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Incorporating the Adjacent Area (AA) to the IEZ within Nuclear Criticality Accident Emergency Planning Evaluations

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ANS Annual Meeting, San Diego CA

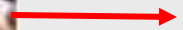
June 15, 2010



The Hazards of Immediate Mass Evacuation



This way
to Darwin
Award



Proper Planning Prevents Poor Performance

Brief Talk

- Winds of Change - An Opportunity
- ANS 8.23 Prompt Protection Areas – IEZ+AA in tandem
- Y-12 Emergency Response Organization (ERO) contribution
- ANS 8.23 (2007) Evaluation Elements and AA
- Application of the Approach - HEUMF (**ITS IMPLEMENTED**)
- Sample Emergency Planning Evaluation Structure
- Concluding Thoughts, Future Direction/Desires

Winds of Change – An Opportunity

- **The opportunity - provide simple, logical construct that is workable in the field for emergency AND normal conditions**
- Emergency planning evaluation - part of safe operations
- New facilities – new planning and response paradigm
- Legacy facilities - old ways (12 rad annunciation zone) linger
- DOE Safety Basis rules - “TSR” level controls for these areas
- EP evaluation for specific identified **Prompt Protection Areas (PPA)**

Prompt Protective Actions and Areas

Link ANS-8.23 Sec. 5 Evaluation

5.1 Determine IEZ Boundary from maximum **acceptable absorbed dose**

To ANS-8.23 Sec. 6 Evacuation

6.1 IEZ – “without hesitation”

6.2 **Adjacent Area – stay or go**

6.3 Assembly (Muster) areas

6.4 Further evacuation away

Thesis: EP Evaluation need not stop at IEZ - our customers want guidance!



**IEZ boundary ?
(CONOPS)**

What is an Adjacent Area to the IEZ?

- An Adjacent Area is
 - **Recognized within 8.23**
 - Specific named area (1997)
 - Occupied area
 - Outside IEZ
 - Radiation monitoring area
 - **Decision making area**
 - Evacuation or shelter area
 - Also a notification area
 - Lower risk area
 - Alternate muster area
 - ERO staging and control area
 - The Yellow Zone
 - **Predetermined by evaluation**
- ANS-8.23 (2007) Section 6
 - 6.2 Radiation levels shall be monitored in **occupied areas adjacent to the immediate evacuation zone after initiation** of the emergency response.
 - 6.4 **If** monitoring required by Sec. 6.2 ...indicates the dose rate is **greater than 1mSv/hr** in areas that **continue** to be occupied, **non emergency response people shall be evacuated**

ANS-8.23 (2007) Evaluation Elements and AA

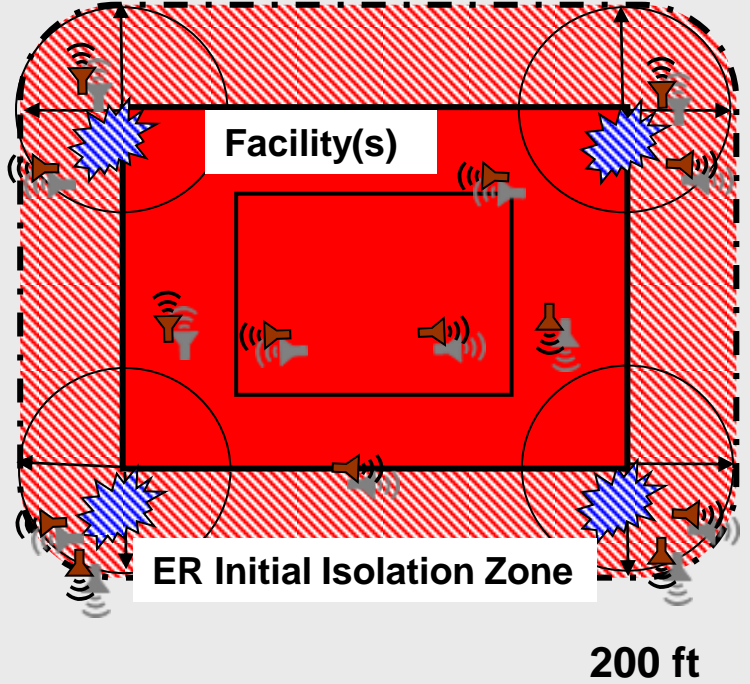
- Emergency Planning Evaluation Elements §5, 4.2.1
 - Determine *potential* accident locations
 - Analyze *predicted accident characteristics*
 - Include likelihood of “recriticality”
 - **Establishes maximum acceptable absorbed dose value**
 - Determine Immediate Evacuation Zone (IEZ)
 - Predict radiation dose (time and space) § 4.2.1
 - Shielding may be used
 - Judgment allowed or more detailed evaluation
- **IEZ determined first, work outwards from accident location**
- **AA will depend on time evolution of dose**

IEZ + AA in Tandem within Evaluation

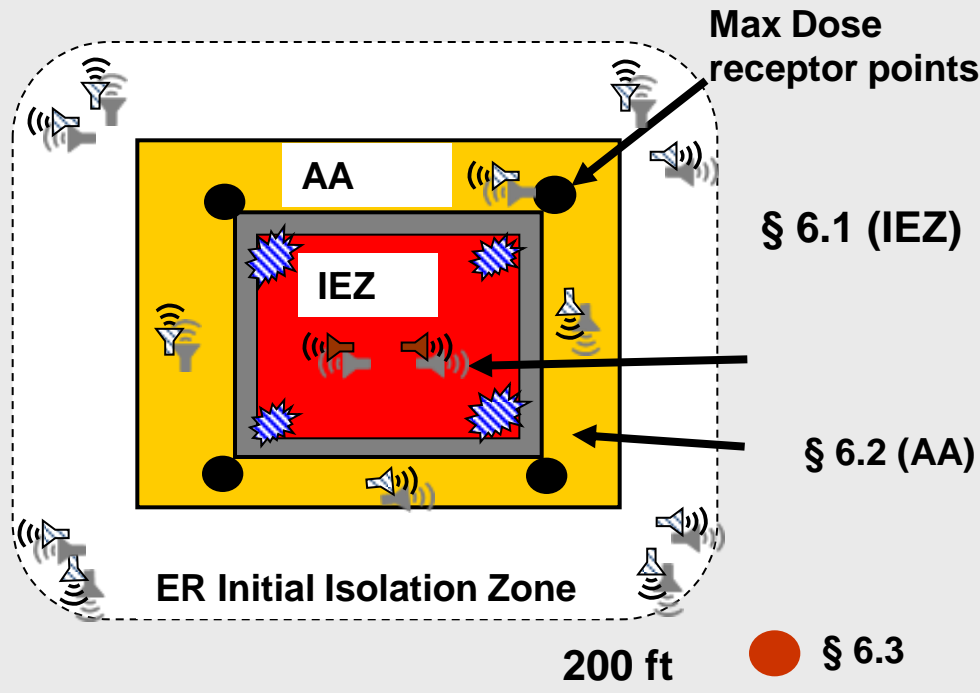
- Defined by **unambiguous, unmistakable physical boundaries**
- Are **readily identified** under normal and emergency conditions
- Improves a previously advanced method (ANS Boston 2007)
- Provides areas of **distinct action** and notification means
- Contained within the **Y-12 ERO “Initial Isolation Zone”** – 200 ft from facility or group of facilities
- IEZ+AA need not be identical to the ERO Initial Isolation Zone

Transition to ANS-8.23 (2007) EP Evaluation

**DOE 420.1A "12 rad zone"
(only one acceptable action)**



**Prompt protection action depends
on conditions**



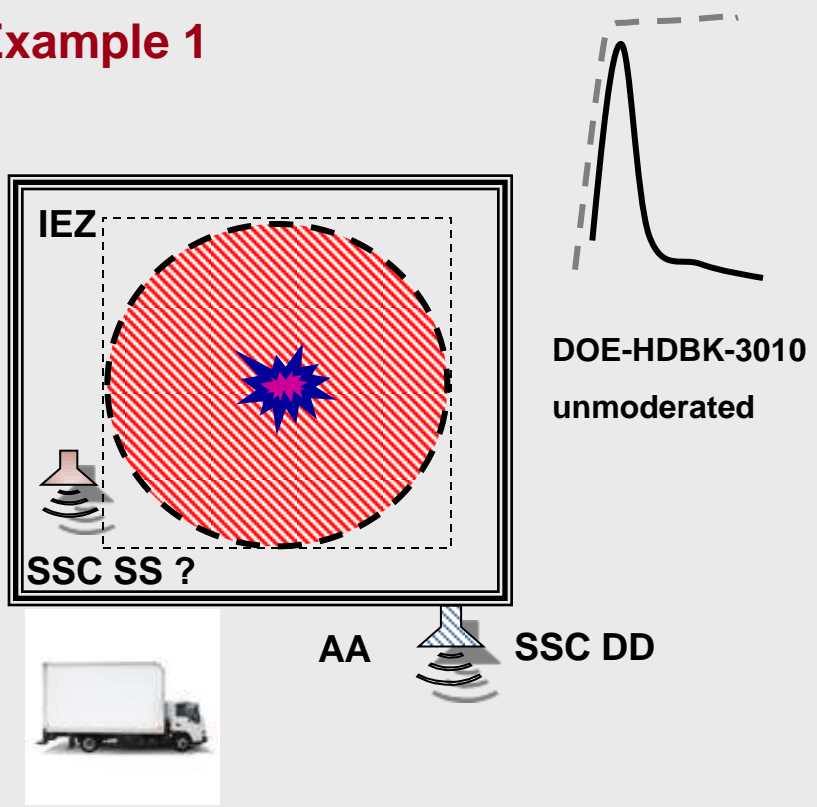
KEY POINT: REAL ESTATE FOR ALL PROMPT PROTECTIVE ACTION - SAME

ERO Initial Isolation Zone (Y-12 specific)

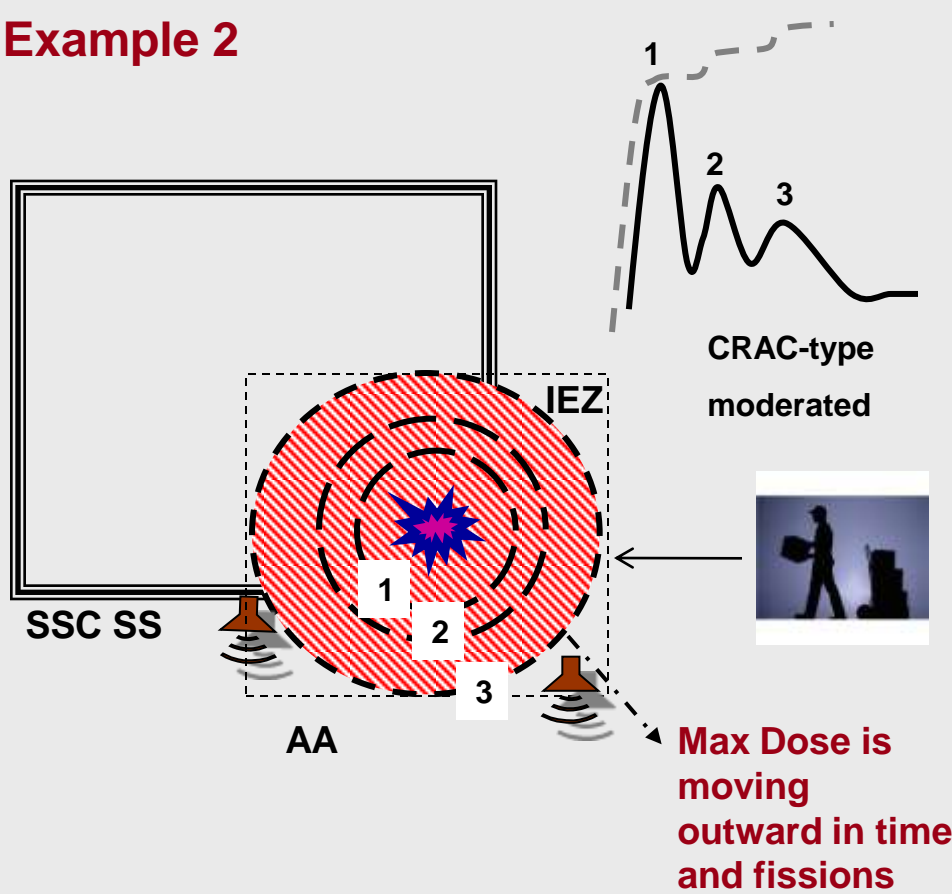
- **Doesn't exist until implemented by ERO at the response phase**
- **Generic** to ANY response given Emergency Action Level (EAL)
- 200 ft or 500 ft depending on Site or General Emergency
- Criticality is Site Emergency (historic 200 ft and < 25 rem - 1959)
- **ERO Procedure Y40-158 Protective Action Decision Making:**
 - ***Evacuation - Controlled relocation of a population from an area of known danger or unacceptable risk to a safer area, or one in which **the risk is acceptable.*****
 - ***IF a Facility Specific, Site-Wide, or Discretionary EAL is used to categorize/classify the **event**, THEN direct the implementation of the Initial Isolation Zone and On-Site Protective Actions identified in the EAL***
 - ***IF conditions allow, THEN evacuate all non-essential personnel from the Initial Isolation Zone.***

Scenario Type, Location, and Adjacent Area

Example 1



Example 2

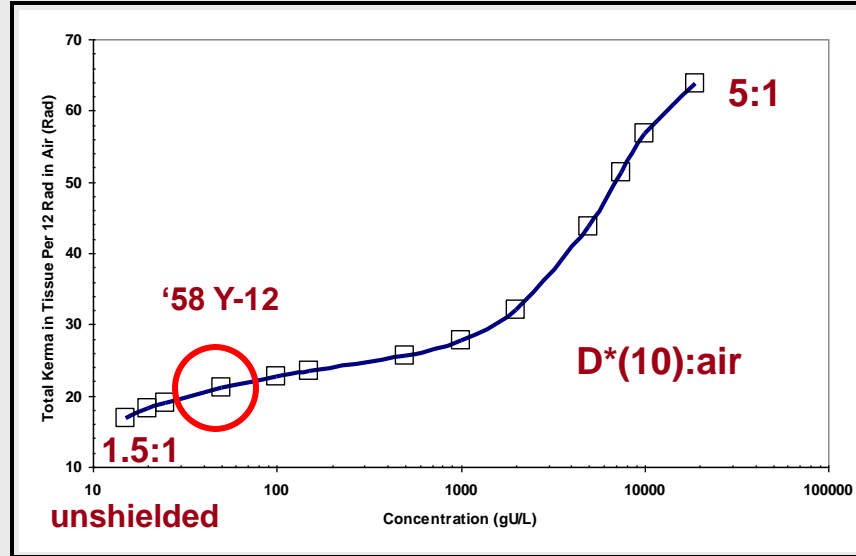
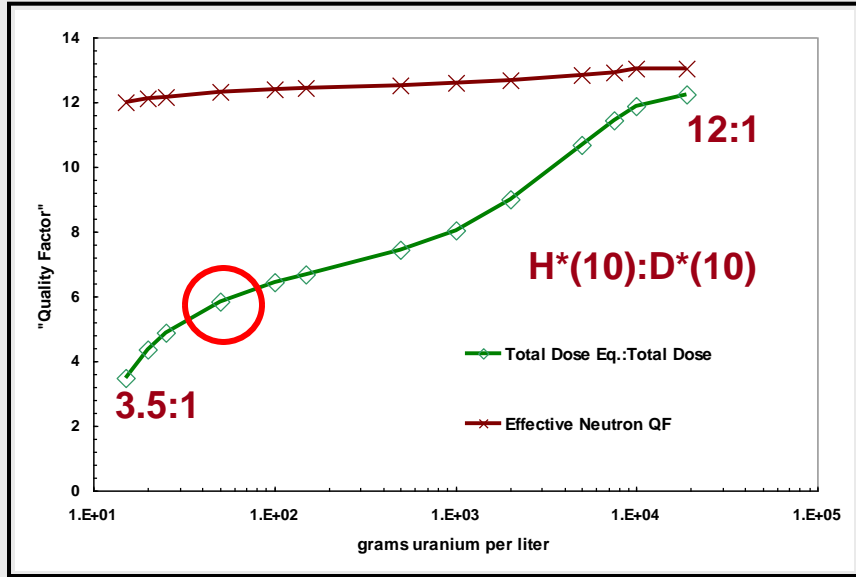


“Single spike” accident well inside facility, Truck Bay in AA

“Multiple spike” criticality accident at facility boundary, Loading Dock in IEZ

Absorbed Dose $D^*(10)$ and Dose Equivalent $H^*(10)$

- Ambient Absorbed Dose $D^*(10)$ and Dose Equivalent $H^*(10)$ – “operational quantities” (**immediate and measurable**)
- ICRP 60 rad protection terminology – 10CFR835 compliant (Atlanta 2009)
- ANS-8.23 intimates
 - $D^*(10)$ for maximum **absorbed** dose
 - $H^*(10)$ for **monitored** dose equivalent
- Y-12 Radcon – 0.5 Sv (**acute**) < IDLH
 $3.5 \times 1.5 \times 12 = 0.63$ Sv fully moderated
- TED~~X~~ lifetime and **long term stochastic** value (organ specific) – **not measurable**



Recent NCRP Guidance for Responders

- ANS-8.23 cites earlier version of NCRP (Report 91, 1987)
- NCRP C19 (2005) guidance for acute dose to **voluntary** responders ~ 0.5 Gy (50 rad).
- Draft ANS N13.3 “0.5 Gy” ~ 0.5 Sv acute effects if all photon
- MARGIN FOR UNCERTAINTY = 2 from lowest **non-zero acute fatality/sickness**
- Total absorbed dose depends on time to initiate monitoring

NCRP

The Decision Dose (related information)

Short-term* Whole-Body Dose [rad (Gy)]	Acute Symptoms (nausea and vomiting within 4 h) (%)
50 (0.5)	0
100 (1)	5 – 30
150 (1.5)	40
300 (3)	75
600 (6)	100

* Short-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.

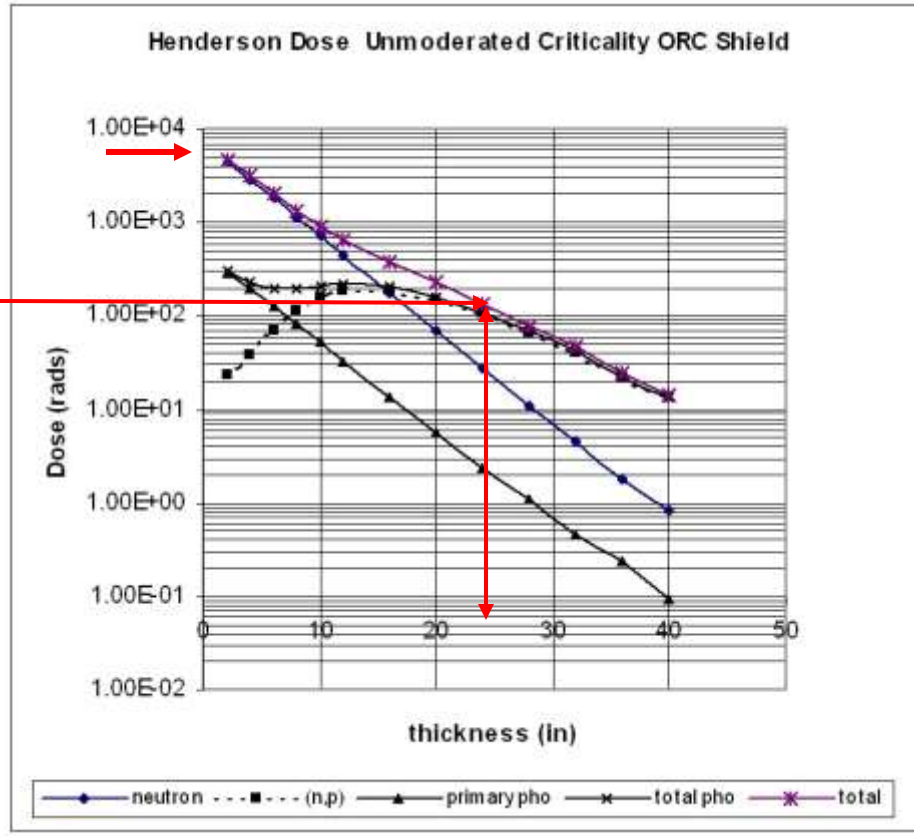
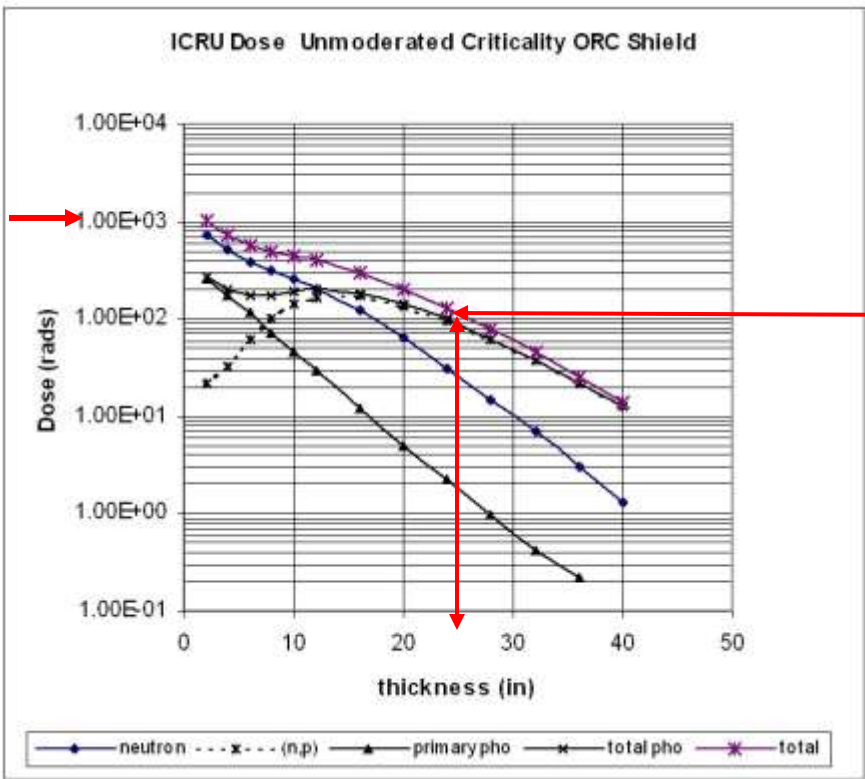
NCRP

The Decision Dose (related information)

Short-term* Whole-Body Dose [rad (Gy)]	Acute Death ^a from Radiation without Medical Treatment (%)	Acute Death ^a from Radiation with Medical Treatment (%)
50 (0.5)	0	0
100 (1)	<5	0
150 (1.5)	5	<5
300 (3)	30 – 50	15 – 30
600 (6)	95 – 100	50
1,000 (10)	100	>90

* Short-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.
^a Acute deaths are likely to occur from 30 to 180 d after exposure and few if any after that time. Estimates are for healthy adults. Persons with other injuries, and children, will be at greater risk.

Absorbed Dose and Concrete Shielding

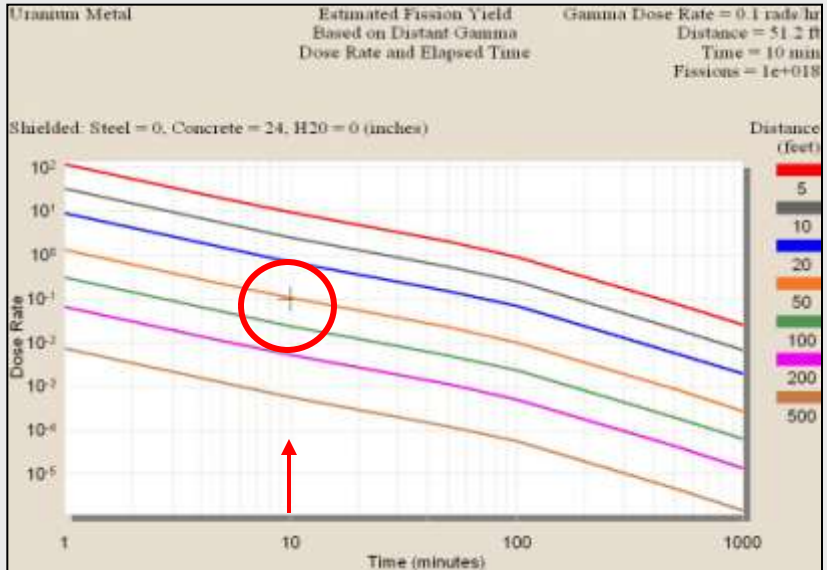


**Unmoderated metal accident
Oak Ridge Concrete (ORC)
Assumes 1e18 basis fissions**

**0" – neutron dose in air 1/10 tissue
12"-18" total photon overtakes neutron
~24" total rad air ~ rad tissue ~ Gy ~ Sv**

Estimating Monitoring Range – First Arrival

- NUREG-CR-6504 (Slide Rule)
- “Estimated Fission Yield Based on Distant Gamma Dose Rate and Elapsed Time”
- Absorbed dose is rad-tissue
- ANS 8.23 1 mSv/hr photon dose rate
- 1e18 fissions over 10 min
- 24” concrete (e.g. two 12” walls)
- Metal – 51 ft - total dose 0.8 rad
- Solution -134 ft -total dose 0.4 rad



Y-12 HEUMF 8.23 EP Evaluation

- Safely Securely Store HEU
- Newly commissioned in 2010
- 8.23 evaluation is first at Y-12
- 8.23 considered where 8.3 system can not be excluded
- Excluded moderated accident formats, $H/X > 10$
- $1e18$ fissions over 10 min
- Excluded potential locations
- Incorporates robust shielding
- Source term different than DOE-HDBK-3010



IEZ+AA contained within facility

Notification within AA is Defense in Depth (SSC DD) – 8.3 system strobes

EMPO Initial Isolation Zone still 200 ft beyond facility

Emergency Planning Evaluation Structure

1. Introduction
2. Process/Facility Description
3. Requirements
4. Evaluation Method
5. Maximum Acceptable Absorbed Dose Evaluation (Preliminary IEZ Boundary)
6. Risk and Benefit Considerations
7. Emergency Response Considerations
8. Finalized IEZ Boundary **AND** Adjacent Area
9. Credited Design Features
10. Summary and Conclusions
11. References

ANS 8.23 §5.1 elements

Location(s)

Source term(s)

Shielding

Dose at receptor(s)



Optimize IEZ+AA

real estate

Unambiguous

physically

unmistakable

boundaries

Concluding Thoughts

- IEZ+AA are unambiguous physically unmistakable areas, bounded by the ERO “Initial Isolation Zone” *when activated*
- ANS-8.23 (2007) now recognized – transition is culture change
- ANS-8.23 does not preclude AA from EP Evaluation
- Total dose to time to establish full situational awareness < MD
- Notification within AA can be flexible and include 8.3 elements
- 10CFR 835 Compliance – $H^*(10)$, $D^*(10)$ versus TEDE rem

Future Direction/Desires

- Instant, Automatic Situational Awareness (telemeter AA?)
- Better location awareness both for people and event
- Incorporate **Protective Action Decision Making** features into facility design
- Adjacent large facilities – decouple notification systems
- Evaluate the need for TSR level controls for some scenarios
- **Preserve Integrated Safety under NORMAL OPERATIONS**

Spare Slides

PS - Regulatory Oversight Observations



“The **IEZ concept** and its implementation **at HEUMF** has the potential to provide **more efficient operations and maintenance** of the CAAS and potentially **reduce TSR violations** associated with the CAAS”

YSO Safety Evaluation Report