Federal Radiological Monitoring and Assessment Center Technical Training

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Introduction

• Under the Nuclear/Radiological Incident Annex of the National Response Plan (NRP), the Federal Radiological Monitoring and Assessment Center (FRMAC) is established “at or near the scene of an incident to coordinate radiological assessment and monitoring.”

• The U.S Department of Energy (DOE) is assigned the initial leadership role within the FRMAC. At a “mutually agreeable time,” responsibility for coordination of the FRMAC transitions from the DOE to the U.S. Environmental Protection Agency (EPA).
Department of Energy’s Radiological Response Assets

**NARAC**
National Atmospheric Release Advisory Capability
Computer Modeling of Transport Diffusion and Disposition of Radioactive and Hazardous Material

**RAP**
Radiological Assistance Program
Radiological measurements and advice to public sector

**FRMAC**
Federal Radiological Monitoring Assessment Center
Operational and logistical management cell focused on radiological consequence management

**AMS**
Aerial Measurement System
Airborne radiological sensing and surveying capabilities

**ARG**
Accident Response Group
Safely recover nuclear weapons

**REAC/TS**
Radiation Emergency Assistance Center/Training Site
Expert medical assistance for radiation exposure accidents
Purpose of FRMAC

• Assist the states in their mission to protect the health and well being of their citizens by:
  • Providing initial prediction based on source term estimate
  • Verifying prediction based on limited ground monitoring data
  • Validation of the prediction using AMS fixed-wing aircraft
  • Comprehensive characterization of environmental and personnel impacts based on ground monitoring, sampling, and analysis and rotary-wing survey data
Critical Capabilities

• Provide equipment and trained personnel for:
  – radiological monitoring and sampling
  – responder health and safety
  – data product development and archiving
  – assessment of radiological consequences
Coordinated Radiological Emergency Response

- Gather facts
- Use Protective Action Guidelines (PAGs) and facts to make projections

Make Protective Action Recommendations (PARs)

- Coordinating Agency and Advisory Team
- State and Local Governments
- Shelter-in-Place
- Evacuate
- Return
- Recovery

RAP, CMHT, CMRT I, CMRT II, CMRT III, FRMAC
FRMAC Divisions

- Assessment
- Support & Logistics
- Monitoring
- Laboratory Analysis
- Health & Safety

FRMAC Director
Phased-Response Concept

- Local / First Responder
- DOE Regional Response
- Early CM Phase I and Phase II response by DOE personnel

Then...

- Federal, state, and local agency activities are integrated and coordinated to form the FRMAC multiagency response
# Response Activation Table

<table>
<thead>
<tr>
<th>Role</th>
<th>Approximate Activation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Dispersion Predictive Plots</td>
<td>15 mins – 1 hr</td>
</tr>
<tr>
<td>RAP Team</td>
<td>2 hrs</td>
</tr>
<tr>
<td>CM Home Team</td>
<td>2 hrs</td>
</tr>
<tr>
<td>CMRT Phase I</td>
<td>4 hrs</td>
</tr>
<tr>
<td>AMS</td>
<td>12 hrs</td>
</tr>
<tr>
<td>CMRT Phase II</td>
<td>24 hrs</td>
</tr>
<tr>
<td>FRMAC</td>
<td></td>
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</tbody>
</table>
Predictive Plume Modeling

Worldwide Coverage
- Terrain and land surface
- Vector and raster maps
- Real-time weather data

Real-time Hazard Advisories
- Available within minutes
- Distributed electronically

Nuclear, Chemical, Biological, Natural Releases
- Generic and specific sources
- Advanced modeling system
- Health effects and action levels

National Center at LLNL
NARAC staff operates the center, trains users, and deploys for special events
Consequence Management Home Team (CMHT)

- Support first responders in collecting and interpreting data while CMRT I is en route to the event scene

- Provide early data assessment resources before the FRMAC is set up (i.e., a virtual FRMAC)
  - function as a conduit for NARAC predictive maps, interpreting early radiological measurements, etc.
  - provide updates and answers to early responder concerns
CMHT Contact Information

• CMHT Room - 702-794-1665
  - 866-816-7459 (bridge line)
  - 702-794-1039 (fax)

• Main number to RSL* - 702-295-8001

• E-mail
  – CMHT cmht@nnsa.doe.gov

* RSL = Remote Sensing Laboratory
**RAP** is a flexible, 24-hour, first-response capability to federal, state, tribal and local governments for incidents involving radiological emergencies.

**Capabilities**

- **Search for Radiological Material**
- **Support Local First Responders**
- **Advise on Radiological Issues**
- **Respond within 2-6 Hours**
- **Characterize Radiation Environment**
  - Initial Assessment
  - Area Monitoring
  - Contamination Control
  - Decontamination
- **Assist with Rad Material Recovery**
- **RAP may call upon other DOE assets**
Consequence Management Response Team
Phase I

- Trained responders - 31
- Equipment – 2,000 pounds
- Operations – 24 hours

- Initial capabilities
  - Assessment
  - Geographical Information Systems
  - Health and Safety
  - Monitoring and Sampling
    - five field teams
  - Logistics
Consequence Management Response Team
Phase II

- Additional responders - 32
  - 24-hour/day operation for several weeks
  - augmented monitoring, sampling and assessment

- Additional equipment – 23,000 lbs.
  - twenty field teams

- Laboratory Analysis
  - sample receipt
  - prepare samples for transport to labs

- Training for additional responders
Augmentation

• Augments CMRT I & II and is staffed through the National Laboratories and the RAP regions

• Their main focus is sampling activities in the effected areas, dose assessment, and cleanup

• Field monitoring and sample control personnel make up the bulk of the response

• Scientific and leadership support is provided by the Interagency and National Laboratories
Responder
Health and Safety
(H&S)
Health and Safety Objectives

Identify:
• Natural environmental hazards that may be encountered by personnel
• Potential hazards related to any radioactive release
• Special hazards

Describe:
• Resources available to control hazards and decon facilities to minimize exposures and cross contamination

Complete a Site Health & Safety Plan
Interactions

• Monitoring
  - assist in developing monitoring and sampling plan
  • where to go to minimize RISK (not just dose)
  • determine requirements for personal protective equipment (PPE), respirators, etc.
  • determine turn-back or call-in levels
    - assist in field team briefing
    - determine “compound” area survey schedule

• Assessment
  - determine turn-back levels
  - develop dose estimates
Assessment
What Assessment Does

• Provides interpretations of radiological conditions in terms of recognized federal or state Protective Action Guides (PAGs)

• Characterizes radiological environment to address reentry, return, and recovery issues
What Assessment Does Not Do

• Does not offer or develop Protective Action Recommendations (PARs)

• Implementation of Protective Action Recommendations is solely the responsibility of the state
Aerial Measurements System
AMS Response Phases

• Pre-Crisis / Pre-Consequence Phase
  – baseline measurements of at-risk facilities
  – environmental work to prepare for mission

• Crisis Response Phase
  – initial response or pre-deployment to provide rapid overview information

• Consequence Management Phase
  – follow-on assets for detailed characterization and monitoring
Aerial Measurement System

- Radiological
  - exposure rate mapping
  - deposition mapping
  - spectral mapping

- Aerial Photography
Monitoring and Sampling
Monitoring Objectives

• Protect the public

• Define plume footprint (ground deposition)

• Monitor key infrastructures

• Validate data to support decision-making

• Archive historical reference data from emergency responses
Monitoring and Sampling Plan

- Defines the monitoring, sampling and AMS activities for the response

- Is developed following the advance party meeting with input from locals

- Becomes “Road Map” for response activities
Implementation Plan

• Defines the daily activities for response
  – assigns the resources available to the priorities identified
  – provides the field teams with routes and instructions for activities
  – is updated daily or by shift
  – is incorporated into the Incident Action Plan
Integration with Other Agencies

• Integration provides local knowledge base for teams

• Problems associated with integration include:
  – unknown levels of knowledge, experience and skills of responders
  – different terminology and paperwork (forms)
  – varying equipment / instruments
Monitoring Interactions

• Health and Safety Division
  – provides turn-back limits
  – defines hotline location and support requirements
  – supports contamination surveys and provides other support

• Assessment Division
  – develops survey detection limits
  – determines sample analysis requirements
Laboratory Analysis
Sampling Evolution

• Emergency Phase
  – focuses on quick results for Protective Actions Guide decisions

• Intermediate / Ingestion Phase
  – focuses on Derived Response Levels / Derived Intervention Levels

• Characterization Phase
  – focuses on environmental / clean-up levels
Sample Preparation

• Packaging and transport to laboratories
  – DOE / non-DOE laboratories
  – DOT considerations

• Documentation
  – database entry
  – chain-of-custody
  – laboratory database
  – QA / QC process
Laboratory Information Management System

- Tracks sample chain-of-custody
- Manages laboratory loads
- Serves as receptacle for analytical data and transfer to Emergency Response Data System
- Imports electronic data deliverables from laboratories (disk, e-mail, ftp)
Data Products
The first 15 min – 1 hour

• Initial NARAC predictive model
  – Estimates based on information available
    • Source term
    • Wind direction and speed

• Used to make decisions on public safety
  – Based on EPA Protective Action Guidelines

• Available through the NARAC Web Site
Planning Set 3: 4-Day TEDE

Consequence Management/FRMAC

Effects or contamination from 13 Nov 2003 14:30 UTC to 22 Nov 2003 1

<table>
<thead>
<tr>
<th>(Rem) Area Extent</th>
<th>Population</th>
<th>Description</th>
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<tbody>
<tr>
<td>&gt;100 0.008 km²</td>
<td>1</td>
<td>n/a</td>
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<tr>
<td></td>
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<td>Serious health effects. Evac. req. Respiratory protection/sheltering req.</td>
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<tr>
<td>&gt;25 0.1 km²</td>
<td>3</td>
<td>n/a</td>
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<tr>
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<td></td>
<td>EPA emerg. worker limit for lifesaving activities. Increased cancer risk.</td>
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<tr>
<td>&gt;5.0 1.1 km²</td>
<td>121</td>
<td>n/a</td>
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<tr>
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<td></td>
<td>EPA early phase upper limit PAG for evacuation.</td>
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<tr>
<td>&gt;1.0 6.1 km²</td>
<td>578</td>
<td>n/a</td>
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<tr>
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<td></td>
<td>EPA early phase PAG for considering evacuation.</td>
</tr>
<tr>
<td>&gt;0.1 57.2 km²</td>
<td>1,870</td>
<td>n/a</td>
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<tr>
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<td>10% of EPA early phase PAG for considering evacuation.</td>
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</tbody>
</table>

Note: Areas and counts in the table are cumulative.

Source Location: 45.333333 N, 93.383333 W
Material: Nuclide mix
Comments: Time-varying release rates.
Time-varying coned metadata
including rain

Map Size: 20.55 km W 20.55 km E
Map: Production,rc7712.rc7712
MaRac Operations: narac@nrl.gov, (825) 424-6455
Requester: (, unknown)
Not approved for further distribution.
What to expect within 2 – 4 hours

• Additional NARAC models
  – Information refined to include
    • Different isotopic mixes
    • Affected population
    • Expected dose level

• Applications:
  – Refine protective action
  – Basis for survey teams
    • Aerial
    • Ground

• Available through the NARAC / FRMAC Web Site
EXERCISE

MONTICELLO CM RESPONSE

NARAC
Planning Set 3: Ground Exposure Dose Rate #1
November 18, 2003
Map #: narac CrossRef

Planning Set 3: Ground Exp. Dose Rate #1
NARAC Product for Nuclide mix
Possibly contaminated areas. Use to confirm with monitoring surveys.

- > 2,500 μRem/hr
  Population: 1,217
- > 600 μRem/hr
  Population: 2,477
- > 50 μRem/hr
  Population: 8,729
- > 7.0 μRem/hr
  Population: 11,480
Once CM / FRMAC is onsite

- NARAC models with survey data
  - Overlaid with “Ground Truth”
    - AMS flyover data
    - Data from survey teams

- Models transition into actual survey data

- Available through the FRMAC Web Site
Consequence Management/FRMAC
NARAC Prediction for I-131 Derived Response Levels
November 21, 2003

Planning Set 3: I-131
Derived Response Levels
November 21, 2003

Map #: 2_narac_set3_i-131_DRLs_031108

Planning Set 3: I-131 DRLs
NARAC Product for I-131

- > 15,000 pCi/m²
  Default Derived Response Level based on FDA DIL for milk (grass-cow-infant).
  Population: 13,657

- > 9,200 pCi/m²
  Default Derived Response Level based on FDA DIL for fresh produce.
  Population: 14,383

Legend:
- Sub-Area
- Evacuated Sub-Area
- MN Grown Producer
- Dairy Product Plant
- Dairy Farm
Questions

???????
Equipment and Techniques
Types of Surveys

• Ground Deposition
  – exposure rate
  – contamination

• Public Monitoring
  – infrastructure
  – evacuation / reentry
Instrumentation

- Integration means using your instruments or ours
- Record data in units displayed (raw data)
- Use standard units
ADM-300A Survey Kit
ADM-300A Multifunction Survey Meter

- Measures gamma radiation
- Detects beta radiation
- Auto-ranging
- Gamma (γ) dose and dose rates
  - range: 10 uR to 10,000 R
- Two G-M detectors in the meter
  - low range: 10 uR/h to 5 R/h
  - high range: 3 R/h to 10,000 R/h
  - also external probe
ADM-300A Survey Meter

Digital display shows:

- Dose rate and accumulated dose values
- Alarm set levels
- Battery conditions
- Test and fault indicators
Beta Probe (BP-100)

- Pancake probe
  - G-M probe
- Unit of measurement:
  - CPM $\beta$
  - CPM $\beta + \gamma$
  - uR/h (gamma from internal detector)
Alpha Probe (AP-100)

- Alpha probe
  - ZnS scintillator
  - Mylar window
  - 100 cm² surface

- Units of measurement
  - CPM
  - $\mu$Ci/M x M (micro Curie per square meter)
  - DPM/CM x CM (per 100 square centimeters)
ADM-300A Survey Kit

- Phase I - 6 Kits
- Phase II - 18 Kits
Violinist III System

• Phase I - 6
• Phase II - 14
Violinist III System

- Used to determine ground deposition of plutonium
- FIDLER detector (Field Instrument for Detecting Low Energy Radiation)
- 256 channel multichannel analyzer
- Preset regions of interest for 17 keV & 60 keV
- Portable operates from AC and DC current
High-Purity Germanium (In situ) Detector

• Phase I – 1
• Phase II – 3
High Purity Germanium (\textit{In situ}) Detector

- Calibrated to determine isotopic mix of ground deposition
- Liquid nitrogen cooled detector
  - requires 4-6 hours to cool down
- Attached to a multichannel analyzer
  - computer software to interpret data
Dosimeters

SAIC PD-10i Self-Reading Electronic Dosimeter

- Additional Dosimetry
  - Phase I - 25 Thermoluminescence Dosimeters
  - Phase II - 400 Thermoluminescence Dosimeters

- Phase I - 20
- Phase II - 50
Consequence Management/FRMAC

Operational Features

- Measures gamma and X-ray radiation
- Audible (chirping) dose and dose rate alarms
- DOSE RANGE: 0 $\mu$R to 999 R
- DOSE: 10 $\mu$R to 999 R
- DOSE RATE: 40 $\mu$R/h to 999 R/h
- DOSE RESOLUTION: < 2 $\mu$R
- ENERGY RESPONSE: Tissue equivalent to within ±25% from 55 keV to 6 MeV
Staplex High Volume Air Sample Pump

• Phase 1
  – 2 with 4-inch paper

• Phase 2
  – 8 – 4-inch filter paper
  – 9 - low volume A/S pumps
  – 4 - grab A/S pumps with either 2-inch filter paper alone or silver zeolite / charcoal cartridge
Team Instrument and Equipment Information Log

Field team members

Equipment serial numbers

- Equipment type
  - Survey meter(s)
  - Air samplers
  - GPS unit
  - Special detectors

Communications and vehicle information

This form must be completed and turned in to the Field Team Supervisor prior to deployment.
## Daily Instrument QC Check

### Event
- **Saving the world**

### Team #
- **Alpha**

### Field Team Supervisor
- Your name here

### Event Details
- **2009**
- **AP-100**
- **Th-232**
- **90002**
- **30 nCi**
- **4.2 kcpm**
- **optional**
- **optional**

### Event Details
- **2009**
- **BGP-100**
- **Cs-137**
- **55002**
- **8 uCi**
- **1.6 mR/hr**
- **optional**
- **optional**

### Additional Details
- **06DEC2006**
- **0800**

### Radiation Levels
- **3.88 – 5.26 kCPM**
- **1.38 – 1.81 mR/hr**
## Field Monitoring Log

<table>
<thead>
<tr>
<th>Time (Military)</th>
<th>Location Description</th>
<th>Latitude (4)</th>
<th>Longitude (5)</th>
<th>Inst ID (6)</th>
<th>Measurement (7)</th>
<th>Units (8)</th>
<th>Radiation Type / Energy (9)</th>
<th>Measurement Surface (10)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) 0900</td>
<td>Lake &amp; Wabash</td>
<td>-36.112345</td>
<td>-116.12345</td>
<td>AP-100</td>
<td>500 DPM</td>
<td>alpha</td>
<td>dirt</td>
<td>SCF-96961 – soil sample</td>
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<td>(B)</td>
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</tbody>
</table>
Personnel Contamination Survey Sheet

Name: Individual being surveyed  Date / Time: 12/6/06 1600  Team: Foxtrot

Instrument Type: AP-100  Number: AP-90002  Bioassay Collected: Yes  No

Mark contamination locations on the diagrams below

FRONT

Measurements: 250 dpm

1 2 3 4 5 6 7 8 9

BACK

Measurements:

1 2 3 4 5 6 7 8 9

Comments: Individual reported that PPE tore at right knee while sampling

Monitored By:  Instrument: Type:  Number:  

May-2003
**Sample Control Form and Chain of Custody**

**Consequence Management/FRMAC**

**Record this number on the Field Monitoring Log and on sample**

**Team identification information**

**Same information as recorded on Field Monitoring Log**

**Descriptive information about sample type, volume, etc. Use only one form per sample media.**

**Signed during transfer**

---

**SAMPLE CONTROL FORM & CHAIN OF CUSTODY**

<table>
<thead>
<tr>
<th>Field Monitoring Log</th>
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<tbody>
<tr>
<td>96491</td>
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</table>

**Signed during transfer**

**Team identification information**

**Same information as recorded on Field Monitoring Log**

**Descriptive information about sample type, volume, etc. Use only one form per sample media.**

**Signed during transfer**

---

**SCF -**

<table>
<thead>
<tr>
<th>Sampling Information (to be filled out by the Field Team)</th>
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</thead>
<tbody>
<tr>
<td>Collection Team ID</td>
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</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<table>
<thead>
<tr>
<th>Collection Date</th>
<th>Collection Time (Military)</th>
<th># of Containers</th>
<th>Contact Dose Rate</th>
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<tbody>
<tr>
<td>12/6/06</td>
<td>1600</td>
<td>1</td>
<td>0.05 mR/hr</td>
</tr>
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</table>

**Remarks:**

 disadvantages

---

**Processing Priority:**

- | | | |

**Screening Value:**

- | | | |

**Sample Remarks:**

 disadvantages

**Analysis Requested:**

 disadvantages

**Laboratory Assignment:**

 disadvantages

**Special Instructions:**

 disadvantages

**Custody Transfer (Signatures)**

<table>
<thead>
<tr>
<th>Relinquished By</th>
<th>Date</th>
<th>Time</th>
<th>Received By</th>
<th>Date</th>
<th>Time</th>
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</table>

**Original with Sample | Copy to Data Center | Copy to Courier | September 2002**
Questions
Monitoring and Sampling Technical Training
Sampling

- Integration with state and local responders is invaluable here

- Duplicate sampling is preferred rather than splitting samples

- Chain of custody is maintained for all samples
Sampling Considerations

• Survey Sample Location (if possible)
  – 2.5 cm (1 in.) contamination level
  – 1 m (waist height) exposure rate

• Use Clean Sampling Tools
  – rinse and survey prior to use (if necessary)
  – use plastic bag as clean work area

• Use Gloves When Sampling
  – change out gloves after each sample
Transport to Sample Receipt

• Documentation
  – chain of custody (sample tracking)
    • type / location / volume of sample
  – tamper seals

• Contamination control
  – seal sample inner bag
  – survey for contamination (if possible)
  – keep paperwork with sample

• Collect all potentially contaminated waste for disposal at the hot line
Sample Collection Gear
Air Sampling

• Post-plume Phase

• Primarily Re-suspension
  – public / general population
  – emergency workers – hot line, laboratory, etc.
Play Air Sampling Video Now
Collecting Air Sampling Media

- Use forceps to remove filter paper
- Bag filter and cartridges separately
- If folding sample media, fold up and over bag
Water Sampling

• Emergency Phase
  – Surface
  – Rain (standing water)
  – Public Drinking

• Ingestion / Characterization
  – Wells
  – Public Drinking
  – Sediments
Play Water Sampling Video Now
Water Sampling

- 1 gallon / 3.5 liter cubetainer
- Rinse cubetainer with clean water
- Avoid areas of debris
Soil Sampling

• Looking for ground deposition before the contamination has migrated

• Sample taken are 2 cm deep x 100 cm$^2$.
  – May take multiple samples at one location

• One gallon Ziploc bag is the default standard container
  – The sample can be transferred to other containers as needed
Play Soil Sampling Video Now
Vegetation Sampling

- Emergency Phase
  - samples chosen to match pathway to man
    - animal feed and/or grass
    - leafy vegetables
    - fruits
- Ingestion / Characterization
  - standing crops
  - root vegetables
  - long term sampling
Milk and Feed Sampling

- Dairy locations
  - farms
  - transfer stations
  - processing plants

- Feed sample
  - stored feed
  - open range
Sample Receipt / Hot Line

- Step Off Pad – Field Team Exit
- Portal Monitor
- Decon Shower
- DRASH Tent
- Sample and Equipment Storage
- Equipment Dropoff, Survey & Decon
- Sample Dropoff & Survey
- Entrance – Wait for Instructions
- Vehicle Parking
- Contamination Area
- Vehicle Hold for Survey and Decon before exit from contamination area
- Sample Receipt / Hot Line

- Sample and Equipment Storage
- Decon
- Portal Monitor
- DRASH Tent
- Sample Dropoff & Survey
- Entrance – Wait for Instructions
- Vehicle Parking
- Contamination Area
- Vehicle Hold for Survey and Decon before exit from contamination area
- Sample Receipt / Hot Line
Play Hot Line Video Now
Play Sample Receipt Video Now
Sample Receiving Line

- Cover work tables with plastic sheeting
- Generally co-located with a hot line
- Boundaries are clearly identified
- Signs demark the area
Monitoring for Contamination
Completed Samples
Data Review – QA / QC

• Data review process
  – Assessment Division
  – sample preparation supervisor
  – laboratory QA / QC process (non-FRMAC)

• QA / QC samples
  – “spiked” samples
  – blank samples
  – “round-robin” analysis
Manuals

  – This manual describes the FRMAC response activities in a major radiological emergency

• FRMAC Assessment Manuals (3 volumes) – April 2003
  – These manuals provide the scientific basis and methods for assessment calculations

• FRMAC Monitoring Manuals (2 volumes) – Dec. 2005
  – These manuals provide the monitoring and sampling methods for a radiological response
Manuals (cont)

- FRMAC Laboratory Analysis Manual – Dec. 2005
  - This manual provides general guidance relating to sample tracking and analysis

  - The manual describes how radiological health and safety plans will be implemented for FRMAC

Link:

http://www.nv.doe.gov/nationsalsecurity/homelandsecurity/frmac/
I’ll Stop Talking Now Unless You Have

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CM / FRMAC Program Manager

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http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac.htm

http://www.eota.doeal.gov/eota/