TMI Lessons Learned & National Response Framework

RAMP Users Meeting

April 2024

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LESSONS LEARNED FROM THREE MILE ISLAND

HISTORY

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Regulatory Changes

- NUREG-0737, “Clarification of TMI Action Plan Requirements”
  - Supplement 1 to this NUREG defined Requirements for Emergency Response Capability
- Regulation Guide 1.97
  - Criteria for accident monitoring instrumentation
- Both codified in 10 CFR 50.34 after working jointly with industry

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Offsite Changes

- Congress passes Public Law 96-295
  - Licenses contingent on approved State and local emergency plans
  - Required NRC to consult with FEMA on adequacy of plans
- 10 CFR 50.47, “Emergency Plans,” and expanded requirements in Appendix E
- NRC and FEMA issue NUREG-0654/REP-1, Rev. 1
  - Protective Action Recommendations

NRC Changes

- NUREG 0728
  - Significant changes to NRC Incident Response Program
- NUREG 0729
  - Defines the infrastructure of telecommunications for NRC Incident Response
- NUREG-0730
  - Genesis of the Nuclear Data Link (NDL) which, following a substantially revised design, is now the Emergency Reactor Data System (ERDS)

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A&P Tools – Before RASCAL

- Source term, transport/diffusion, and dose calculations were in separate codes
- Computers were mainframes or mini-computers
- Primary programming language for these codes was Fortran

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ATD Before RASCAL

MESOI (Version 1.0, October 1981)

- Interactive, Lagrangian puff trajectory diffusion model
- Designed to work on Boeing UNIVAC 1100 with communication via a video display terminal using a modem
- Used video terminal cursor control and user followed prompts to enter information

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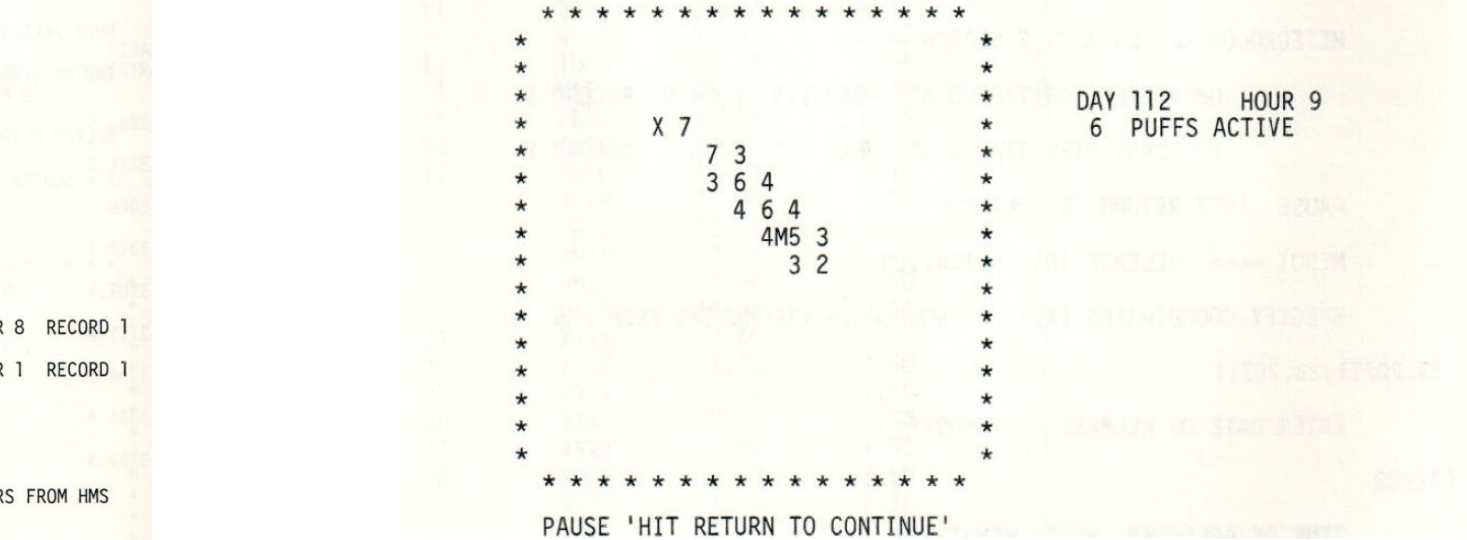
MESOI 1.1 Input and Output Examples

```
        MESOI --->  SET UP ARRIVAL CHECKPOINTS FROM FILE ARRCP.
                THERE ARE 30 CHECKPOINTS ACTIVE ON THE CURRENT GRID
        MESOI --->  PRIMARY INITIALIZATION
        ENTER RUN IDENTIFICATION TITLE OF UP TO 50 CHARACTERS
> TEST 1A
        ENTER A 2 CHARACTER PLOT ID
>AA
        ENTER DATE FOR START OF SIMULATION ---   MMDDYY
>042282
        JULIAN DATE = 112  1982
        ENTER HOUR FOR START OF SIMULATION
>8
        METEOROLOGICAL DATA FILE SEARCH --
                OBSV FILE POSITIONED AT:  DAY 112  HOUR 8  RECORD 1
                FORECAST FIEL STARTS AT:  DAY 112  HOUR 1  RECORD 1
        PAUSE  'HIT RETURN TO CONTINUE'
        MESOI --->  RELEASE INITIALIZATION
        SPECIFY COORDINATES (X,Y) OF SOURCE IN KILOMETERS FROM HMS
>-23.20711,23.20711
        ENTER DATE OF RELEASE --  MMDDYY
>042282
```

```
        SELECT OUTPUT OPTIONS
        S = SCREEN  L = LISTING  P = PLOT  T = TERMINATE  BLANK = NO OUTPUT
>SLP
```




```
        PAUSE 'HIT RETURN TO CONTINUE'
```

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MESOI Version 2.0 (late 1983?)

Improved:

- Depletion of puffs by dry and wet processes
- Decay of nuclides and ingrowth of daughters
- Adjustment of wind fields for terrain
- Estimation of plume rise

Main criterion was model run time could not exceed 15 minutes

Target computers DEC VAX and Data General MV 8000

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Adding dose calculations - MESORAD

- Developed for the Intermediate Dose Assessment System (IDAS) at the NRC Operations Center; 1985-1986(?)
- Target hardware was super mini-computer such as VAX-11/780 and DG MV-6000
- Coding still all in Fortran
- Separated the calculation models from the inputs/outputs (no longer interactive like MESOI)

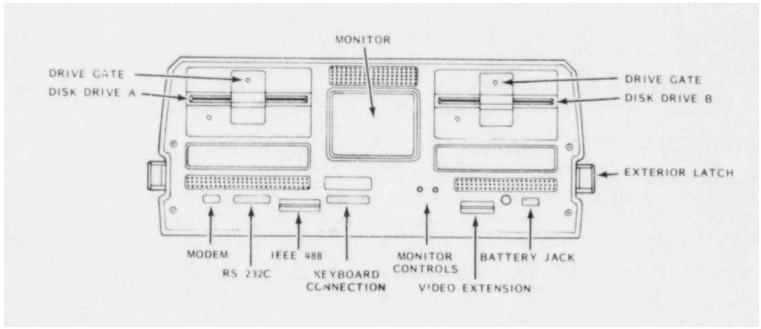
IDAS

- TACT 5 provided the source term
- MESORAD handled the transport and dose
- Separate programs handled the inputs, outputs, and communication between the models
- System had state-of-the-art graphical display terminals
- First real use of mapping and color

Adding dose calculations - IRDAM

Interactive Rapid Dose Assessment Model – 1982 (?)

- Micro-computer; written in BASIC
- Straight-line Gaussian plume, 20 nuclides (Kr, Xe, Cs, I)
- Goal was fast, portable, with guided inputs and defaults
- Somewhat a proof of concept using Osborne 1 computer



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Start of RASCAL

- Development started in 1987
- Purpose
  - "The Radiological Assessment System for Consequence Analysis (RASCAL) has been written to replace the U.S. Nuclear Regulatory's (NRC's) screening model, the Interactive Rapid Dose Assessment Model, IRDAM (Poeten et. Al., 1983)
  - "The model and its graphics are designed to run on microcomputers presently in use by NRC personnel who report to the site."

From NUREG/CR-5247; ORNL/TM-10955; RASCAL Version 1.3 User's Guide; 1989

Changes to Methods

- NUREG 1228
  - Published source term estimation concepts and methodologies assuming not all releases would be monitored
- NUREG 1465
  - Published revised LWR source terms based
- Response Technical Manual – 96
  - Published simple methods for estimating possible consequences of radiological accidents
  - Conservatism included
  - Consistent with Protective Action Guidelines (PAGs)

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Continued Improvements

- RASCAL
  - 1989 – v1
  - 1992 – v2
  - 2001 – v3
  - 2010 – v4
  - 2022 – v4.3.4
- Response Technical Tools
  - Computerized RTM
- Continued source term estimation work with MELCOR (i.e., SOARCA)

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NATIONAL RESPONSE FRAMEWORK

RESPONSE COORDINATION

Policy

Reorganization Plan of 1980

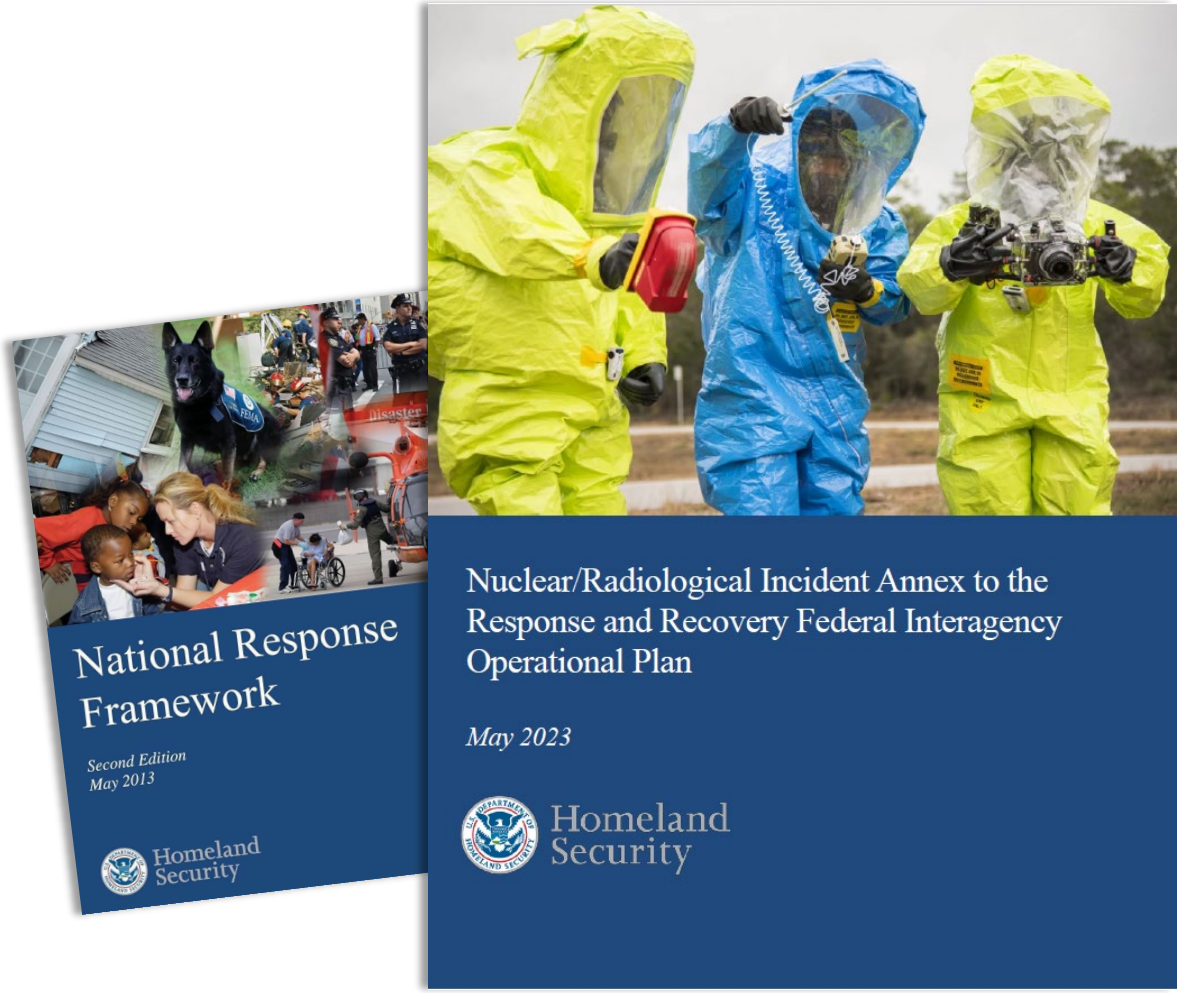
– NRC Chairman Emergency Authorities

Doctrine/Guidance that directs response efforts:

- Presidential Policy Directive 8 *(PPD-8 National Preparedness)*
  - National Preparedness Goal
    - 5 Frameworks *(Prevention, Protection, Mitigation, Response, Recovery)*
      - Federal Interagency Operational Plans *(FIOPs)*
        - Nuclear Radiological Incident Annex *(NRIA)*

Nuclear/Radiological Incident Annex (NRIA)

- Annex to the NRF
- Defines roles and responsibilities of Federal agencies in response to nuclear/radiological incidents



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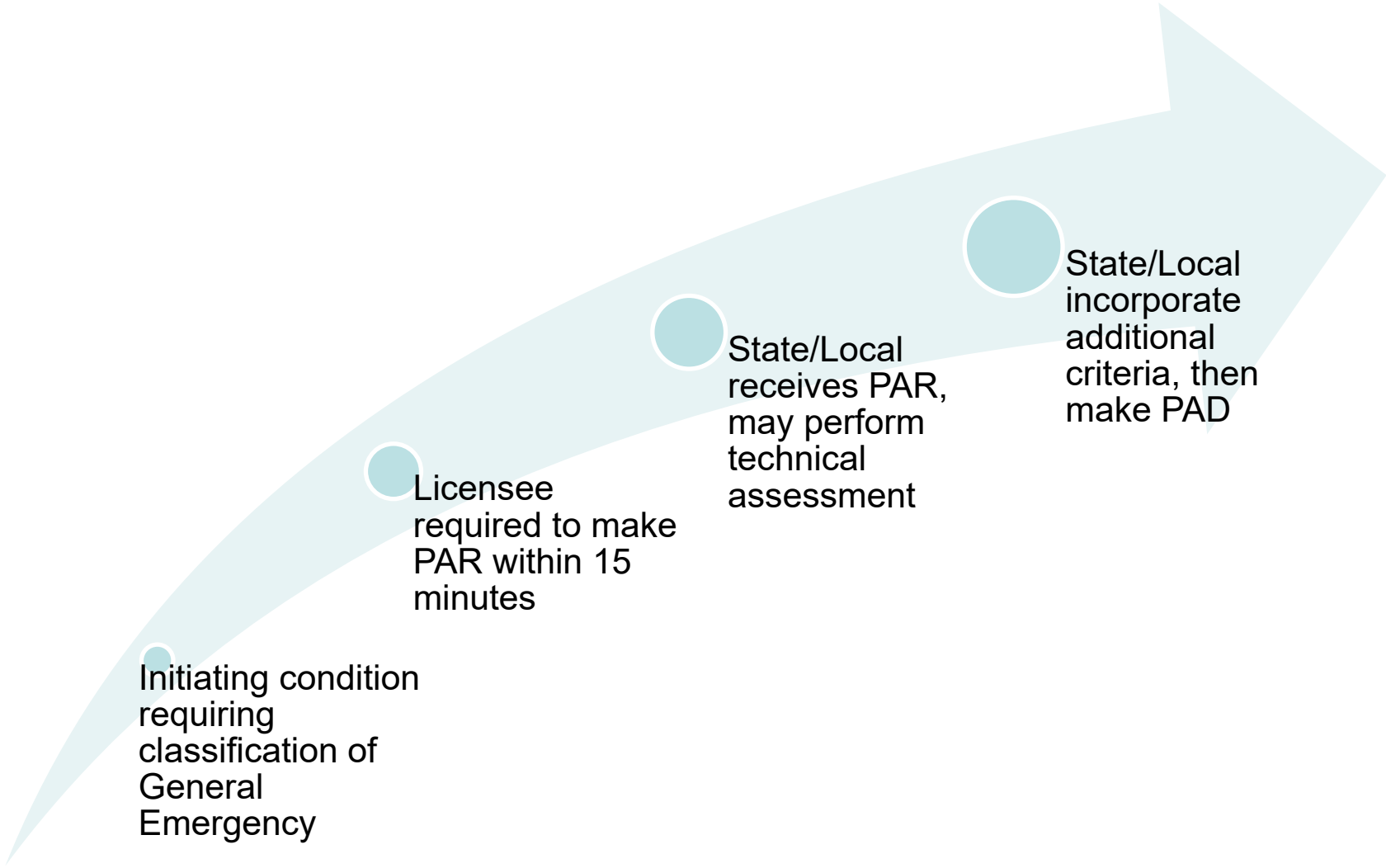
Response Roles

- Licensee/Operator
  - Maintain safe operations of the facility in accordance with emergency plans
  - Includes event classifications, notifications, dose assessment, and recommendations
- State/Local government
  - Make Protective Action Decisions (PADs)
  - Protect public through public information, warning, evacuations/sheltering, etc.

Protective Actions in the US

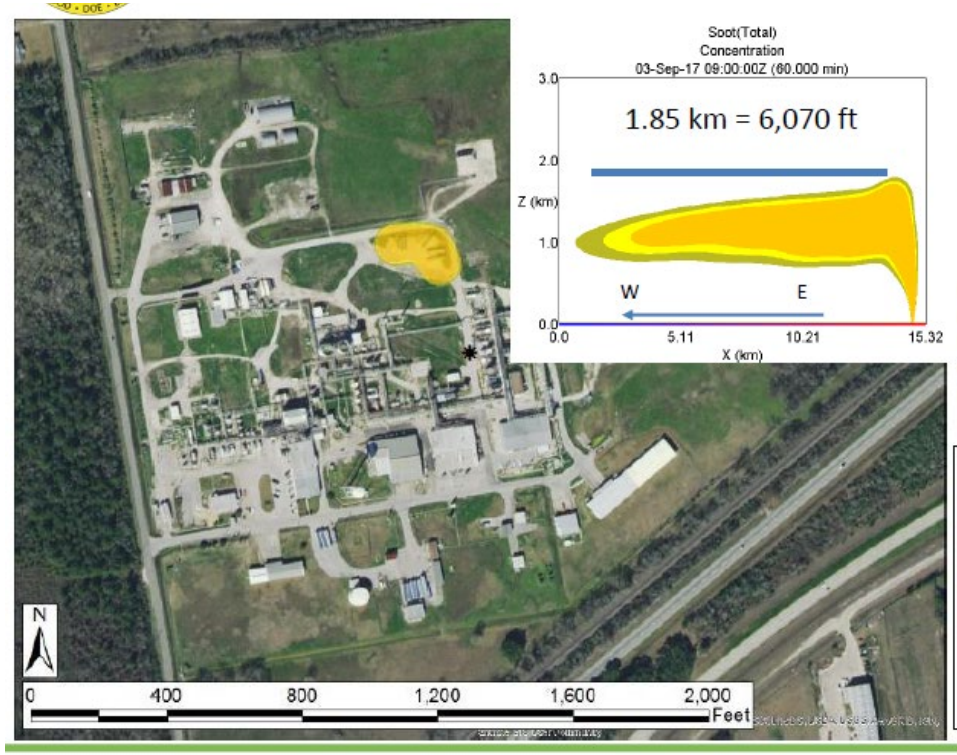


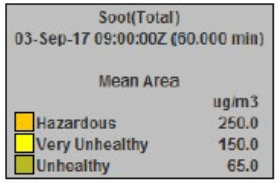
NRC Roles

- NRC primarily focused on-site
  - Oversight of utility actions/recommendations
  - Support State/Local with technical information
  - Support larger Federal response efforts
  - Provide information to public/media
- NRC Recovery Functions
  - Oversight of the restoration of the licensee facility
  - Determining whether an Extraordinary Nuclear Occurrence has taken place
  - Fulfilling post-incident responsibilities under the Price-Anderson Act

IMAAC

- Interagency Modeling & Atmospheric Assessment Center
- Coordinates and disseminates Federal atmospheric dispersion modeling and hazard prediction products to aid in decisionmaking
- Establishes Federal position during actual or potential incidents involving hazardous material releases
- Frequently activated for chemical releases; infrequent for nuclear

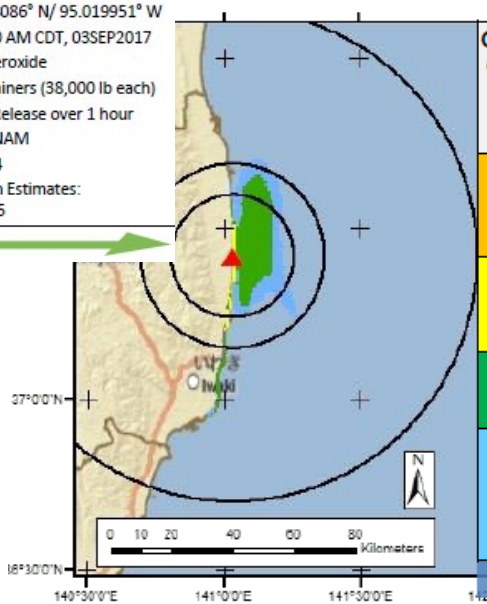




Note: Hazard is from estimated incidental material burning (e.g. tires, trailer, insulation). The combustion products from organic peroxide constitute minimal atmospheric hazards.

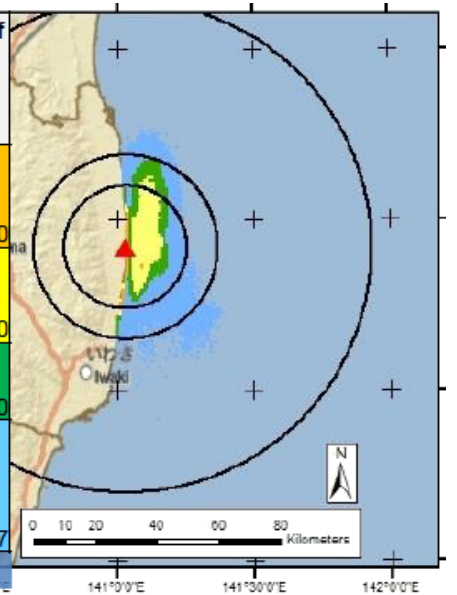
FACTS

Crosby, Texas
Location: 29.948086° N/ 95.019951° W
Event Time: 3:00 AM CDT, 03SEP2017
Type: Organic Peroxide
Amount: 6 containers (38,000 lb each)
Dissemination: Release over 1 hour
Weather: 3 km NAM
Model: HPAC 6.4
Static Population Estimates:
LandScan 2015

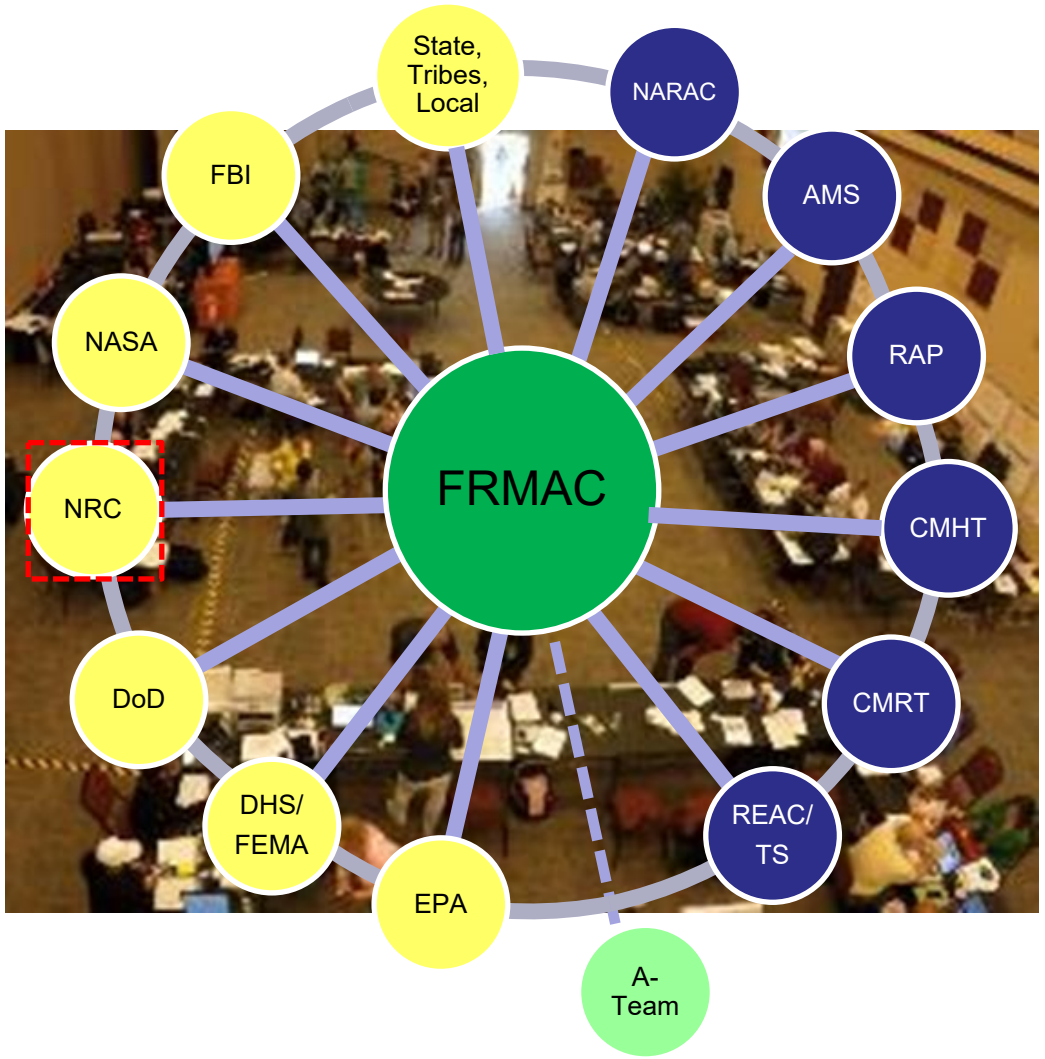


Conc of Cs-137 (Bq/L) ←	Significance	Reference	Conc of I-131 (Bq/L) →
>2000*	Min. acceptable ground water protection standards for water safety (**All Others**)	*IAEA General Safety Guide – (17 MR 2011)*	>300
200-2000*	Min. acceptable ground water protection standards for water safety (**All Others**)	*Japan NSC Guidance (General Population)*	100-300
37-200	Ingestion of effluent water discharged to the environment (**Reference Man**)	*10CFR20 Appendix B, Table II*	37-100
7.4-37	Max. contaminant level limits in drinking water. Derived Concentrations of Beta and Photon Emitters in Drinking Water	*Radionuclides in Drinking Water, A Small Entity Compliance Guide: EPA std, NBS Handbook 69*	0.11-37

This model does not estimate effects on marine life



Federal Radiological Monitoring & Assessment Center (FRMAC)



- Federal asset available on request by the Department of Homeland Security (DHS) and state and local agencies to respond to a nuclear or radiological incident
- Coordinate and manage all federal radiological environmental monitoring and assessment activities
- Primarily DOE/NNSA assets with coordination from interagency

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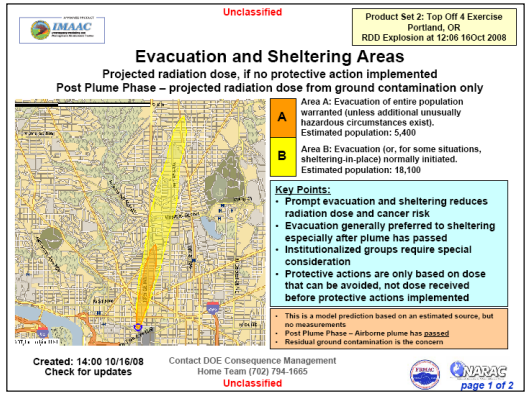
Federal Radiological Monitoring & Assessment Center (FRMAC)

NNSA Response Resources


Unclassified

Product Set 2: Top Off 4 Exercise
Portland, OR
RDD Explosion at 12:06 16Oct 2008

Evacuation and Sheltering Areas

Projected radiation dose, if no protective action implemented
Post Plume Phase – projected radiation dose from ground contamination only

A — Area A: Evacuation of entire population warranted (unless additional unusually hazardous circumstances exist). Estimated population: 5,400

B — Area B: Evacuation (or, for some situations, sheltering-in-place) normally initiated. Estimated population: 18,100

Key Points:
- Prompt evacuation and sheltering reduces radiation dose and cancer risk
- Evacuation generally preferred to sheltering especially after plume has passed
- Institutionalized groups require special consideration
- Protective actions are only based on dose that can be avoided, not dose received before protective actions implemented

- This is a model prediction based on an estimated source, but no measurements
- Post Plume Phase – Airborne plume has passed
- Residual ground contamination is the concern

Created: 14:00 10/16/08
Check for updates

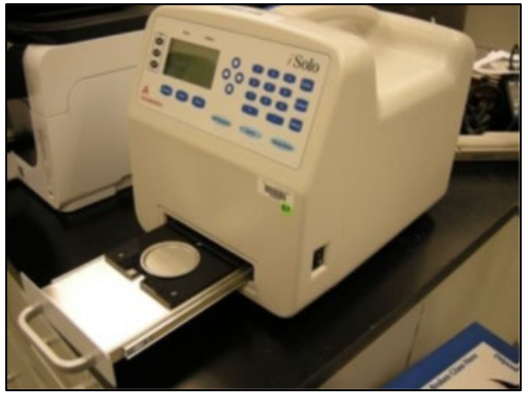
Contact DOE Consequence Management
Home Team (702) 794-1665

Unclassified

NARAC

page 1 of 2

Asset	Capabilities
National Atmospheric Release Advisory Center (NARAC)	Technical reach back center for planning, technical assessment & interpretation
Consequence Management Response Team (CMRT)	Technical reach back center for planning, technical assessment & interpretation AND Deployable assets for delivery of planning, technical assessment, interpretation, hazard/risk communication and operational coordination
Consequence Management Advance Command (CMAC)	Deployable assets for delivery of planning, technical assessment, interpretation, hazard/risk communication and operational coordination
Aerial Measuring System (AMS)	
Radiation Emergency Assistance Center/Training Site (REAC/TS)	Technical reach back center/deployable asset for planning and medical services



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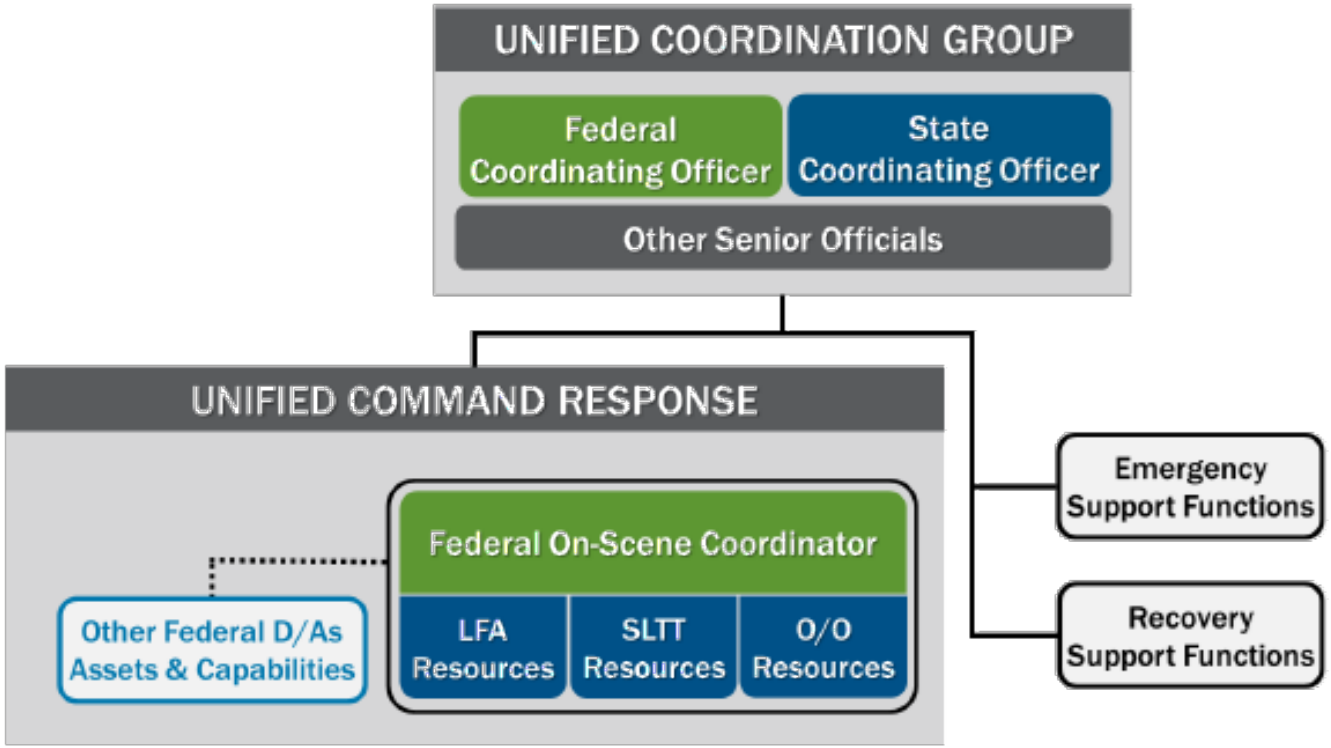
A-Team

- Advisory Team for Environment, Food and Health
- Radiological emergency response group that provides protective action recommendations to State and local governments
- Primary members are EPA, FDA, CDC, and USDA

FEMA Coordination

- Federal Emergency Management Agency
- Coordinates large responses that require Federal resources in support of State/Local



International Coordination

- Canada & Mexico
  - Through Bilateral Agreements
- IRSN (France)
  - Through Memorandum of Cooperation
- International Atomic Energy Agency (IAEA)

Questions?

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