INTRODUCTION TO FRMAC DOSE ASSESSMENT METHODOLOGY AND TURBO FRMAC SOFTWARE*



* Presentation edited to conform to be 508 Compliant





Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy s National Nuclear Security Administration under contract DE-AC04-94AL85000.

INTRODUCTIONS



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WHAT IS FRMAC?

FEDERAL RADIOLOGICAL MONITORING AND ASSESSMENT CENTER (FRMAC)

- Federal asset available to respond to nuclear/radiological incidents
- Described in the National Response Framework (NRF) and the Nuclear/Radiological Incident Annex
- Comprised of multiple Federal Agencies that provide a "one-voice" federal response





WHAT IS FRMAC?

Upon Request, FRMAC assets deploy in a phased approach Assets include:

- Field Monitoring Teams, Plume Modeling,
- Aerial Measurement Capability, Home Team, Liaisons, etc.

More information available at the website: NNSS FRMAC





FRMAC PARTICIPATION

- Department of Agriculture (USDA)
- Department of Energy (DOE)/National Nuclear Security Administration (NNSA)
- Department of Health & Human Services(DHHS)/Food & Drug Administration (FDA) and Center for Disease Control & Prevention (CDC)
- Department of Homeland Security(DHS)/Federal Emergency Management Agency (FEMA)
- Environmental Protection Agency (EPA)
- Nuclear Regulatory Commission (NRC)
- State/Local/Tribal agencies



HOW FRMAC FITS WITHIN THE ICS



FRMAC STRUCTURE



PROTECTIVE ACTIONS GUIDELINES (PAGS)

- Interim Release for use as of April 2013
- Comment period through September 16, 2013
- Currently in Comment Resolution process



PAG MANUAL REVISIONS KEY CHANGES

- Incorporates FDA's recommended PAG of 5 rem projected child thyroid dose for administration of stable iodine (KI)
- Removes the 25 rem Adult Thyroid Dose and the 50 rem Skin Dose Evacuation PAGs
- Removes the 50-year, 5 rem Relocation PAG
- Provides guidance for reentry, late phase cleanup and waste disposal
- Adopts the FDA's 1998 Food PAGs

PAG MANUAL REVISION KEYS

- Applies to all radiological incidents including RDDs and INDs
- Refers to the FRMAC Assessment Manual (FAM) for methods and calculations to implement the PAGS
- Removed all data tables (DCFs, DRLs, etc.) and refers users to the FAM
- Encourages the use of Turbo FRMAC to implement the PAGs
- Drinking Water guidance under development

PAG MANUAL DEFINITIONS

- Protective Action Guide (PAG) A projected dose to an individual from released radioactive material at which a specific protective action to reduce or avoid that dose is recommended
- Projected Dose The prediction of the dose that a population or individual could receive
- Derived Response Level (DRL) A level of radioactivity in an environmental medium that would be expected to produce a dose equal to the corresponding PAG
- Protective Action An activity conducted in response to an incident or potential incident to avoid or reduce radiation dose to members of the public

PAG MANUAL GUIDANCE - TIME PHASES

Time Phase	Start	Duration	Protective
			Actions
Early	Begins with the radiological release	May last hours to days; Generally considered to last 4 days (~96 hours)	Evacuation and/or Shelter in Place
Intermediate	Release under control or terminated	1 st Year 2 nd & Subsequent Years	Relocation
Late	Transition from strategies driven by urgency, to strategies aimed at reducing longer-term exposures	Not Defined	Relocation



Early Phase									
Protective Action Recommendation	PAG (Projected Dose)	Comments							
Sheltering-in-Place or Evacuation	1-5 rem	Evacuation (or, for some situations, sheltering-in-place) should be initiated when projected dose is 1 rem							
Administration of prophylactic drugs – Kl	5 rem to child thyroid from iodine exposure	May require approval of state medical officials (or in accordance with established emergency plans)							
	Interm	nediate Phase							
Relocate the general population	2 rem	1 st year following the event							
Relocate the general population	0.5 rem	In the 2 nd and subsequent years							
Late Phase									
Relocate the general population	NA	PAGs will not be used to guide restoration and recovery							

EXPOSURE PATHWAYS

• Early Phase

- 1. Inhalation of radioactive materials in the plume
- 2. Direct exposure from radioactive materials in the plume
- 3. Inhalation of ground-deposited radionuclides resuspended into the breathing zone
- 4. Direct exposure from "groundshine" from deposited radioiodines and particulates
- Intermediate and Late Phase
 - 1. Inhalation of ground-deposited radionuclides resuspended into the breathing zone
 - 2. Direct exposure from "groundshine" from deposited radioiodines and particulates

Exposure from the ingestion of food and water is considered independently of decisions for relocation and decontamination

RELEASE EXPOSURE PATHWAYS



FDA INGESTION PAG MANUAL

ACCIDENTAL RADIOACTIVE CONTAMINATION OF HUMAN FOOD AND ANIMAL FEEDS: RECOMMENDATIONS FOR STATE AND LOCAL AGENCIES



FDA INGESTION PAGS

Protective Action Recommendation		PAG (Projected Dose)	Comments				
See Below		0.5 rem (E ₅₀) 5 rem (H _T)	Whichever is more limiting (Whole Body or Organ) from ingestion of contaminated food in 1 st year				
		Ingestion Protectiv	e Action Recommendations				
All foods	Isolate Deterr	by temporary embarg nine whether condemr	o until survey and initial sampling is completed nation or other disposition is appropriate				
Milk	Hold fo (e.g., c	or decay or divert to ot heese, butter, dry milk	her products involving adequate decay during processing solids, or evaporated milk)				
Fruits and Vegetables	Fruits and Vegetables Vash, brush, scrub or peel to remove surface contamination Preserve by canning, freezing, dehydration, or storage to permit decay						
Grains	Proces	s by milling and polishi	ng to remove surface contamination				
Animals	Move	to shelter and/or corra	I; provide protected feed and water				

FRMAC ASSESSMENT MANUAL

- Latest Version Dated April 2015
- Available on FRMAC Home
 Page

https://www.nnss.gov/pages/programs /FRMAC/FRMAC_DocumentsManuals.h tml

LANDOUTPS, 2004 Supersentes Salido 2012-OBSS # CONTRACTOR OF TAXABLE FEDERAL RADIOLOGICAL MONITORING AND ASSESSMENT CENTER FRMAC ASSESSMENT MANUAL VOLUME 1 OVERVIEW AND METHODS RESPONSE TRIBAL LOCAL STATE NONTONING AND The Federal Manual for Assessing Environmental Data During a Radiological Emergency April 2015

FRMAC ASSESSMENT MANUAL

- Provides the technical basis for and documents the process for FRMAC assessments
- Provides the technical basis for the Turbo FRMAC© Software Package
- Provides updated tabulated reference data for default assessment conditions (e.g., Time Phases, PAGs, likely nuclides of concern)

NOTE: The FRMAC Assessment Division implements the best health physics practices to perform radiological assessments, however these practices may differ from those in other agencies' publications due to a difference in publication date or based upon alternate assumptions.

FRMAC ASSESSMENT METHODS

FRMAC Assessment Working Group (AWG) develops and implements consistent, defensible and state-ofthe-art radiological assessment methods across all the represented agencies/organizations

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FRMAC ASSESSMENT MANUAL

Section 1, Public Protection Methods Section 2, Worker Protection Methods Section 3, Ingestion Pathway Methods Section 4, Supplemental Methods Appendices

WHAT IS TURBO FRMAC?

- Turbo FRMAC automates FRMAC Assessment Manual methods
- Turbo FRMAC eliminates most human errors
- Turbo FRMAC is a deployable software application
- Turbo FRMAC is not a replacement for Health Physics knowledge and experience

Jurbo JFRMAC 2015



ASSESSING TURBO FRMAC

- Final approval of Turbo FRMAC Copyright from DOE
- Software may only be issued to Federal, State, Local responders with Justification
- Registration required via the following site: <u>nirp.sandia.gov/</u>





TURBO FRMAC WEB BETA



Ribbons and Tabs

- Controls calculations
- Allows movement to other work options
- Provides any error messages

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Drop Down Menu

- Emulates Microsoft layouts
- Provides easy access to many commands



Quick Access bar

- Start New Calculation
- Open Existing Calculation
- Save Current Calculation
- Start from Home

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Buttons

- Required Inputs
- Advanced Inputs

Panels

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FEATURES → MAIN WINDOW

Clicking the button brings the panel into viewing area

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FEATURES → MAIN WINDOW Panel will display any errors and resolution

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FEATURES → MAIN WINDOW

Once the user provides required data, error message is removed and calculation buttons are "active"

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FEATURES --> RESULTS

Calculation completed for all radionuclides and for all age groups



FEATURES → RESULTS

Units can be converted as needed





Example for Demonstration Only



Automated Report: Testing (36.7158.-121.623) RDD Release at 30 Jun 2011 13:00 UTC

Predicted Evacuation and Sheltering Areas - Most Limiting Criteria The Whole Body Dose is the most limiting of the EPA Guide criteria <u>Avoidable Dose - Applicable 12 hr after start of release</u>



Shelter of entire population warranted, often followed by a delayed, deliberate evacuation. Those already outdoors should be removed from the area (exceeds 5 rem). Estimated Population: 360 Area: 0.1 km2 Extent: 0.7 km Evacuation or sheltering normally initiated (1 to 5 rem). Estimated Population: 10,300 Area: 2.7 km2 Extent: 3.6 km

Notes:

•EPA's Early Phase Guides provide separate criteria to limit dose to both the whole body and the thyroid. Separate predictions of the affected area were compared based on each criteria. •The Whole Body Dose criterion is the most limiting in this case. •Protective actions are normally based on the most limiting case. •Prompt evacuation and/or sheltering reduces radiation dose and cancer risk. Sheltering-in-place may be more protective than evacuation while the radioactive cloud is present. •Protective actions are only based on dose that can be avoided. •Prediction excludes dose received before 01 Jul 2011 01:00 UTC.

Assumptions:

 Areas shown are model predictions based on an estimated release of airborne radioactivity, but no measurements yet available.
 Avoidable dose predicted from 12 hr to 108 hr after release start.
 Dose predicted for maximally exposed adult externally exposed to radiation from contamination on the ground and inhalation of resuspended contaminated dust. Also includes dose due to external exposure from and inhalation of the radioactive cloud, if present.

Briefing Product for Public Officials Produced: 17 May 2013 21:56 UTC Check for updates Technical Details: CMHT Advice & Recommendations: A-Team

Example for Demonstration Only

page 1 of 3

DATA PRODUCTS

EXERCISE EXERCISE EXERCISE



Set 3: Exercise (34.40304,-80.15844) NPP Release at 21 Jul 2015 15:51 UTC

#4 Predicted Areas Warranting Administration of Potassium Iodide (KI) Supplemental Protective Action based on dose to the thyroid due to radioiodine Applicable only if radioactive cloud is present or imminent



KI administration warranted for all individuals. Exceeds 500 rem adult thyroid dose. Area: 0.08 km2 Extent: 0.5 km

KI administration warranted for all individuals under 40 yr. and all pregnant/lactating females. Exceeds 10 rem adult thyroid dose. Area: 7.9 km2 Extent: 6.3 km

KI administration warranted for children under 18 yr. and all pregnant/lactating females. Exceeds 5 rem adult thyroid dose. Area: 15.3 km2 Extent: 9.1 km

KI administration warranted for children under 18 yr. Exceeds 5 rem child thyroid dose. Area: 40.1 km2 Extent: 15.1 km

Notes:

- Due to logistic constraints, administration of KI at the lowest intervention threshold may be necessary.
- Some individuals with certain medical conditions are not candidates for KI administration.
- The protective value of KI administration is time sensitive. If at all
 possible, administer KI before exposure to the radioactive cloud.
 Benefit diminishes rapidly after exposure to the cloud.
- · Contact the Advisory Team for simplification of these guidelines.

Assumptions:

- Areas shown are model predictions based on an estimated release of airborne radioactivity, but no measurements yet available.
- Plume Phase Radioactive cloud may be present or imminent.
- Prediction assumes max, dose to an adult. Includes dose from inhalation of contamination in the radioactive cloud and dose from inhalation of resuspended contaminated dust over first 4 days.

Briefing Product for Public Officials Produced: 22 Jul 2015 11:46 UTC Check for updates Technical Details: FRMAC Home Team 702-794-1665 Advice & Recommendations: A-Team 866-300-4374

EXERCISE EXERCISE EXERCISE

page 1 of 3

RADIONUCLIDE VIEWER

- Displays Full Radionuclide Decay Chain
- Displays basic nuclide data
 - Half Life
 - Decay mode
- Provides access to Dose Coefficients for each nuclide

New Derived Response Levels Calculation - Turbo FRMAC Web										
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Committed Effective Dose 1.45E2	Cs-131 Cs-132 Cs-134 Cs-134m Cs-135 Cs-135 Cs-136 Cs-137 Cs-138			Dose Coefficients Dose Coefficients External Surface -1 cm Soil De -5 cm Soil De -15 cm Soil D -Infinite Soil I -Air Submers Water Imme -Inhalstion -Ingestion	s spth spth hepth Depth ion sision	Cs-137 Stor Inhalation Organ Adrenal Bone Surface Brain Breasts Kidneys Liver Lower Large Lung Muscle Ovaries Pancreas Red Marrow Skin Small Intestin Stomach Testes Thymus/Esog Thymos/Esog	Intestine	n Dose Coeff	Ticlents	32.6 17.3 14.8 34.3 17.0 27.3 20.9 1.10E3 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.6 23.1 17.6 23.1 17.6 23.1 17.6 23.1 17.6 23.1 17.8 17.6 23.1 17.6 23.1 17.8 17.8 17.8 17.8 17.8 17.8 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 17.9 13.5 17.6 17.9 13.5 17.6 17.9 17.9 13.5 17.6 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.8 17.8 17.9 17.9 17.9 17.9 17.9 17.8 17.9 17.8 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.	ICRP Guidance: IC Age: A Commitment Period: C View Particle Sizes for: © Compound Distributi © Vapor or Gas Compound Distribution © View/Edit D Distribution Summary: 1 Monodispersed Lung Clearance Class Maximum Fast (F) - Most Likely Medium (M) Slow (S)	CRP 60 dult hronic ion Distributic	DIDS
	Cs-131 Cs-132 Cs-134 Cs-134m Cs-135 Cs-135 Cs-136 Cs-137 Cs-138			Dose Coefficients Dose Coefficients External Surface	s the spth spth Depth ion rrsion	Cs-137 Stor Inhalation Organ Adrenal Bone Surface Brain Breasts Kidneys Liver Lower Large: Lower Large: Lower Large: Lower Large: Lower Large: Lower Large: Stor Muscle Ovaries Pancreas Red Marrow Skin Small Intestin Spleen Stomach Testes Thymus/Esop Thyroid Userse Large	Intestine	n Dose Coeff	Ticlents	32.6 17.3 14.8 34.3 17.0 27.3 20.9 1.10E3 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.2 15.8 18.0 24.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 13.5 17.6 23.1 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.	ICRP Guidance: IC Age: A Commitment Period: C View Particle Sizes for: © Compound Distributio © Vapor or Gas Compound Distributio © View/Edit D Distribution Summary: 1 Monodispersed Lung Clearance Class Maximum Fast (F) - Most Likely Medium (M) Slow (S)	CRP 60 Idult Ihronic ion m Distributic	DDS

RADIONUCLIDE MIXTURE MANAGER

- Allows User to Create/Save/Export/Import Custom Mixtures
- User may select Pre-determined Mixtures

New Deri	ived Response	e Levels Calculation	on - Turbo FRM	MAC Web	
AD!)			
Ho	me Shar	e Tools			
2				5	🛃 Recycle Bin
Analyst	Mixture	Radionuclide	Unit	Screen	🔘 Backup Utility
Manager	Manager	Viewer	Converter	Capture	Options
		1	ools		

RADIONUCLIDE MIXTURE MANAGER



TURBO FRMAC

- Designed for Windows 7
 Compatible with Windows 8, 7, Vista, XP
- Minimum 2 GHz Pentium 4 Processor Recommended: Dualor Quad-Core or higher
- Minimum 2 GB RAM Memory Recommended: 4 GB RAM or higher
- Minimum 15 GB Free Disk Space. Recommended: 25 GB Free or higher

- Minimum 1024 x 768 Screen Resolution Recommended: 1280 x 1024 or higher
 - Other Software:
 - MS Excel 2007 or newer (for special data export capabilities) MS Outlook 2007 or newer (for built-in email attachment support) MS Word 2007 or newer (for report generation) Adobe Acrobat Reader (for viewing related documents)

QUESTIONS