



Assessment of Radiation Exposures of Military Personnel aboard McMurdo Station, Antarctica (1962 to 1979)

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Background



- 1. The Secretary of Defense and the Secretary of the Navy committed the Navy [specifically, Naval Dosimetry Center (NDC)] to work with Defense Threat Reduction Agency (DTRA), Veterans Affairs (VA), & Veterans' Advisory Board on Dose Reconstruction (VBDR) to assess possible radiation doses associated with the PM-3A**
- 2. An interim brief on the status of the dose assessment efforts was provided by the Navy at the VBDR meeting in San Antonio, TX, March 23, 2012**
- 3. The brief included a call for additional veteran input**
- 4. Veteran input was subsequently received and incorporated, along with information gathered from additional research**



Objectives



- 1. Estimate upper-bound doses for non-reactor personnel (veterans who were not monitored for radiation exposure)**
- 2. Develop procedures for individualized radiation dose assessments for:**
 - Non-monitored support personnel
 - Monitored, PM-3A Nuclear Power Plant (NPP) staff



UPPER BOUND DOSE ASSESSMENT



Radiation Exposure Scenarios and Calculations



- 1. External and Internal pathways remain unchanged**
- 2. Some parameters were updated to reflect more accurate values, based on additional veteran input and research:**
 - Dose rates for packages of waste shipped as DOT category Yellow III and Radioisotope Thermal Generator (RTG) shipments reflect average dose rate measured at one meter for the respective packages shipped from McMurdo Station**
 - Activity concentrations of contaminated soil reflect the maximum contamination measured in all soil samples**
 - Ratio of gaseous iodine to aerosol iodine matches NUREG-0017[†] and published data on particulate to non-particulate iodines in reactor effluents**
 - Water intake accounts for increased consumption in the extreme cold and dry Antarctic environment**

[†]NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors", Chandrasekaran et al., NRC, 1985.



Radiation Exposure Scenarios and Calculations



Additional revisions:

- **Assignment of a tritium ingestion dose for all years**
- **Assignment of a ship loading dose for all years**
- **Air sampling results partitioned into both iodine and cesium exposures for all years**



Uncertainty Consideration for External Dose



- 1. In addition to using high-sided values in the exposure parameters, all reconstructed doses for external exposure are multiplied by an uncertainty factor of 3 to:**
 - Account for uncertainties in measurements and calculations**
 - Based on standard operating procedures methodologies of the DTRA Nuclear Test Personnel Review (NTPR) program**
- 2. External dose components from various pathways assumed uncorrelated**
- 3. External doses combined in quadrature**
- 4. Upper-bound doses rounded up to one significant digit to ensure maximum benefit to veteran**



Uncertainty Consideration for Internal Dose



- 1. In addition to using high-sided values in the exposure parameters, all reconstructed doses for internal exposure are multiplied by an uncertainty factor of 10 to:**
 - Account for uncertainties in measurements and calculations**
 - Be consistent with standard operating procedures of the NTPR program**
- 2. Internal dose components from various pathways assumed correlated**
- 3. Upper-bound doses determined from summing upper-bounds of each internal dose component**
- 4. Upper-bound doses rounded up to one significant digit**



Upper-Bound Estimates of External and Internal Doses for Non-Reactor Personnel



Dose	Range of Upper-Bound Doses (rem)	
External Doses		
Winter	<i>Initial</i>	0.06 - 0.3
	Final	0.2 – 0.4
Summer	<i>Initial</i>	0.06 - 0.3
	Final	0.2 – 0.3
Internal Doses – Effective*		
Winter	<i>Initial</i>	0.004 - 0.05
	Final	0.03 – 0.4
Summer	<i>Initial</i>	0.001 - 0.03
	Final	0.009 – 0.2

**Determined upper-bound doses for committed effective dose (50 year CED)*



Upper-Bound Estimates of Organ Doses for Non-Reactor Personnel



Dose	Range of Upper-Bound Doses (rem)	
Internal Committed Equivalent Doses – Thyroid		
Winter	<i>Initial</i>	0.004 - 0.1
	Final	0.06 – 0.4
Summer	<i>Initial</i>	0.001- 0.04
	Final	0.03 – 0.2
Internal Committed Equivalent Doses – Red Marrow		
Winter	<i>Initial</i>	NC [‡]
	Final	0.02 – 0.3
Summer	<i>Initial</i>	NC [‡]
	Final	0.008 – 0.2
‡NC = Not calculated at the time of initial presentation		



Medical Radiation Exposures for Relative Comparisons



Examinations and Procedures	Effective Dose (rem)
Upper GI	0.6
Barium Enema	0.7
CT Head	0.2
CT Chest	0.7
CT Abdomen/Pelvis	1.0
Whole-Body CT Screening	1.0
CT Biopsy	0.1
Chest	0.01
Cervical Spine	0.02
Thoracic Spine	0.1
Lumbar Spine	0.15
Pelvis	0.07
Abdomen or Hip	0.06

Comparable dose to the year with the highest sum of external & internal upper-bound doses

Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: A catalog. Radiology 248(1):254-263; 2008.



PROCEDURES FOR INDIVIDUAL DOSE ASSESSMENTS



Established Process for Individualized Dose Assessment



- 1. Veteran (or authorized representative) submits claim to VA via established VA protocol**
- 2. VA provides McMurdo Station Radiation Dose Assessment Questionnaire to veteran**
- 3. Veteran returns the completed questionnaire to VA**
- 4. VA submits a request for dose assessment to NDC, forwarding the completed questionnaire and other pertinent documents**
- 5. NDC assesses veteran's total effective dose equivalent according to the exposures pathways established in the report, using year-specific high-sided parameters for each pathway or veteran input from questionnaire**
- 6. NDC assigns dose to veteran with response letter to VA**



Questionnaire Sample Page



B. Assigned to McMurdo Station while the NPP was decommissioned (1973-1979)

1. Did you ever enter the NPP facility during decommissioning? Yes ___ No ___

If No, skip to the next numbered question. If Yes, answer the following sub-questions:

○ Approximately, how many times did you enter the facility? _____

○ What were the reasons for entering the NPP facility? _____

○ What areas and buildings were you in and what activities did you carry out in the NPP?

2. Did your duties require you to assist in the decommissioning of the NPP? Yes ___ No ___

If No, skip to the next numbered question. If Yes, answer the following sub-questions:

○ What did you do to assist in decommissioning activities? _____

○ How many hours/days did you spend inside the NPP facility assisting in its decommissioning?

3. Did you handle radioactive waste such as helped move radioactive waste or load packages containing radioactive materials on a ship? Yes ___ No ___

If No, skip to the next numbered question. If Yes, answer the following sub-questions:

○ What was your role in the handling of waste or packages containing radioactive materials?

○ How many times approximately? _____

○ For how long on average each time? _____



Individualized Dose Assessment Processing Parameters



- 1. Assigned dose will match published year-specific dose unless veteran provides supporting justification for use of higher values as input to specific exposure scenarios**
- 2. Initial dose assessments will all be subjected to independent, 3rd party review of NDC calculations**
- 3. Subsequent dose assessments with exposure scenarios deviating from the established parameters of the report will continue to be subject to independent, 3rd party review of NDC calculations**
- 4. Consistent with established practices aboard NDC for other exposure assessments, assigned doses will be entered into the Naval Automated Radiation Exposure Registry in a similar manner as exposures recorded from monitoring devices**



Validations of Process for Individualized Dose Assessments



NDC completed a validation and verification of procedures with DTRA to confirm consistency of NDC procedures and results to the procedures and results for the report

- 1. Confirmed nominal high-sided values for Winter and Summer scenarios**
- 2. Confirmed values based on variances for Winter and Summer scenarios**
- 3. Confirmed that values are equal to or greater than upper-bound values from the report**



Conclusions



- 1. The upper-bound radiation dose assessment for military personnel stationed aboard McMurdo Station, Antarctica between 1962 and 1979 is complete:**

“DTRA-TR-12-003: Upper Bound Radiation Dose Assessment for Military Personnel at McMurdo Station, Antarctica, between 1962 and 1979”

- 2. NOTE: The finalized report is available online at <http://www.dtra.mil/SpecialFocus/NTPR/NTPRHome.aspx>, under the “Learn More” section of the page**



Conclusions



- 1. A method for providing individualized radiation dose assessments for both: 1) Non-monitored support personnel; and, 2) Monitored, PM-3A NPP staff has been developed**
- 2. NDC has already received McMurdo-related exposure history requests from VA**
- 3. The first round of assigned doses will undergo independent, 3rd party review by DTRA NTPR personnel and returned to VA as soon as complete**



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QUESTIONS?