1]).

Potential Sources of Exposure

The following sources of potential external radiation exposure are considered:

[List all applicable sources of potential exposure(s). The following are examples:]

- Initial gamma and neutron radiation from Operation [insert name of operation] detonations.
- Residual gamma radiation from [insert name of operation or specific shots] fallout [and/or neutron-activated soil/material] on [insert location, e.g., name of an island at the PPG, ship or NTS location].
- Residual gamma radiation from [insert name of operation or specific shots] fallout [and/or neutron-activated soil/material] while [insert specific activity, e.g., "digging trenches", "traveling on small boats", "handling contaminated equipment", etc.].

Dose Assessment

[Initial Radiation Exposures: If the veteran was exposed to initial neutron radiation, insert the following:]

Initial Radiation: [Insert statement reporting the initial neutron dose here; also include the dose in the external dose summary table.]

[If the veteran was not exposed to initial neutron and gamma radiations, insert the applicable statement from the following:]

Initial Radiation: The veteran was more than [insert number of miles] miles (mi) [/nautical miles (nmi)] from each of the detonations. At such distances, he was not exposed to any measurable initial gamma or neutron radiation (DTRA, [year1], SM ED02).

[or]

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Initial Radiation: The veteran was not in the test area for any of the detonations. Therefore, he was not exposed to initial gamma or neutron radiation (DTRA, [year1], SM ED02).

[Residual Radiation Exposures: discuss external residual radiation doses from each source/activity, as appropriate, for which a dose is reconstructed. The following are examples:]

Residual Gamma Radiation from Fallout on [insert location, e.g., name of an island, ship, or NTS site]: Fallout from [insert operation/shot name(s)] detonations contributed to the radiation environment at [insert location] during the veteran’s presence in the test area (DTRA, [year1], Appendix X-#) and (DTRA, [year2]). Based on the peak radiation intensities at [insert location] reported for Shot(s) [insert shot names] (DTRA, [year1], Appendix X-#) and further assuming [include any additional assumptions, if necessary - e.g., the veteran spent up to 60 percent of his [her] day outdoors], the veteran accrued a gamma dose of _____ rem.

Residual Gamma Radiation from [include other applicable sources such as indicated above]: [Describe dose accrual as was done for the previous exposure].

A summary of the veteran’s external radiation doses is provided in Table [##].

Table [##]. External Dose Summary for Operation [insert operation name]

Type	Inclusive Dates	Dose (rem)	Remarks
Neutron:	<i>Enter date range</i>		(Upper bound dose: _____ rem)
Gamma:	<i>Date range 1</i>		Reconstruction [<i>Enter location/activity</i>]
	<i>Date range 2</i>		Reconstruction [<i>Enter location/activity</i>]
	<i>Date range 3</i>		Film Badge [<i>Enter badge number(s)</i>]
	Total Gamma		
	Reported*		(Upper bound dose: _____ rem)**
* Determined by rounding upward.			
** The veteran’s upper bound external gamma dose is based on an uncertainty factor of 3 applied to each independent component of his [her] reconstructed dose [<i>insert the following only if film badge doses are used</i>] and to other uncertainties inherent in his [her] film badge readings. Uncertainties are combined using standard statistical methods. (DTRA, [year1], SM UA01).			

Internal Dose Assessment

Neither radio-bioassay nor air sampling data pertinent to the veteran were found. Fifty-year committed equivalent doses (CEDs) to internal body organs are determined from other radiological measurements using the methodologies and assumptions presented in SM ID01 (DTRA, [year1]) and shot-specific radiochemistry data and standard assumptions given in Appendix X-# of the SOP Manual (DTRA, [year1]), unless indicated otherwise.

[If some of the dose factors used are for surrogate organs, insert the following paragraph:]

The calculation of internal doses requires the selection of dose factors for the organs affected by the medical conditions, or their surrogates. The organs selected as surrogates for dose calculations that are relevant to the veteran’s medical conditions are 1) [*insert surrogate organ*] for [*insert medical condition #1*], 2) [*insert surrogate organ*] for [*insert medical condition #2*], 3) [*and so on*]. (SOP RA02, DTRA, [year1].)

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The veteran is assumed to have accrued internal doses to his [/her] [insert organ name(s)] concurrently with his [/her] accrual of the external gamma doses described above in “External Dose Assessment.” Therefore, his [/her] locations and activities as described above establish the radiological environment in which his [/her] intake of contaminated materials occurred.

Potential Sources of Exposure

The following source(s) of potential radiation exposure pathways to the veteran’s [insert organ name(s)] are considered:

[List all applicable sources of potential exposure pathways. The following are examples:]

- Inhalation of both descending and subsequently resuspended [insert shot name(s)] fallout at [insert location name(s)].
- Inhalation of suspended [insert shot name(s)] neutron-activated soil/material at [insert location name(s)] while [insert specific activity, e.g., “digging trenches”, “handling contaminated equipment”, “traveling on small boats”, etc.].
- Ingestion of descending [insert shot name(s)] fallout at [insert location name(s)].
- Incidental ingestion of contaminated soil and dust while at [insert land location name(s)].
- *[Other applicable sources of internal exposure, e.g., ingestion of seawater while swimming, intake of contaminants on equipment contacted by the veteran, etc.].*

Dose Assessment

[Discuss internal doses from each source/activity. The following are examples: (if the number of pathways/sources is large, consider reporting the doses in a table inserted at the end of the last exposure pathway description)]

Inhalation of [insert name of operation/shot] Resuspended Fallout: During the veteran’s period of deployment at [insert location], he [/she] inhaled resuspended fallout from [identify detonation(s)]. The CEDs to the veteran’s [insert organ name (s)] resulting from the inhalation of resuspended fallout are _____ [or “less than 0.001 ”] rem from alpha radiation and _____ [or “less than 0.001 ”] rem from beta-plus-gamma radiation.

Ingestion of Radioactive Materials: During the veteran’s deployment at [insert location], he ingested contaminated material from [enter sources from those identified above]. The CEDs to the veteran’s [insert organ name(s)] resulting from the ingestion of contaminated material are _____ [or “less than 0.001 ”] rem from alpha radiation and _____ [or “less than 0.001 ”] rem from beta-plus-gamma radiation.

Internal Dose Summary: The total rounded CEDs to the veteran’s [insert name of organ(s)] that resulted from all intakes of radioactive material during his [/her] participation in [insert name of operation] are presented in Table [###]. Applying an uncertainty factor of 10 [or other appropriate uncertainty factors as discussed in SM UA01] to the total mean internal doses results in the rounded upper bound CEDs shown in Table [###]. (DTRA, [year1], SMs ID01 and UA01).

[Use dose coefficients for inhalation and ingestion currently recommended by ICRP. In cases of claims for cancers other than leukemia, calculate 50-year Committed Equivalent Doses (CED) to organ(s) of concern. When directed by NTPR Program Manager, for cases involving

leukemia, calculate annual equivalent doses received over time to year of diagnosis from each intake.]

Table [###]. Internal Dose (Rounded) Summary for [*insert name of operation*]*

Organ/Condition	Dose (rem)		Upper Bound (rem)	
	alpha	beta-gamma	alpha	beta-gamma
[<i>Organ name 1</i>]				
[<i>Organ name 2</i>]				
[<i>Organ name 3</i>]				
* Doses less than 0.001 rem are reported as <0.001 rem here and in the Dose Summary (Table 1).				

Skin Dose Assessment [*If required*]

The doses to the skin of the veteran’s [*insert skin site(s)*] are determined for the basal cell layer of the epidermis, which lies at an average depth of 70 micrometers below the surface of the skin. These doses are determined in accordance with SOP RA02 and SMs ED03 and ED04 (DTRA, [*year1*]).

Potential Sources of Exposure

The following source(s) of potential radiation exposure of the veteran’s [*insert name(s) of skin site(s)*] are considered:

[*List all applicable sources of potential exposures. The following are examples:*]

- Radiation (beta and gamma) from ground-deposited fallout/neutron-activated soil/material at [*insert location*] while [*insert specific activity, e.g., “digging trenches”, “traveling on small boats”, “handling contaminated equipment”, etc.*]
- Radiation (beta and gamma) from contaminants resuspended from the ground or descending fallout at [*insert location*] which are deposited directly on the veteran’s skin or his [*her*] clothing.
- [Radiation from contamination (not already included) for specific activities, *e.g., digging trenches, handling contaminated equipment, swimming in contaminated seawater, etc.*]

Dose Assessment

[*Discuss skin doses from each source/activity. The following are examples:*]

*Ground-Deposited Fallout at [*insert location, e.g., name of an island, etc.*]:* The skin of the veteran was exposed to radiation from [*insert operation/shot names*] fallout/neutron-activated soil. The veteran accrued beta and gamma doses simultaneously during the periods [*insert dates of exposure*]. The beta-plus-gamma doses to the skin of the veteran’s [*insert name(s) of skin site(s)*] from this source of radiation are [*insert b+g dose for site #1*], [*insert b+g dose for site #2*], and [*insert b+g dose for site #3*] rem, respectively.

*Contact Skin Contamination while Stationed at [*insert location*]:* In addition to skin doses from fallout contaminants deposited on ground/ship surfaces, it is assumed that the veteran’s skin was contaminated by descending and resuspended fallout/neutron-activated soil that was deposited directly on the skin of his [*her*] [*insert name (s) of skin site(s)*]. To maximize his [*her*] skin doses, the veteran is assumed to have been outside for the entire duration of any episodes of

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descending fallout he experienced. Based on these assumptions, the total (beta-plus-gamma) doses to the veteran's [insert skin site(s)] from contaminants that were deposited directly on the skin from descending and resuspended fallout (/neutron-activated soil) while he [/she] was at [insert locations] during [insert dates] are [insert b+g dose for skin site #1], [insert b+g dose for skin site #2], and [insert b+g dose for skin site #3] rem, respectively.

Skin Dose Summary: The total skin dose(s) to the veteran's [insert skin site(s)] that resulted from exposure to radioactive material during his [/her] participation in [insert name of operation], are [insert total dose for skin site #1], [insert total dose for skin site #2], and [insert total dose for skin site #3] rem, respectively. The application of appropriate uncertainty factors (DTRA, [year1], SM UA01) to each independent source of exposure results in upper bound doses to the skin of the veteran's [insert name(s) of skin site(s)] of [insert upper bound dose for skin site #1], [insert upper bound dose for skin site #2], and [insert upper bound dose for skin site #3] rem, respectively.

Lens of Eye Dose Assessment [If required]

The doses to the Lens of the Eye of the veteran's are determined for the lens of the eye which lies at an average depth of 3 millimeters below the surface of the eye. These doses are determined in accordance with SOP RA02 and SM ED05 (DTRA, [year1]).

Potential Sources of Exposure

The following source(s) of potential radiation exposure of the veteran's lens of the eye are considered:

[List all applicable sources of potential exposures. The following are examples:]

- Residual beta and gamma radiation from ground-deposited fallout/neutron-activated soil/material at [insert location]
- Beta radiation from dermal contamination of the eyelid (not already included) for specific activities, e.g., digging trenches, handling contaminated equipment, swimming in contaminated seawater, etc.]

Dose Assessment

[Discuss lens doses from each source/activity. The following are examples:]

Residual beta and gamma radiation at [insert location, e.g., name of an island, etc.]: The lens of the eye of the veteran was exposed to radiation from [insert operation/shot names] fallout/neutron-activated soil. The veteran accrued beta and gamma doses simultaneously during the periods [insert dates of exposure]. The beta-plus-gamma doses to the lens of the eye of the veteran from this source of radiation are [insert b+g dose for site #1], [insert b+g dose for site #2], and [insert b+g dose for site #3] rem, respectively.

Dermal Contamination on Eyelid while Stationed at [insert location]: In addition to lens of the eye doses from fallout contaminants deposited on ground/ship surfaces, it is assumed that the veteran's eyelid was contaminated by descending and resuspended fallout/neutron-activated soil that was deposited directly on the eyelid of his [/her] [insert name (s) of skin site(s)]. To maximize his [/her] lens of the eye dose, the veteran is assumed to have been outside for the entire duration of any episodes of descending fallout he experienced. Based on these

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assumptions, the total (beta-plus-gamma) doses to the veteran's lens of the eye from contaminants that were deposited directly on the eyelid from descending and resuspended fallout (/neutron-activated soil) while he [/she] was at [insert locations] during [insert dates] are [insert b+g dose for skin site #1], [insert b+g dose for skin site #2], and [insert b+g dose for skin site #3] rem, respectively.

Lens of the Eye Dose Summary: The total lens of the eye dose(s) to the veteran's that resulted from exposure to radioactive material during his [/her] participation in [insert name of operation], are [insert lens of the eye dose here] rem, respectively. The application of appropriate uncertainty factors (DTRA, [year1], SM UA01) to each independent source of exposure results in upper bound doses to the lens of the veteran's, is [total lens of the eye dose] rem, respectively.

References

1. [Latest revision:] DTRA (Defense Threat Reduction Agency), [year1]. "Standard Operating Procedures Manual for Radiation Dose Assessment - Nuclear Test Personnel Review Program," Revision [insert revision number], [Enter insert current revision date].
2. DTRA (Defense Threat Reduction Agency), [year2]. "Scenario of Participation and Radiation Exposure Pertaining to [insert veteran's full name] for Operation(s) [List Operations (Year of Operation)]," signed by the veteran [or a representative] on [insert the date], and received on [insert the date] (Attached).
3. DTRA (Defense Threat Reduction Agency), [year3]. Pertinent documents in the veteran's Nuclear Test Personnel Review (NTPR) file, including his [/her] Statement in Support of Claim, dosimetry records, service record excerpts, unit morning reports, correspondence, and interviews.
4. [Additional references pertaining to information, which is not included or referenced in the above references]

Attachment 2 Template for the RDA Report Decision Summary Sheet)

A copy of the RDA Report Decision Summary Sheet is provided on the next page.

Nuclear Test Personnel Review Program

RDA Report Decision Summary Sheet

Date:		DSS Prepared By:	
Veteran's Name:		Rank, Branch, ID:	
Unit:		Duty Station:	
		Dates of Participation:	
Affected Internal Organs:		Surrogates (if any):	
Film Badges/ Dosimetry:	<input type="checkbox"/> Yes → <input type="checkbox"/> All periods of presence covered <input type="checkbox"/> Some periods covered <input type="checkbox"/> No		

Key Decisions

<u>Decision #1:</u>	
Rationale:	
Assumptions:	
References:	

<u>Decision #2:</u>	
Rationale:	
Assumptions:	
References:	

<u>Decision #3:</u>	
Rationale:	
Assumptions:	
References:	

<u>Decision #4:</u>	
Rationale:	
Assumptions:	
References:	

<u>Decision #5:</u>	
Rationale:	
Assumptions:	
References:	

Attachment 3 Template for a Standardized Calculation Worksheet (Mathcad)

A copy of a standardized calculation worksheet is provided starting on the next page.

Note: An electronic copy of the template is available from the NTPR Program Manager, who may be contacted at:

NTPR Program Manager
Toll Free: (800) 462-3683
Email: ntpr@dtra.mil

Postal Address:
Defense Threat Reduction Agency
RD-NTSN/NTPR
8725 John J. Kingman Road
Stop 6201
Fort Belvoir, VA 22060-6201

To use the electronic template, Mathcad, Ver. 14 (or later) software with minimum system requirements is requisite. Reference to Mathcad software is for illustrative purposes only and should not be interpreted as an official Defense Threat Reduction Agency endorsement.

NUCLEAR TEST PERSONNEL REVIEW PROGRAM - RADIATION DOSE CALCULATION WORKSHEET													
1.0 WORKSHEET INFORMATION													
1.1 Worksheet Origin, Notes and Review History													
<p>This worksheet was prepared with Mathcad Version 14 using the following: Standard Template Date: 12-30-2009 [DRAFT] Worksheet Revision and Date: Worksheet Revision Notes: [This worksheet displays the standard format for RDA worksheets]</p>	<p>Worksheet Production and Review:</p> <table style="width: 100%; border: none;"> <tr> <td style="border: none;">Analyst and Date:</td> <td style="border: none;">XXX mm/dd/yy</td> <td style="border: none;">[Final]</td> </tr> <tr> <td style="border: none;">Reviews and Dates:</td> <td style="border: none;">XXX mm/dd/yy</td> <td style="border: none;">[Mngt]</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none;">XXX mm/dd/yy</td> <td style="border: none;">[CHP]</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none;">XXX mm/dd/yy</td> <td style="border: none;">[Technical]</td> </tr> </table>	Analyst and Date:	XXX mm/dd/yy	[Final]	Reviews and Dates:	XXX mm/dd/yy	[Mngt]		XXX mm/dd/yy	[CHP]		XXX mm/dd/yy	[Technical]
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1.2 Worksheet Outline													
<p>The worksheet is organized according to the Standard Outline for NTPR Mathcad Dose Calculation Worksheets. The main sections of the worksheet are listed below. Double click on a section title to jump to that section of the worksheet.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">1.0 <u>Mathcad Worksheet Information</u></td> <td style="width: 50%; border: none;">6.0 <u>Dose Calculations - Skin Doses from External Radiation</u></td> </tr> <tr> <td style="border: none;">2.0 <u>General Description of the Case</u></td> <td style="border: none;">7.0 <u>Dose Calculations - Eye Doses</u></td> </tr> <tr> <td style="border: none;">3.0 <u>Definitions and Data</u></td> <td style="border: none;">8.0 <u>Dose Summary and Upper Bound Doses</u></td> </tr> <tr> <td style="border: none;">4.0 <u>Dose Calculations - Whole Body Doses from External Radiation</u></td> <td style="border: none;">9.0 <u>References</u></td> </tr> <tr> <td style="border: none;">5.0 <u>Dose Calculations - Organ Doses from Internal Radiation</u></td> <td style="border: none;">A. <u>Data Annex</u></td> </tr> </table>		1.0 <u>Mathcad Worksheet Information</u>	6.0 <u>Dose Calculations - Skin Doses from External Radiation</u>	2.0 <u>General Description of the Case</u>	7.0 <u>Dose Calculations - Eye Doses</u>	3.0 <u>Definitions and Data</u>	8.0 <u>Dose Summary and Upper Bound Doses</u>	4.0 <u>Dose Calculations - Whole Body Doses from External Radiation</u>	9.0 <u>References</u>	5.0 <u>Dose Calculations - Organ Doses from Internal Radiation</u>	A. <u>Data Annex</u>		
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<u>Go to Worksheet Outline</u>													
2.1 Veteran Identification													
<table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">Veteran's name:</td> <td style="border: none;">Test Series:</td> </tr> <tr> <td style="border: none;">Service Branch, Rank, Military ID:</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">Unit and Duty Ship or Station:</td> <td style="border: none;"></td> </tr> </table>		Veteran's name:	Test Series:	Service Branch, Rank, Military ID:		Unit and Duty Ship or Station:							
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Unit and Duty Ship or Station:													
2.2 Summary Description of the Case and the Doses Calculated in the Worksheet													
<p>This case involves { <i>identify group or unit attached to, if TDY, etc.</i> }. He/She served as a { <i>rank</i> } with the { <i>service branch</i> } with { <i>duties</i> }. His/Her duty station during Operation { } was at { <i>duty location</i> }, where he/she arrived on { <i>date</i> } and departed { <i>date</i> }. {<i>Include other relevant summary information in this section as appropriate</i>}</p> <p>Doses evaluated and calculated in this worksheet are: {<i>bullet listing of pathways and sources included</i>}</p>													

3.0 DEFINITIONS AND DATA
 Definitions and assigned values for all variables, and identification and definition of all data tables/files used in subsequent calculations. Lengthy data tables are displayed in the Annex at the end of this worksheet rather than in Section 3.

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$$f(a) := \text{floor}(a)$$

$$J(y,m,d,t) := 24 \cdot \left[2 - f(\text{if}(m < 3, y - 1, y) \cdot 10^{-2}) + f(\text{if}(m < 3, y - 1, y) \cdot 400^{-1}) + [f(365.25 \cdot \text{if}(m < 3, y - 1, y)) + f[30.6001 \cdot (\text{if}(m < 3, m + 12, m) + 1)]] \dots \right. \\ \left. + (d + t \cdot 24^{-1}) + 1720994.5 \right]$$

NOTE: Use the function J(y,m,d,t) to define all dates and times (restricted to Jan 1, 1900 - Dec 31, 1999).

For example, "Date1" of 0815 hours on 6 Aug 1945 is defined as $\text{Date1} := J\left(45, 08, 06, 08 + \frac{15}{60}\right)$

3.1 Dates and Times
 Dates of veteran's arrival/departure, attach/detach, timing of particular activities, shot(s) date(s), etc., as needed.

3.1.1 Shot Dates and Times

3.1.2 Veteran's Arrival and Departure Dates

3.1.x { Additional subsections as needed }

3.2 Film Badge Data
 Badge number(s), dates, reading(s), notes regarding damage, FBDOSE results, etc., as needed.

3.2.1 Film badge records (e.g., from Personnel Information Form (PIF))

3.2.x { Additional subsections as needed }

3.3 General Exposure Variables
 Time outside/topside, shielding factors, GSMF, decay constants, etc., as needed.

3.3.1 General Exposure Variables for Land-Based Dose Calculations

3.3.2 General Exposure Variables for Ship-Based Dose Calculations

3.3.x { Additional subsections as needed }

3.4	Fallout Intensities Start/stop times, time-intensity data pairs, peak/measured intensities and associated times, intensity functions and descriptions, etc., as needed, from {SOP reference}.
3.4.1	External Gamma Variable Definitions for { Shot 1 }
3.4.2	External Gamma Variable Definitions for { Shot 2 }
3.4.x	{ Additional subsections as needed }
3.5	Inhalation Dose Data and Variables Specify organ, breathing rate, dose factors, interpolation functions, resuspension factor(s), R/hr per Ci/m ² data sets, etc., as needed from NTPR SOP Manual (see References Section).
3.5.1	Inhalation Dose Factors for {Source 1}
3.5.2	Inhalation Dose Factors for {Source 2}
3.5.x	{ Additional subsections as needed }
3.6	Ingestion Dose Data and Variables Specify organ, dose factors, interpolation functions, soil density, soil intake rate, plate parameters, water ingestion rate, etc., as needed
3.6.1	Generic Food Ingestion Dose Parameters
3.6.2	Generic Soil Ingestion Dose Parameters
3.6.3	Ingestion Dose Parameters for { Source 1 }
3.6.3	Ingestion Dose Parameters for { Source 2 }
3.6.x	{ Additional subsections as needed }
3.7	Skin Dose Data and Variables Specify skin site and height, wind speed, interception/retention fraction(s) and associated modifiers, rad/hr per Ci/m ² data tables, beta/gamma ratios, finite geometry modifications, etc., as needed from NTPR SOP Manual (see References Section) ED03 and ED04.
3.8	Eye Dose Data and Variables Heights of skin sites, beta/gamma ratios, etc., as needed from NTPR SOP Manual (see References Section) ED05.

4.0 DOSE CALCULATIONS - WHOLE BODY DOSES FROM EXTERNAL RADIATION

Calculations of whole body doses due to all sources of initial and external residual radiation.

[Go to Worksheet Outline](#)

4.1 Doses from Initial Neutron Radiation

Doses from neutrons emitted from a nuclear detonation

4.1.1 Initial Neutron Dose for { Shot 1 }

4.1.x { Additional subsections as needed }

4.2 External Doses from Initial Gamma Radiation

Doses from gamma radiation emitted from a nuclear detonation or shortly thereafter (within 1 minute).

4.2.1 Initial Gamma Dose for { Shot 1 }

4.2.x { Additional subsections as needed }

4.3 External Gamma Doses from Residual Radiation During Badged Periods

Doses from all activities and sources during time periods that a film badge was issued to the veteran or that valid cohort film badge data exist based on methods and equations in NTPR SOP Manual (see References Section) ED01.

4.3.1 External Gamma Dose for { Shot 1 / Badged Period 1 / etc. }

4.3.x { Additional subsections as needed }

4.4 External Gamma Doses from Residual Radiation During Non-Badged Periods

Doses from activities and sources during time periods that the veteran was not issued a film badge, or for which valid cohort film badge data do not exist, based on methods and equations in NTPR SOP Manual (see References Section) ED02.

4.4.1 External Gamma Dose for { Shot 1 / Non-Badged Period 1 / etc. }

4.4.x { Additional subsections as needed }

4.5 External Gamma Doses from Radiation Other than Residual Radiation

Doses from activities and sources that are not from residual radiation resulting from nuclear detonations, such as calibration sources and test sources.

4.5.1 External Gamma Dose for { Source 1 / Activity 1 }

4.5.x { Additional subsections as needed }

5.0 DOSE CALCULATIONS - ORGAN DOSES FROM INTERNAL RADIATION

Calculation of organ doses due to all sources of internal radiation based on equations and methodology in NTPR SOP Manual (see References Section), ID01.

[Go to Worksheet Outline](#)

5.1 Inhalation Doses from Descending Fallout

Doses resulting from inhalation of descending fallout.

5.1.1 Inhalation Dose from Descending { Shot 1 } Fallout

5.1.x { Additional subsections as needed }

5.2 Inhalation Doses from Resuspended Fallout

Doses resulting from inhalation of resuspended fallout previously deposited on a surface (e.g., ground).

5.2.1 Inhalation Dose from Resuspended { Shot 1 } Fallout

5.2.x { Additional subsections as needed }

5.3 Inhalation Doses from Highly-Resuspended Fallout

Doses resulting from inhalation of fallout resuspended by thermal or blast effects of a detonation.

5.3.1 Inhalation Dose from Highly-Resuspended { Shot 1 } Fallout During { Activity 1 }

5.3.x { Additional subsections as needed }

5.4 Inhalation Doses from Suspended Activation Products

Doses resulting from inhalation of neutron-induced contaminants suspended from a surface or volume.

5.4.1 Inhalation Dose from Suspended Activation Products from { Shot 1 } during { Activity 1 }

5.4.x { Additional subsections as needed }

5.5 Inhalation Doses from Other Sources

Sources of inhalation exposure not previously addressed.

5.5.1 Inhalation Dose from { Source 1 }

5.5.x { Additional subsections as needed }

5.6 Food Ingestion Doses Doses resulting from contaminants transferred directly into the mouth and swallowed during incidental, routine, or one-time events.
5.6.1 Ingestion Dose from { Shot 1 } Fallout
5.6.x { Additional subsections as needed }
5.7 Soil Ingestion Doses Doses resulting from incidental ingestion of dust and soil.
5.7.1 Ingestion Dose from Incidental Ingestion of { Source 1 }
5.7.x { Additional subsections as needed }
6.0 DOSE CALCULATIONS - SKIN DOSES FROM EXTERNAL RADIATION Calculation of skin doses from external beta and gamma radiation sources. Go to Worksheet Outline
7.0 DOSE CALCULATIONS - EYE DOSES External beta and gamma radiation doses to the lens of the eye and other eye locations (e.g., choroid). Go to Worksheet Outline
8.0 DOSE SUMMARY AND UPPER BOUND DOSES Arranged to facilitate comparison with dose listing in RDA Report Go to Worksheet Outline
8.1 External Dose Summary Listing of estimated external doses (e.g., initial and residual, by pathway or activity or time period) and upper bound external doses (neutron and gamma) based on equations and methodology in NTPR SOP Manual (see References Section) UA01.
8.1.1 External Doses From Badged and Unbadged Periods (include initial, residual and other types of external radiation -- Sections { 4.x.x }
8.1.2 Total External Dose
8.1.3 Upper Bound External Dose

8.2 Internal Dose Summary

Listing of internal doses by pathway or activity or time period, to include doses from both alpha and beta plus gamma radiations, for each organ. Upper bound internal doses for both alpha and beta/gamma radiations, for each organ, based on equations and methodology in from NTPR SOP Manual (see References Section) UA01.

8.2.1 Internal Doses -- Sections { 5.x.x }

8.2.2 Total Internal Doses

8.2.3 Upper Bound Internal Doses

8.3 Skin Dose Summary

Listing of skin doses by pathway or activity or time period, and total beta plus gamma doses for each skin site. Upper bound external dose (beta plus gamma doses) for each skin site.

8.3.1 Skin Beta+Gamma Doses From Badged and Unbadged Periods -- Sections {6.x.x }

8.3.2 Total Skin Beta+Gamma Doses

8.3.3 Upper Bound Skin Beta+Gamma Doses

8.4 Eye Dose Summary

Listing of eye doses by pathway or activity or time period, and total beta plus gamma dose for the eye. Upper bound external dose (beta plus gamma dose) for the eye.

8.4.1 Eye Beta+Gamma Doses From Badged and Unbadged Periods -- Sections {7.x.x }

8.4.2 Total Eye Beta+Gamma Dose

8.4.3 Upper Bound Eye Beta+Gamma Dose

8.2 Internal Dose Summary

Listing of internal doses by pathway or activity or time period, to include doses from both alpha and beta plus gamma radiations, for each organ. Upper bound internal doses for both alpha and beta/gamma radiations, for each organ, based on equations and methodology in from NTPR SOP Manual (see References Section) UA01.

8.2.1 Internal Doses -- Sections { 5.x.x }

8.2.2 Total Internal Doses

8.2.3 Upper Bound Internal Doses

8.3 Skin Dose Summary

Listing of skin doses by pathway or activity or time period, and total beta plus gamma doses for each skin site. Upper bound external dose (beta plus gamma doses) for each skin site.

8.3.1 Skin Beta+Gamma Doses From Badged and Unbadged Periods -- Sections {6.x.x }

8.3.2 Total Skin Beta+Gamma Doses

8.3.3 Upper Bound Skin Beta+Gamma Doses

8.4 Eye Dose Summary

Listing of eye doses by pathway or activity or time period, and total beta plus gamma dose for the eye. Upper bound external dose (beta plus gamma dose) for the eye.

8.4.1 Eye Beta+Gamma Doses From Badged and Unbadged Periods -- Sections {7.x.x }

8.4.2 Total Eye Beta+Gamma Dose

8.4.3 Upper Bound Eye Beta+Gamma Dose

9.0 REFERENCES

SOP reference and primary sources as necessary. (List by author, year, title, publisher, date)

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A. DATA ANNEX

Display of non-veteran specific input data used in the dose analysis. These data should include, for example, dose conversion factors for applicable shots and organs, beta-to-gamma ratios, intensity-to-surface contamination values, and similar data sets.

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A.1 Data Set 1

A.2 Data Set 2

A.3 Data Set 3