

# Update on Fukushima: *Enterprise•SRS* *Next Generation Cleanup Technologies*

July 23, 2013



## *Update to Citizens Advisory Board*

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**Karen Guevara**

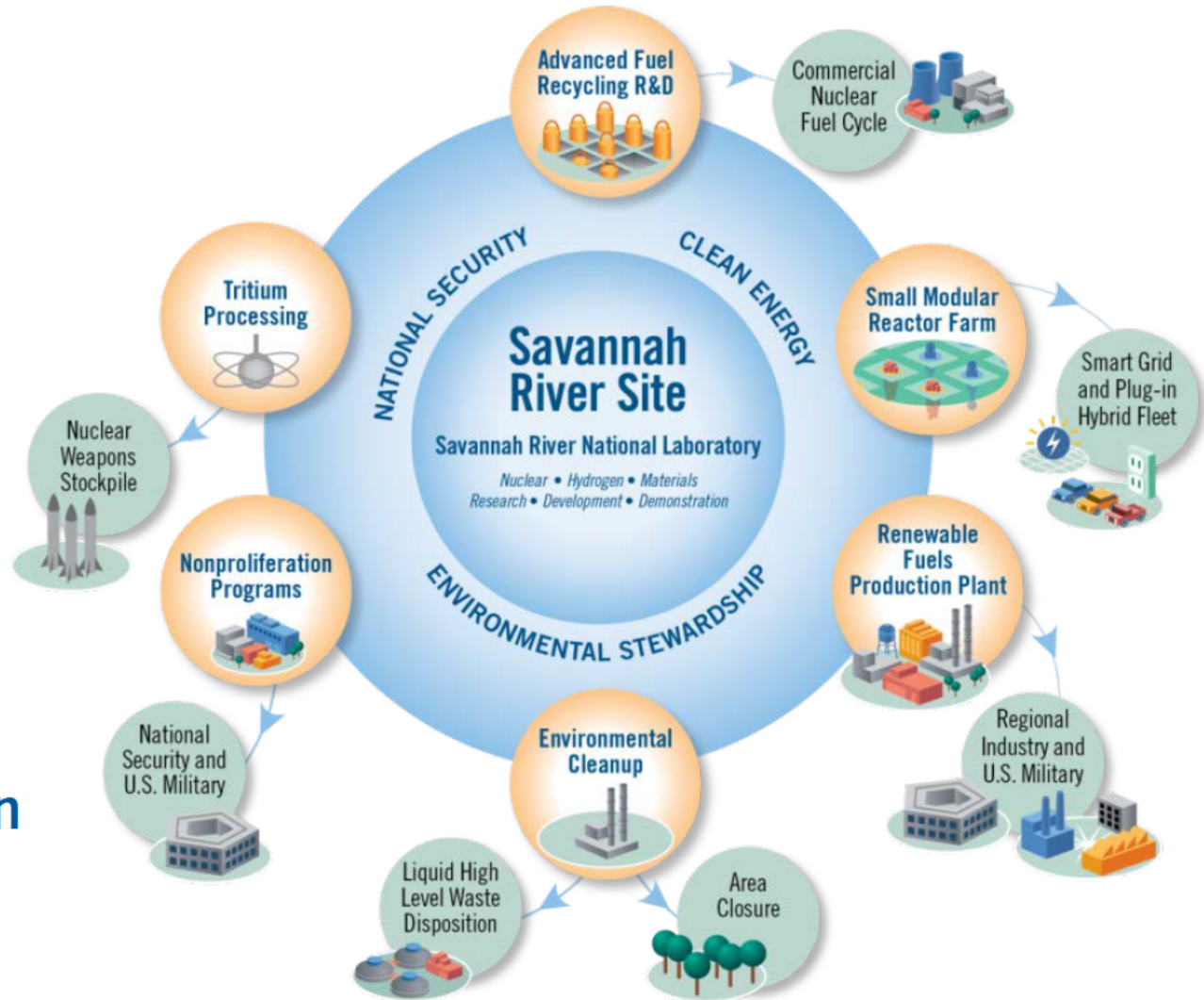
*Assistant Manager for Infrastructure and Environmental Stewardship*

# Strategic and Legacy Management Subcommittee Work Plan

- Subcommittee's 2013 Work Plan requested an update on support to Fukushima
- SRS's support to Fukushima is part of its Enterprise•SRS *Next Generation Cleanup Technologies* Initiative
- Briefing provides overall update on Enterprise•SRS and details on *Next Generation Cleanup Technologies* initiative
- Will point out for each area whether it is part of DOE-EM work scope or being done with external funding as Work for Others

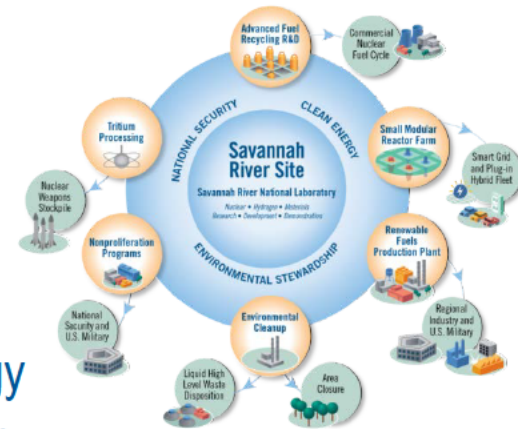


- Safe clean energy
- Safeguarding and securing nuclear materials
- Maintaining our national security
- A clean environment
- Leveraging science, innovation and technology



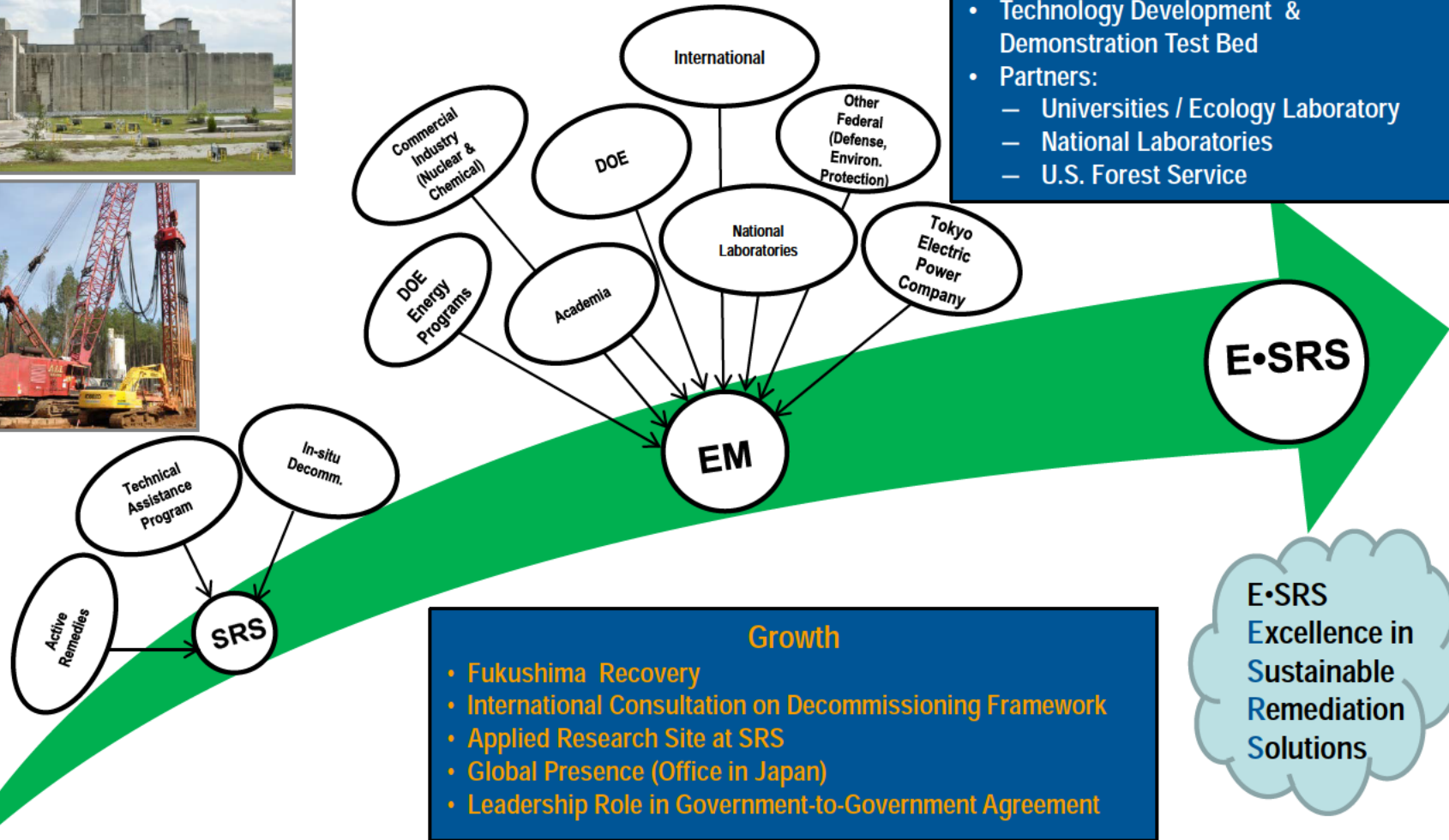
- Broken into 12 specific initiatives:

- Deliver Disposition Paths for Nuclear Materials
- Increase Helium-3 Supply to Aid Nuclear Nonproliferation
- Develop and Deploy Next Generation Cleanup Technologies
- Expand Reach and Impact of National Center for Radioecology
- Establish Advanced Center for Nuclear Forensics and Attribution
- Center for Applied Nuclear Materials Processing and Engineering Research
- Develop Solutions to Close and Better Secure the Nuclear Fuel Cycle
- Lead Research and Development of Transformational Waste Disposal Technologies
- Leverage and Revitalize Site Assets to Solve National and Regional Issues
- Reduce Greenhouse Gas Emission via Clean Alternative Energy Projects
- Accelerate Deployment of Small Modular Reactors (SMRs)
- Tritium Infrastructure and Technologies



# Reminder: Next Generation Cleanup Technologies Vision

Today



**Vision**

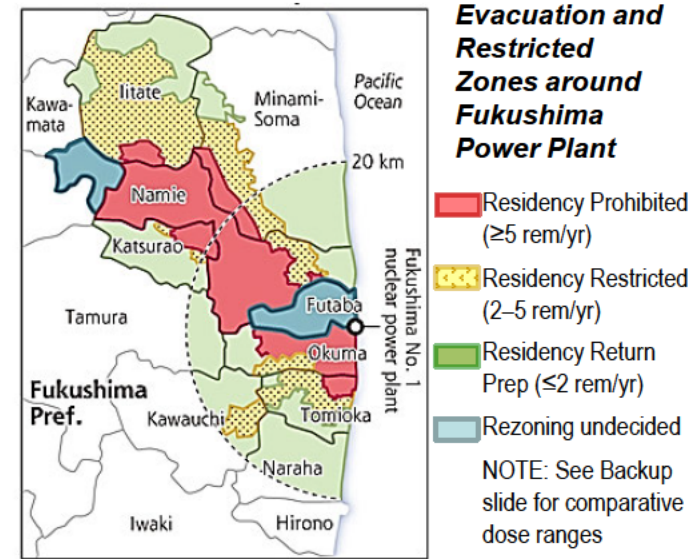
- EM Strategic & Technical Authority
- International Technical Ambassador
- Technology Development & Demonstration Test Bed
- Partners:
  - Universities / Ecology Laboratory
  - National Laboratories
  - U.S. Forest Service

**Growth**

- Fukushima Recovery
- International Consultation on Decommissioning Framework
- Applied Research Site at SRS
- Global Presence (Office in Japan)
- Leadership Role in Government-to-Government Agreement

# Reminder: Fukushima Daiichi Reactor Accident

- March 11, 2011 earthquake and subsequent tsunami damaged the Fukushima Daiichi Nuclear Power Station
  - Resulted in airborne release of radioactive material that settled and caused contamination of a large land areas, within the Fukushima Prefecture and extending to adjacent prefectures
  - Tokyo Electric Power Company responsible for on-site cleanup of Fukushima Daiichi Nuclear Power Station (~3 ½ sq. miles)
  - Japan's Ministry of the Environment responsible for decontamination of lands beyond power station
- Overall remediation effort includes:
  - Treat and stabilize radioactive sea water introduced into Fukushima Daiichi reactors for emergency cooling
  - Remediate large volumes of contaminated groundwater within and beyond power station
  - Remediate cesium-contaminated soils within and beyond power station
  - Dispose of radioactive wastes generated within and beyond power station
  - Decommission reactors within power station



# Update: Fukushima Recovery

- Building on successful development & deployment of cost effective remediation:

Initiative Element	SRS Success	Fukushima Support
Active to Passive	Initially Pump & Treat; Install reactive barrier; implant sensors in area(s) of interest	Groundwater Bypass approach implemented
In-situ Decommissioning	3 reactors	Develop & deploy grout to stop water leakage between reactor and turbine buildings, off gassing considerations
Long-term Monitoring	Blend of typical & rapid data collection techniques	Place sensors & electronically send data to offsite receivers  Develop & deploy analytical laboratories (e.g. mobile initially converts to modular over time)

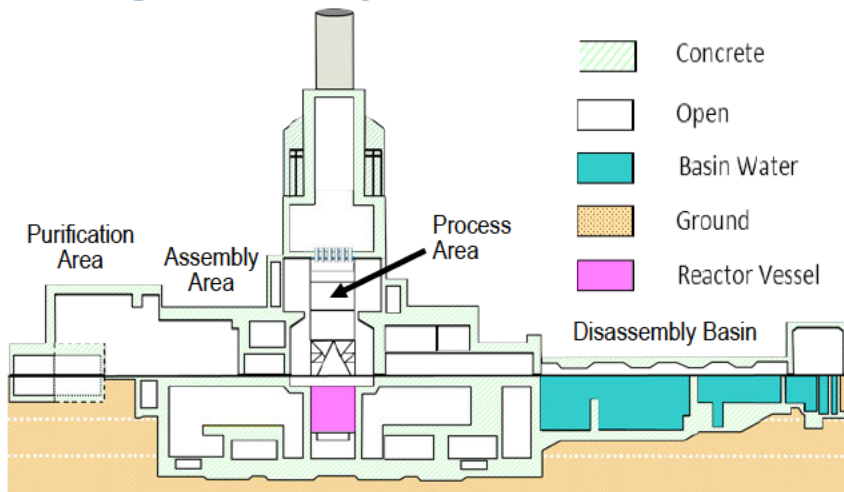
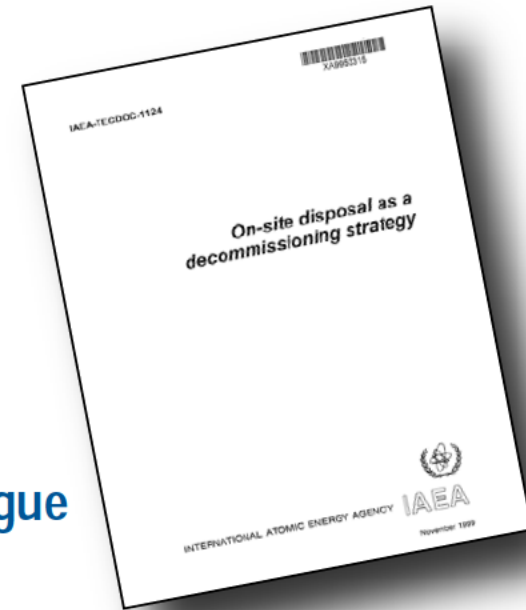
- **Tokyo Electric Power Company**

- Successfully completed first six-month contract with Tokyo Electric Power Company
  - Aided definition of cleanup scope, matching DOE capabilities and technologies to needs
  - Identified specific groundwater modeling tools/approaches to help characterize contaminants
  - Developed risk-based decision tools for waste management and reactor building remediation
- Working now to finalize second contract
  - Builds on initial contract scope to refine areas of needed support within power station
  - Focuses specifically on grout formulation and testing, fuel debris characterization and criticality, tritium in water and decommissioning strategies and options

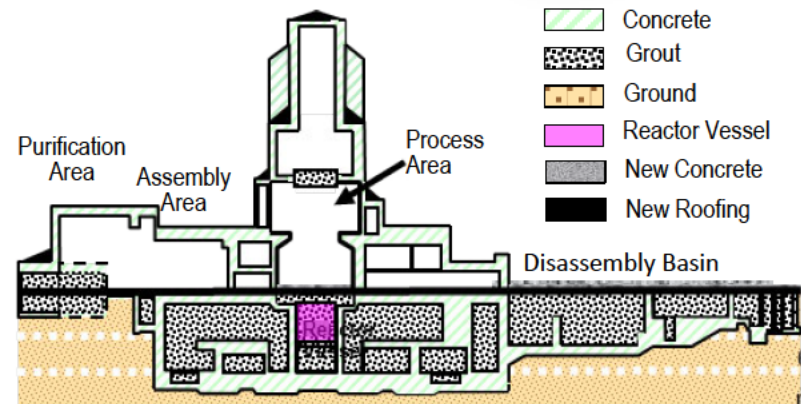


# Update: International Consultation on Framework

- International Atomic Energy Agency continues to address on-site decommissioning/disposal options:
  - Discuss experience/lessons learned from entombment projects
  - Develop information on entombment options that comply with internationally agreed regulatory standards
  - Part of US delegation, working with Belgium, France and Russia
- Contributing to IAEA Fukushima Comprehensive Report
- Just participated in May 2013 Trilateral Nuclear Energy Dialogue among Korea, Japan, and the United States



*P Reactor before decommissioning*

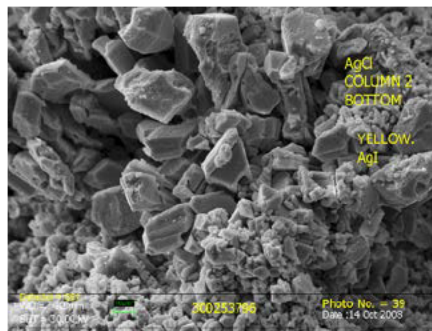


*P Reactor after decommissioning*



# Update: SRS EM's Groundwater Applied Field Research Site

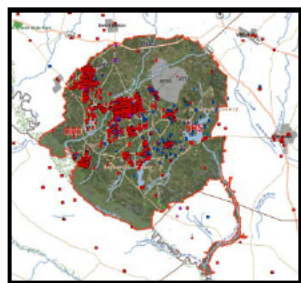
Developed and deployed Silver Chloride technology for sequestering Iodine-129 – Deployed 2011



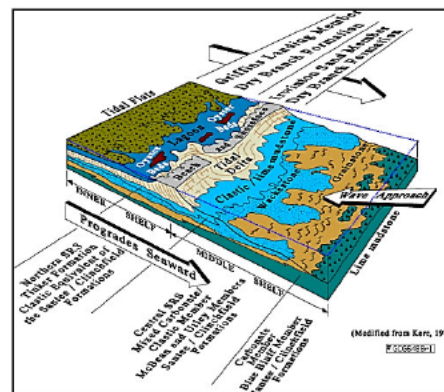
Radioactive iodine replaces chlorine molecules, to bind mobile iodine within soils

Developed innovative paradigm for long term monitoring of residual contamination

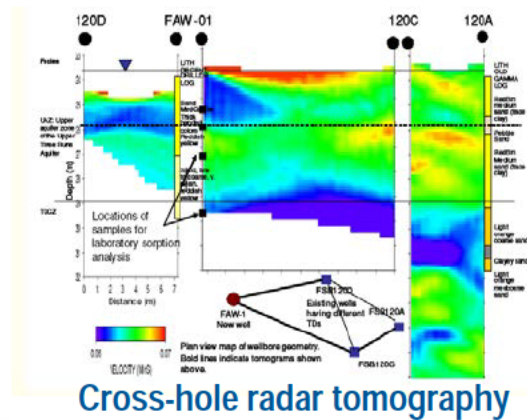
Identify "leading" indicators of plume behavior (e.g., water pH, elevation and flow rates) to improve monitoring effectiveness and lower cost



Developing "reactive facies approach" to model complex underground plumes



Augment limited subsurface well data with surface tomography to better model and predict contaminant migration



# Update: Global Presence (Office in Japan)

## Embassy Science Fellow

- Completed 2-month U.S. Embassy Science Fellow assignment
  - Provided on-the-ground expertise on remediation technologies and techniques
  - Promptly responded to over 15 Government of Japan requests for specific information on DOE & SRS experience in soil decontamination, radiation monitoring, cesium in the environment, etc. applicable to Fukushima cleanup
- Finalizing report for Japanese Ministry of Environment on cleanup beyond power station
- SRNL, Ecology Lab and Forest Service developing joint proposal on bioremediation in the exclusion zone – using SRS laboratory assets to analyze contamination, crops, and energy sources

[\[Rhizatron Video Placeholder hotlink\]](#)

- SRNL will host representatives from the Fukushima prefecture in early September for discussions on monitoring and cleanup technology R&D
- Pacific Northwest National Lab Collaboration
  - Partnering to augment SRNL's technology deployment expertise with Pacific Northwest's groundwater modeling capabilities to craft specific solutions for Fukushima cleanup

市町村名	福島市	二本松市	伊達市	本宮市
除染計画	5/21 策定済	10/1 策定済	8/10 策定済	11/2 策定済
除染作業状況	実績 計画 進捗率 (実績/計画)	実績 計画 進捗率 (実績/計画)	実績 計画 進捗率 (実績/計画)	実績 計画 進捗率 (実績/計画)
公共施設(施設数)	532 666 679	78 79 82	90 %	199 252 380
住宅(戸)	3774 20806 20806	18 %	1399 4358 5002	28 %

**Public Information Board at the Decontamination Information Plaza in Fukushima City (showing different areas' radiation readings and percentage cleaned up)**



**Laboratory Partnering on Fukushima Cleanup**



# Update: Leadership Role in Govt-to-Govt Agreement(s)

- **China**

- SRS hosted delegation from China Atomic Energy Authority in October 2012
- SRS sent delegation to Beijing in April 2013 as part of US-China *Peaceful Uses of Nuclear Technology* joint convention
- Exploring potential for collaboration with Chinese on soil and groundwater technologies, liquid waste treatment and waste forms, and reactor entombment

- **Russia**

- SRS hosted delegation from Rosatom, Russia's equivalent to DOE

- **Japan**

- Supporting DOE Office of Environmental Management role in the US-Japan government-to-government collaboration
- Participated in Spring 2013 Bilateral Commission Working Group on decommissioning
- Focusing on decommissioning concepts, especially risk-informed basis for consideration of in-situ decommissioning/entombment
- Provided consult on permanent barrier technologies and experience to TEPCO and Government of Japan Ministry personnel



# Conclusion on *Next Generation Cleanup Technologies*

- Progress has been steady
- SRS has become key participant in many DOE and EM international activities
- SRS remains positioned to provide assistance to Japan in the cleanup of Fukushima and the surrounding countryside
- Embassy Science Fellow participation has delivered contacts and a venue within the Government of Japan for proposing SRS expertise and technology in bioremediation



# Ionizing Radiation Dose Ranges

(Rem)



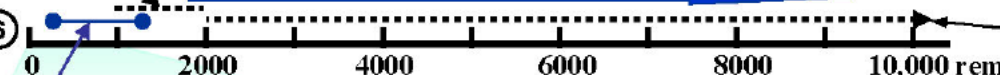
Whole body, acute: G-I destruction; lung damage; cognitive dysfunction (death certain in 5 to 12 days)\*

Cancer Radiotherapy  
total doses to tumor

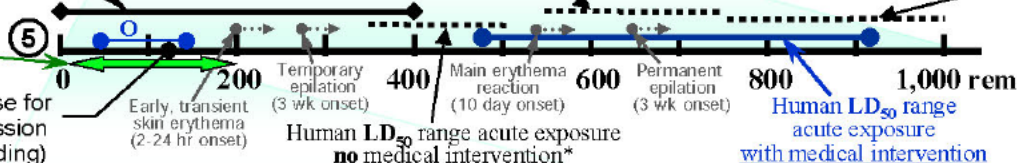
acute exposure = all at once;  
chronic = hours, days, years

Whole body, acute: cerebral/vascular breakdown (death in 0-5 days)\*

Life Span Study (A-bomb survivor epidemiology)



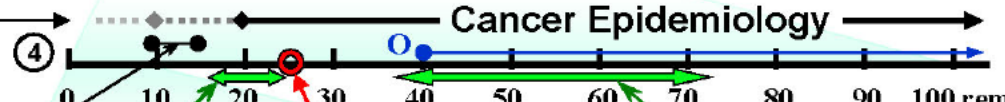
Charged particle event (Solar flare) dose on moon, no shielding



Whole body, acute: marked G-I and bone marrow damage (death probable in 1-2 wks)\*

\*Note: Whole body acute prognoses assume **no** medical intervention (G-I = gastrointestinal)

Evidence for small increases in human cancer above 10 rem acute exposure or 20 rem chronic exposure



Medical Diagnostics rads  
(Estimated maximum organ dose)

X-ray films

A - Chest (PA & Lat)	0.014
B - Dental Panoramic	0.07
C - Lumbar-Sacral Spine	0.2 - 0.3
D - Mammogram	0.2 - 0.4

Radiotracer Imaging

E - Heart Stress (Tc-99m)	0.6 - 1.2
F - Bone (Tc-99m)	0.4 - 1.5
G - Dual Isotope Stress Test	4.0 - 4.5
H - PET: F-18 FDG (bladder)	5.5 - 8

CT Scans (X-ray)

(multiple scan average dose)	
I - Chest	2 - 3
J - Head	3 - 5
K - Abdominal	2.2 - 6
L - Full Body	5 - 10

Fluoroscopy /Procedures

M - Barium Contrast G.I.	1 - 2.2
N - Cardiac Catheterization	1.2 - 4
O - TIPS Procedure	40 - 140

Typical mission doses on International Space Station (ISS)

DOE Low Dose Program



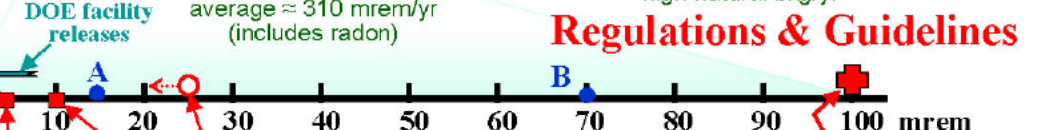
Medical Diagnostics (A-O)  
see chart >>

Typical added annual dose for commercial airline flight crews



Regulations & Guidelines

Airport x-ray whole body scanner: 0.007 mrem/scan (Limit = 25 mrem/yr ≈ 4000 scans/yr)



LD<sub>50</sub> = Lethal Dose to 50%  
(whole body dose that results in lethality to 50% of exposed individuals in 30-60 days)

Chart units are in Equivalent Dose: 100 rem = 1 Sievert  
Absorbed Dose units: 100 rad = 1 Gray  
100 mrem = 1 mSv  
1 rem ≈ 1 rad for x- and gamma-rays  
(“≈” stands for “approximately equal to”)

Chart compiled by NF Metting, Office of Science, DOE/BER. "Orders of Magnitude" revised June 2010  
<http://www.lowdose.energy.gov/>

NOTE: This chart was constructed with the intention of providing a simple, user-friendly, "order-of-magnitude" reference for radiation exposures of interest to scientists, managers, and the general public. In that spirit, most quantities were expressed as equivalent dose\* in the more commonly used radiation protection units, the rem and Sievert. Medical diagnostics are expressed as estimated maximum organ dose, they are **not** in "effective dose" - that is, they do not imply any estimation of risk. It is acknowledged that the decision to use this set of units does not address everyone's needs. (NRC = Nuclear Regulatory Commission; EPA = Environmental Protection Agency; DHS = Department of Homeland Security)  
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