



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**

FISCAL YEAR 2017
CONSOLIDATED INNOVATIVE NUCLEAR RESEARCH:
FUNDING OPPORTUNITY ANNOUNCEMENT
No. DE-FOA-0001515

DRAFT WORKSCOPES FOR U.S. UNIVERSITY-LED INTEGRATED RESEARCH PROJECTS

- **IRP-EM-1: WEARABLE ROBOTIC DEVICES FOR WORKERS**
- **IRP-EM-2: ADVANCED ROBOTIC TELE-MANIPULATORS FOR GLOVEBOXES AND HOT CELLS**
- **IRP-EM-3: MULTI-USE AND MULTI-USER ROBOTS**

WEBINAR – TUESDAY, AUGUST 9, 2016
OFFICE OF NUCLEAR ENERGY AND
OFFICE OF ENVIRONMENTAL MANAGEMENT

Nuclear Cleanup

Environmental Management

Mission Overview



Safe cleanup of the environmental legacy created by the Manhattan Project, the ensuing Cold War nuclear arms race, and the early years of federal government-sponsored nuclear science research and technology development



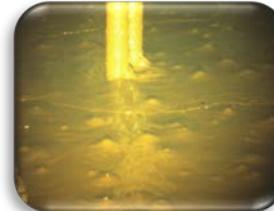
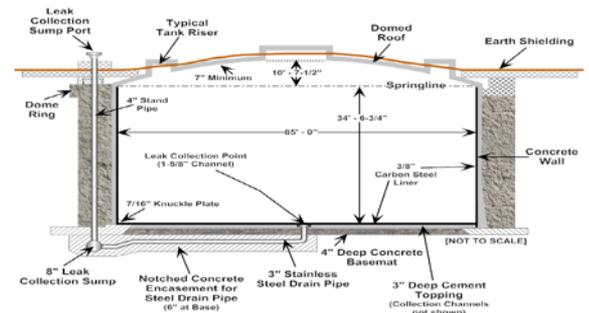
The Hanford Reach
White Bluffs Overlooking the Columbia River



Nuclear Facility Decommissioning

Soil and Water Cleanup

Liquid Radioactive Waste Processing & Disposition

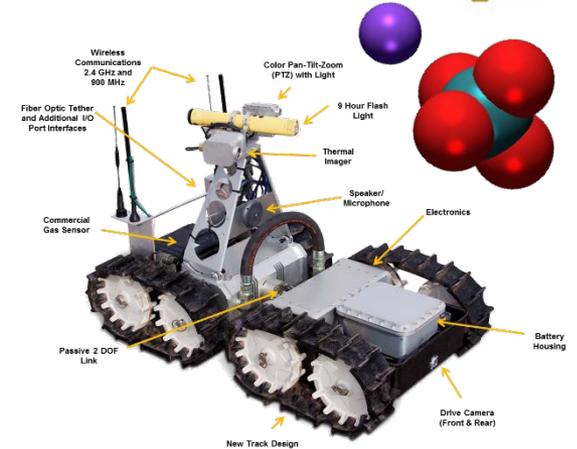
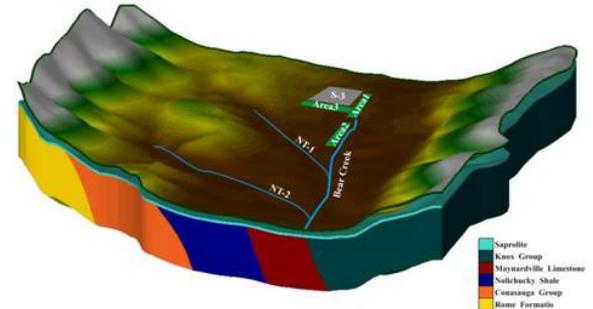




Solid Radioactive Waste Treatment, Storage & Disposal

Nuclear Materials & Spent Nuclear Fuel Management

Science & Technology





Initial Footprint of the Cold War Legacy

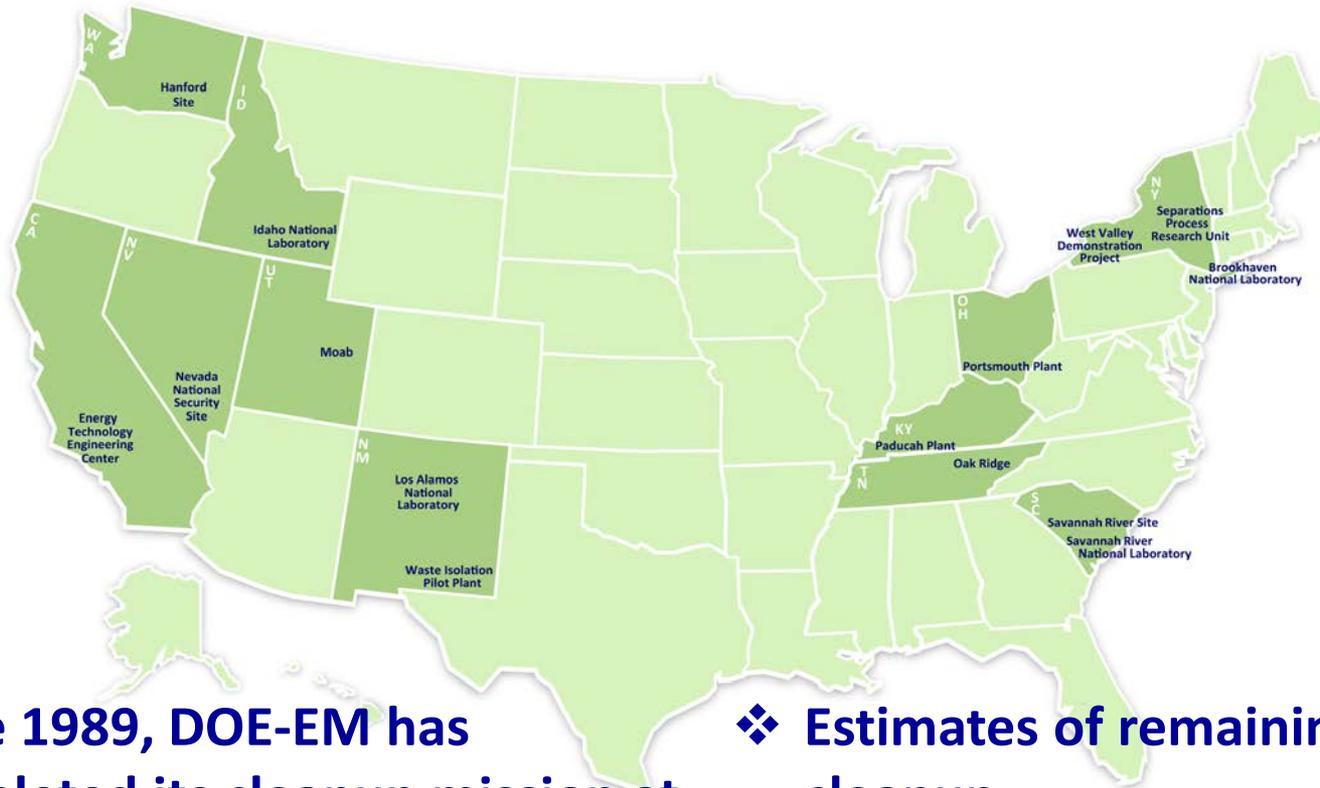


KEY:

- Assembly and Dismantlement
- Former Contaminated Industrial Sites
- Fuel and Target Fabrication
- Non-Nuclear Components
- Nuclear Components
- Number of Sites in State
- Reprocessing to Separate Plutonium
- Plutonium Production Reactors
- Uranium Enrichment
- Uranium Foundry
- Uranium Mining and Tilling
- Uranium Refining
- Warhead Assembly
- Weapons Research/Design



Collapsing the Footprint of the Cold War Legacy

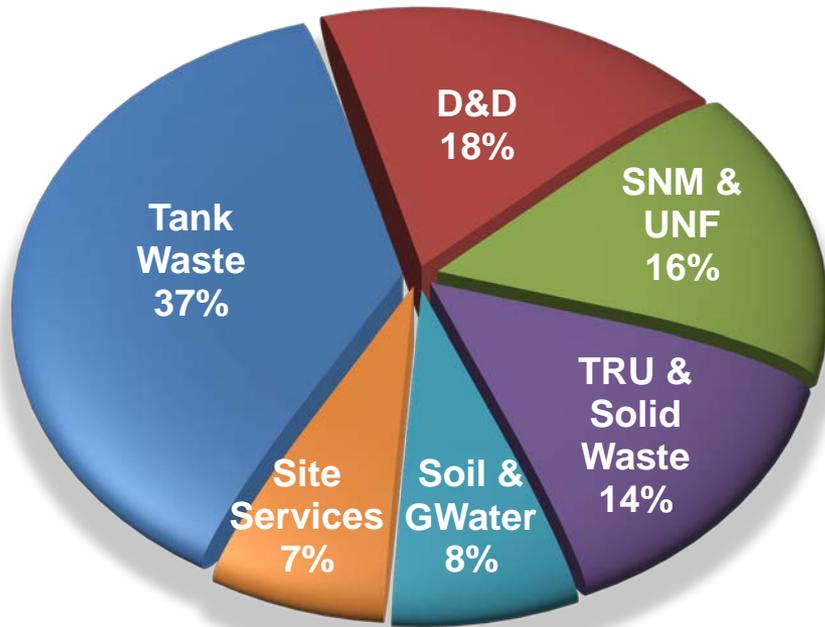


- ❖ Since 1989, DOE-EM has completed its cleanup mission at 91 of the 107 major nuclear sites
 - \$152 billion spent

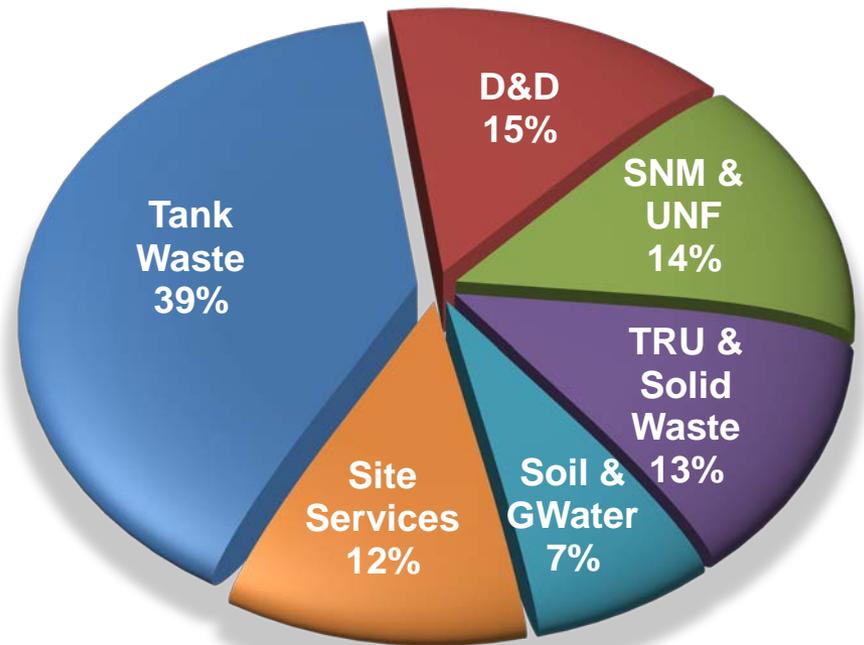
- ❖ Estimates of remaining cleanup
 - \$235 billion
 - 2065 completion



Fiscal Year 2016 (Approved): \$6.218 Billion



Fiscal Year 2017 (Requested): \$6.119 Billion



Robotics

EM Mission Enabler

- ❖ Rooted in the EM mission is the **science of safety** whereby scientific and technological advancements are infused and integrated into the routines of work planning and execution in a manner that improves safety and quality and reduces the government's cleanup liability
- ❖ EM is actively promoting the use of **advanced robotics** as a key **enabling technology**



- ❖ DOE-EM encourages robotics research and technology development for
 - Handling of **high-hazard, high-consequence** materials and waste
 - Tasks that are **dirty** (contaminated, toxic, nuisance), **dull** (routine, labor-intensive, repetitive, mundane), **dangerous** (pose significant occupational hazards), and/or **difficult** (require engineered measures)
 - **Easing the performance** of worker/operator tasks that are physically demanding on or stressful to human body or are otherwise ergonomically challenging
 - Performing tasks that are **beyond human abilities**
 - Improving the ability to **response** to and recover from unplanned events or operational **emergencies**
 - **Improving** the safety, quality, efficiency, and productivity of facility **operations**

IRP-EM-1

Wearable Robotic Devices for Workers

- ❖ **Federal POC: Rodrigo Rimando, DOE Office of Environmental Management**
 - **rodrigo.rimando@em.doe.gov**
- ❖ **Technical POC: Thomas Nance, Savannah River National Laboratory**
 - **thomas.nance@srnl.doe.gov**
- ❖ **Up to 2 years and \$1,000,000**
- ❖ **Technical Objective: This IRP seeks a functional prototype(s) of a wearable, prosthetic-like, exoskeletal, bionic, and other attachable human assistive robotic devices(s) that can serve the workforce by functioning as**
 - **Smart personal protective equipment (PPE) and/or**
 - **Performance augmentation and amplification devices (PAADs)**

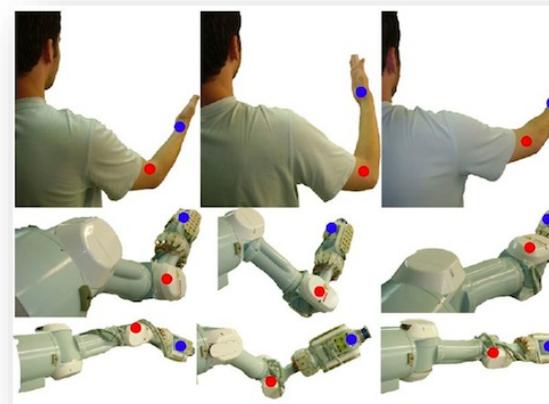
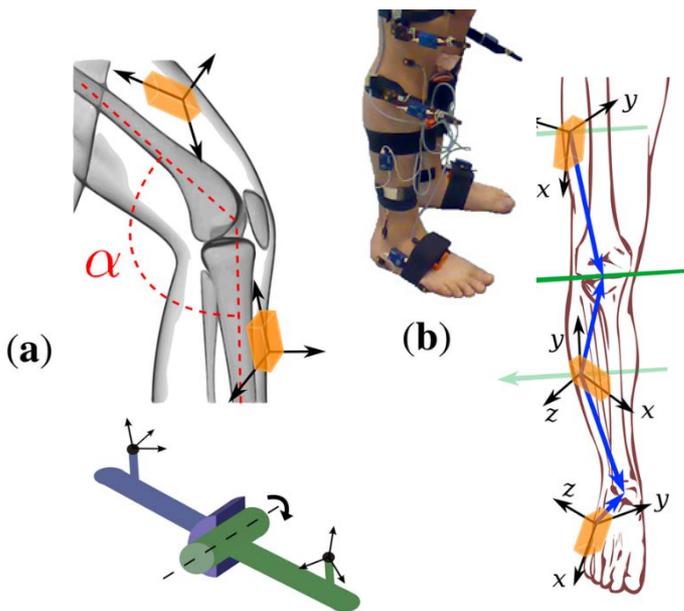
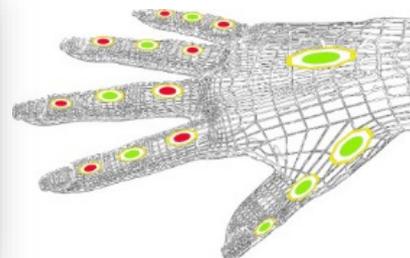


IRP-EM-1: Wearable Robotic Devices *Enhance Worker Health and Safety*

Robotic PPE is intended to help protect workers from sustaining **internal injuries** due to forceful or over-exertion, fatigue, hyperextension, over-rotation, abrupt movements, repetitive motion or stress, repetitive or excessive vibration, awkward or prolonged postures, and possibly the latent effects of aging



Complementary technologies such as anatomical sensing devices, brain-computer interface devices, and biomechanical sensors can help prevent worker injuries → *Smart PPE*



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IRP-EM-1: Wearable Robotic Devices What's the Difference?

“Traditional” PPE protect workers from exposure to workplace, facility, or environmental external hazards that have not or could not be fully mitigated through engineered and/or administrative controls





IRP-EM-1: Wearable Robotic Devices *Improve Performance and Productivity*

- ❖ Robotic PAADs enable workers to perform tasks that are physically stressful or demanding, mentally taxing, ergonomically challenging, or even beyond human capability
- ❖ Robotic PAADs will help **improve performance and productivity**

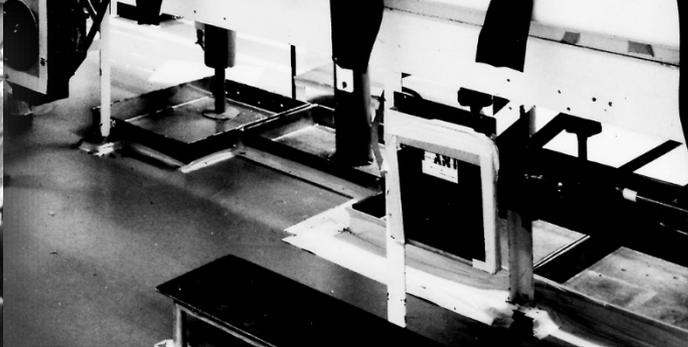


- ❖ **Proposals must satisfy all four requirements below**
 - 1) **Demonstrate the leveraging of technologies and advancements already made in wearable robotics devices by universities/colleges, other federal agencies, other federally funded research and development centers, or the non-nuclear industry**
 - 2) **Indicate the intention for collaboration with at least one other US university/college having established robotics expertise and assets**
 - 3) **Indicate the intention for collaboration with at least one DOE national laboratory/technology center OR indicate the intention for collaboration with a non-DOE federally funded research and development center**
 - 4) **Demonstrate full functionality of the wearable robotic device (smart PPE/PAAD) such that it can be readily demonstrated by an actual worker at one of EM's sites/projects**

IRP-EM-2

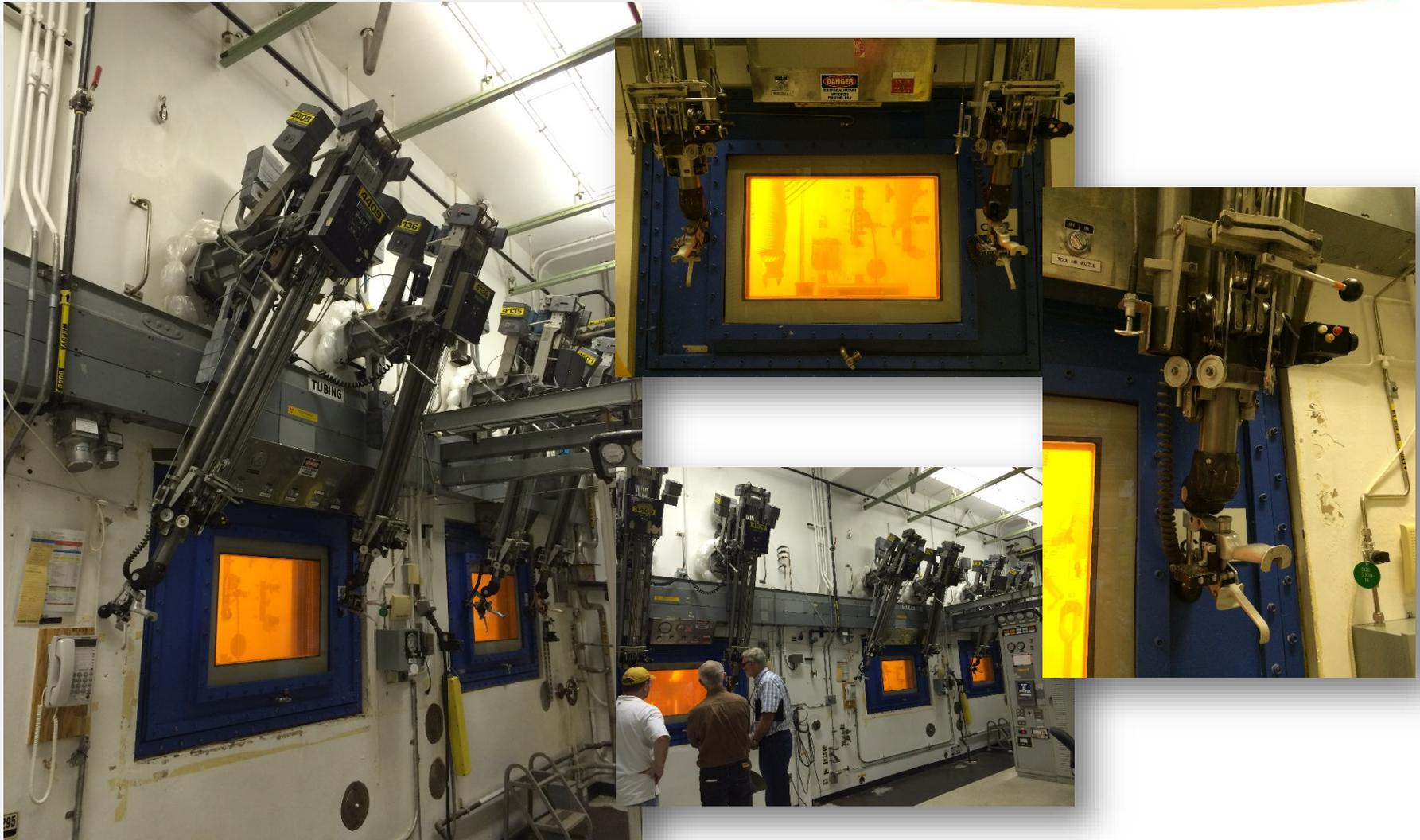
Robotic Tele-Manipulators for Gloveboxes and Hot Cells

- ❖ **Federal POC: Rodrigo Rimando, DOE Office of Environmental Management**
 - **rodrigo.rimando@em.doe.gov**
- ❖ **Technical POC: Thomas Nance, Savannah River National Laboratory**
 - **thomas.nance@srnl.doe.gov**
- ❖ **Up to 2 years and \$1,500,000**
- ❖ **Technical Objective: This IRP seeks a functional prototype(s) of advanced robotics to accomplish tele-manipulation in gloveboxes and hot cells**
 - **Integration of robotic arms/hands that can be tele-operated by an operator/lab tech offer increased**
 - **Ability (dexterity, fine motor skills and grip)**
 - **Efficiency (work longer and with more focus)**
 - **Capability (added strength and extended reach)**
 - **Safety (improved ergonomics)**

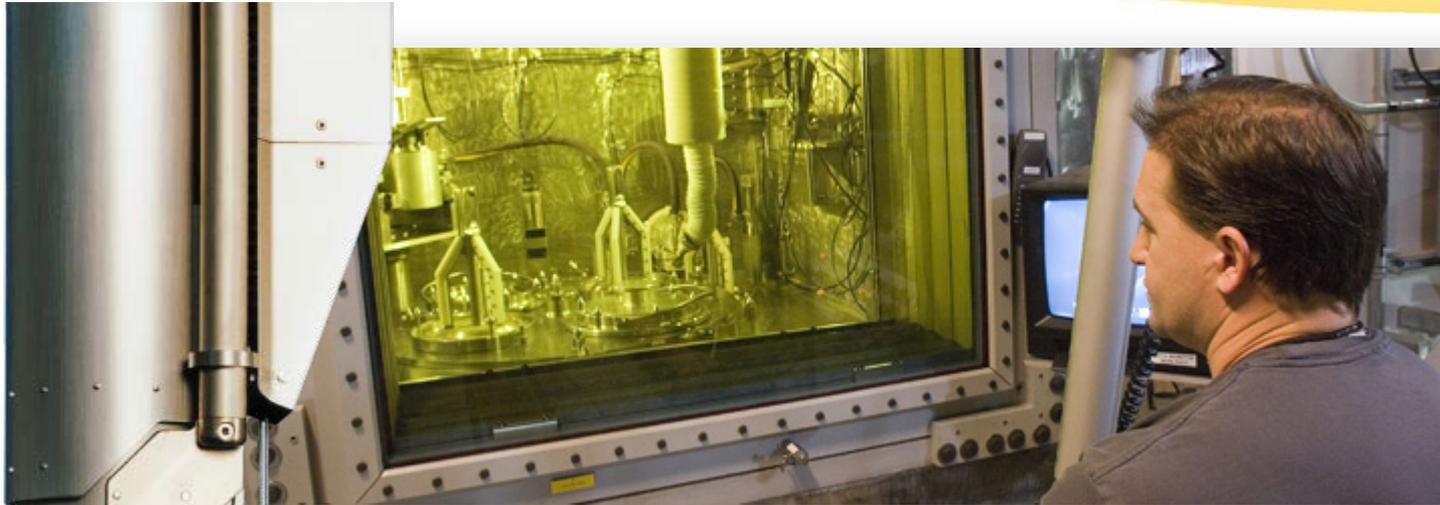












- ❖ **Desirable features include, but are not limited to**
 - **Real-time response (minimal latency)**
 - **Human-like movements (smooth and fluid)**
 - **Haptic or kinesthetic communication (sense of touch)**
 - **Compactness (small and slim)**
 - **Replaceable skins or coverings that can be readily decontaminated or cleaned**
 - **Easy and quick replacement (swap-out) of the robotic arms/components**
 - **Inherently safe (no sharp edges and does not spark or produce static charges)**
 - **Can be disposed as low-level radioactive waste**

- ❖ **Proposals must satisfy all four requirements below**
 - 1) **Indicate the intention for collaboration with at least one other US university/college having established robotics expertise and assets**
 - 2) **Indicate the intention for collaboration with at least one DOE national laboratory/technology center OR indicate the intention for collaboration with a non-DOE federally funded research and development center**
 - 3) **Demonstrate utility in standard or common gloveboxes (i.e., no “one-off” glovebox designs) or hot cells in existing DOE facilities and laboratories**
 - 4) **Demonstrate full functionality of the robotic tele-manipulator such that it can be readily demonstrated by an actual worker at a glovebox/hot cell mock-up**

IRP-EM-3

Multi-Use and Multi-User Robots

- ❖ **Federal POC: Rodrigo Rimando, DOE Office of Environmental Management**
 - **rodrigo.rimando@em.doe.gov**
- ❖ **Technical POC: Thomas Nance, Savannah River National Laboratory**
 - **thomas.nance@srnl.doe.gov**
- ❖ **Up to 2 years and \$1,500,000**
- ❖ **Technical Objective: This IRP seeks a functional prototype(s) of a MU2 robot(s) that can**
 - 1) **Perform routine operations and**
 - 2) **Be deployed in response to operational upsets and emergencies**



- ❖ MU2 robots must be useable by different professional disciplines
 - An assistive robot that is used by a health physics technician for performing routine radiological surveys can also be used by a first-responder to screen for the presence of airborne radioactivity prior to entering an area or space → **physicist to firefighter**
 - High-mobility robots used for routine surveillance and inspection of outdoor or rugged areas can be quickly reconfigured to perform search and rescue operations in unstructured environments
- ❖ MU2 robots will ultimately provide **interoperability, dissimilar redundancy,** and response **defense-in-depth**

- ❖ **Proposals must satisfy all four requirements below**
 - 1) **Indicate the intention for collaboration with at least one other US university/college having established robotics expertise and assets**
 - 2) **Indicate the intention for collaboration with at least one DOE national laboratory/technology center OR indicate the intention for collaboration with a non-DOE federally funded research and development center**
 - 3) **Indicate the intention for collaboration with at least one emergency/disaster/first response organization (e.g., public safety, police officers, firefighters, paramedics, emergency medical technicians, etc.) or special response/crisis teams (e.g., mine rescue, special weapons and tactics, bomb disposal, etc.)**
 - 4) **Demonstrate full functionality of the MU2 robot such that it can be readily demonstrated for normal as well as off-normal operations at a mock-up facility**

Final Thoughts

Perspectives on Robotics



Robotic devices will enhance **worker safety** and **protection** keeping occupation exposures to hazards and hazardous substances and injuries as low as reasonably achievable (ALARA)



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Robotic devices will become a **common tool** in the workers' toolbox



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