

# Project Pele Overview

## *Mobile Nuclear Power For Future DoD Needs*

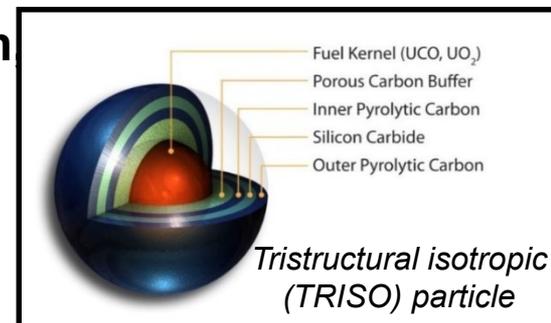


**Jeff Waksman**  
**Program Manager**  
*February 2021*



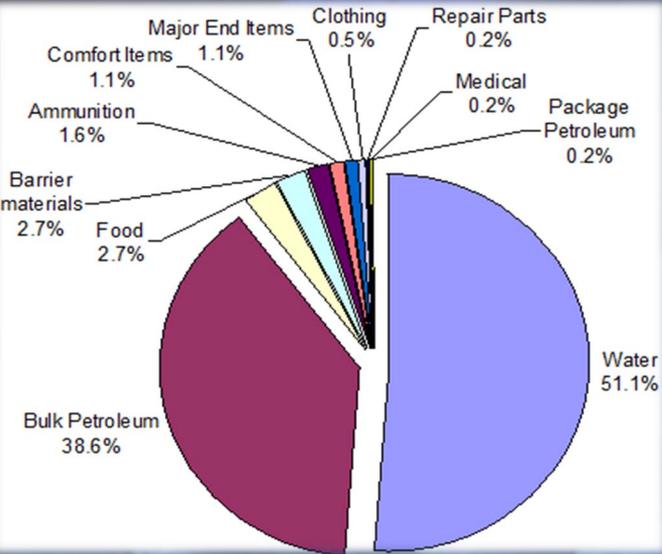
# Project Pele

- **The Department of Defense has a need for a mobile, reliable, sustainable, and resilient power source which does not require a long logistics tail**
  - Nuclear power is uniquely suited to meet these needs (2,000,000x as energy dense as diesel)
  - Need identified by 2016 Defense Science Board report, echoed in FY19+FY21 NDAA language, FY20+FY21 appropriations funding, and 2021 executive order
  - Advances in nuclear technology have made possible a largely autonomous, fully inherently safe reactor which can be safely moved by DoD
- **TRISO fuel is a game-changing technology developed by DOE**
  - Extremely resistant to meltdown/destruction
  - Changes paradigm of nuclear safety and transportation regulations
  - SCO/DOE/NASA have re-established a national TRISO production capability at BWXT
- **Two-year reactor design competition kicked off in March**
  - Full power testing of the Pele reactor is planned for the end of 2023, with outdoor mobile testing at a DOE installation in 2024



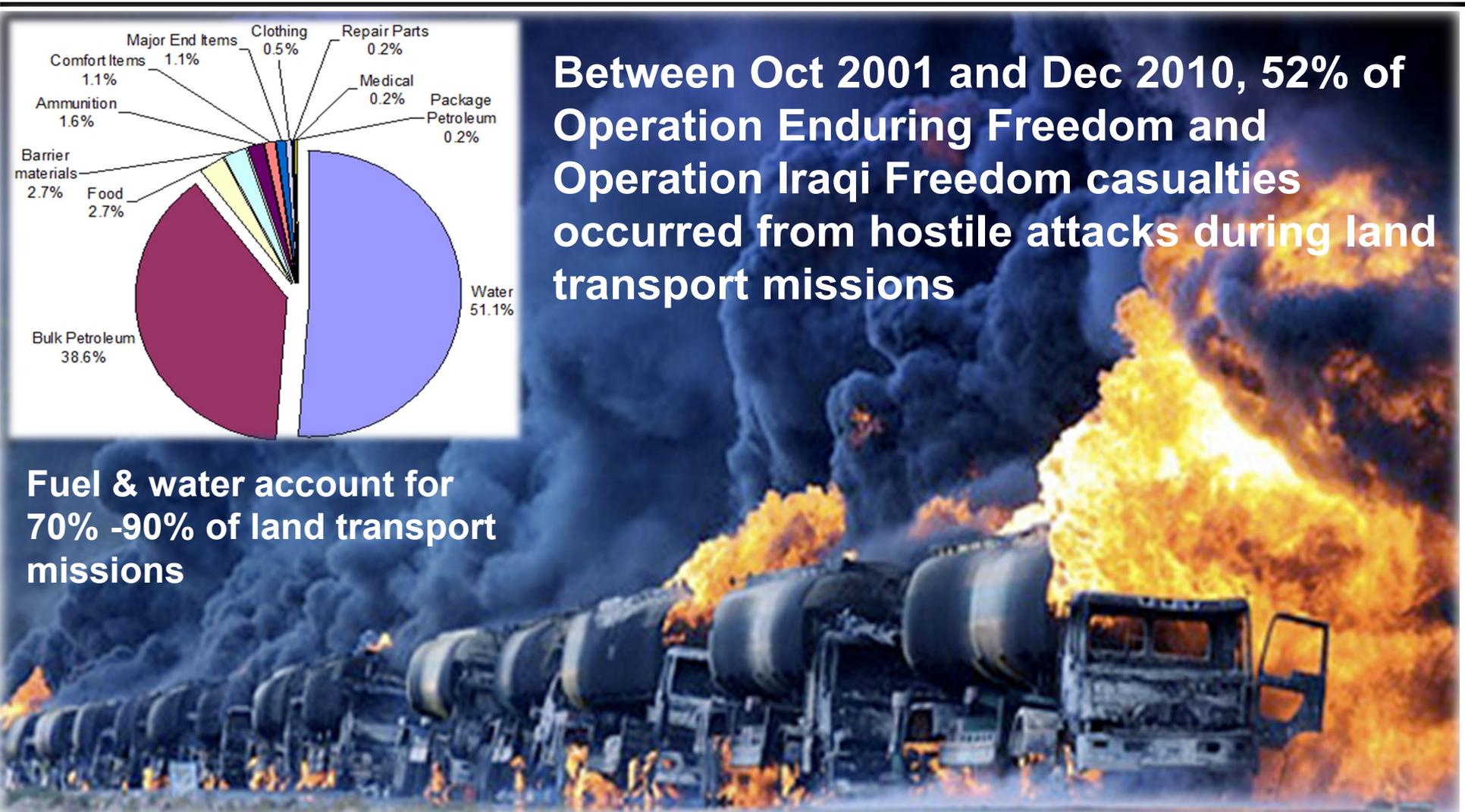


# In A War Zone, Energy Logistics Are Critical



Between Oct 2001 and Dec 2010, 52% of Operation Enduring Freedom and Operation Iraqi Freedom casualties occurred from hostile attacks during land transport missions

Fuel & water account for 70% -90% of land transport missions

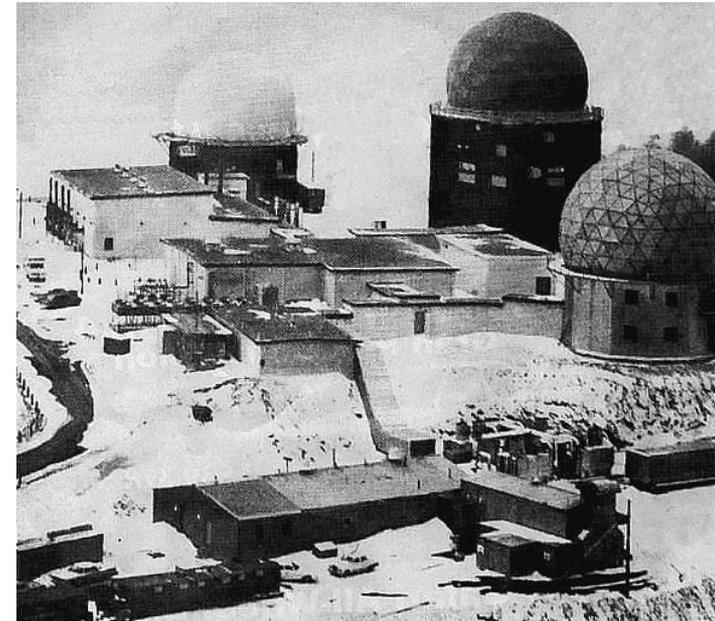


“Relieve the dependence of deployed forces on vulnerable fuel supply chains” *Commanding General, 1st Marine Division in OIF*



## *Portable Nuclear Power: An Old Idea*

- **The U.S. Army Nuclear Power Program ran from 1954 through 1977**
  - Eight reactors were constructed (five were portable), each between 1-10 MWe, of various designs and for various purposes
- **The first U.S. nuclear reactor to be connected to an electrical grid, in 1957, was an Army reactor (SM-1)**
- **As some of the earliest nuclear reactors ever built, they were technologically difficult to operate, unreliable, and too expensive relative to abundant fossil fuel alternatives**



PM-1 Nuclear Plant (PWR), Sundance Air Force Station, Wyoming, 1962-1968

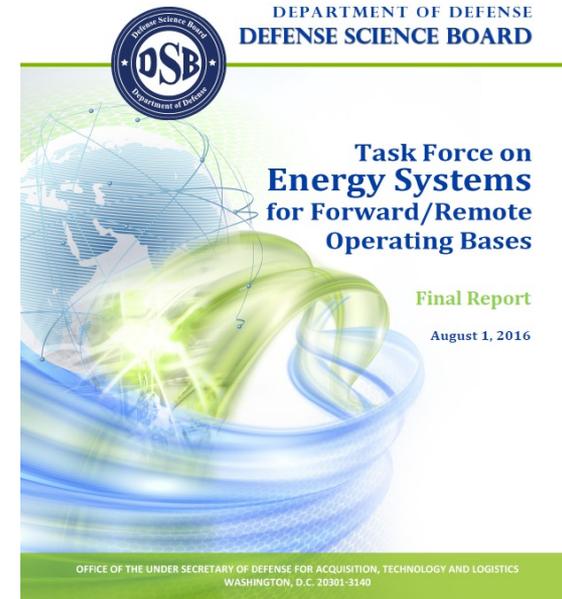


ML-1 US Army reactor, 1958, Arco, Idaho



# Portable Nuclear Power: Why Now?

- **Defense Science Board (DSB) in 2016 identified critical growing energy challenges**
  - Energy usage on the battlefield is likely to increase significantly over the next few decades making energy delivery and management a continuing challenge.
  - Exponential growth in energy demand is forcing a serious re-evaluation of DoD energy logistics
  - The study found that longer term energy solutions should support sustainment of technical superiority.
  - New modern warfighting systems (e.g. directed-energy lasers, railguns, and UAVs) have ever-increasing demands for reliable, high-density energy.
- **Significant technological advances in nuclear power since the 1960s**
  - Generation III reactors have been operating safely since 1996, and significant development and risk-reduction on Generation IV reactors is already complete.
  - Fully inherently safe reactors have been built and tested, allowing autonomous operation and eliminating meltdown risks.



***DSB Conclusion: “There is opportunity to invert the paradigm of military energy. The U.S. military could become the beneficiaries of reliable, abundant, and continuous energy through the deployment of nuclear energy power systems.”***



# *Advanced Nuclear Reactors Are Already Here*

## **Floating Nuclear Reactor** *(in service July 4, 2019)*



## **Nuclear-Powered Cruise Missile**



## **Nuclear Power Plans For South China Sea**



## **First Gen-IV Nuclear Reactor** *(first operations expected in 2021)*





# TRISO Fuel: A Paradigm Shift For Nuclear Power

- **The Advanced Gas Reactor (AGR) Fuel Development Program was initiated in 2002**

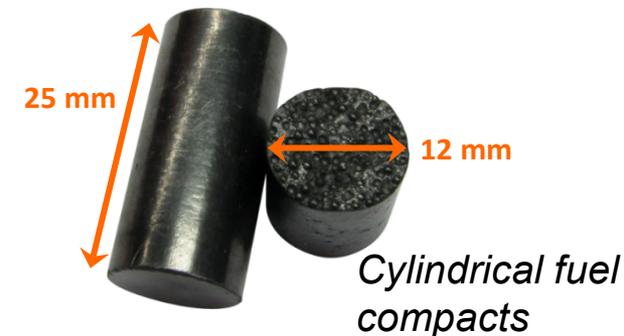
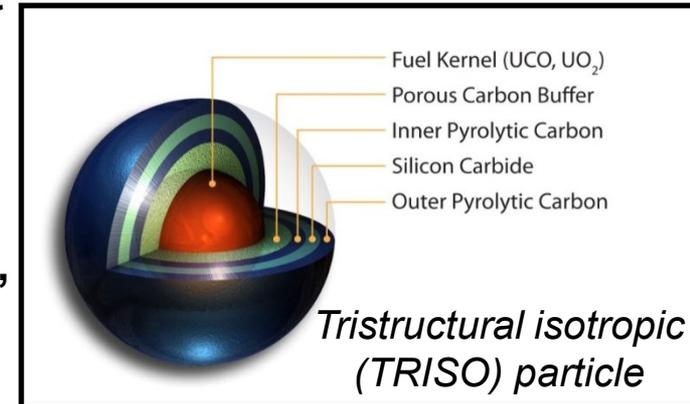
- TRISO fuel has already been subjected to rigorous testing by DoE, eliminating the need for DOD/SCO to develop or qualify a new fuel

- **Silicon carbide keeps fission products sealed inside, meaning that a containment vessel failure is no longer catastrophic**

- Design reduces diversion and proliferation risks due to low (< 20% U235) enrichment and individually coated particles
- Rugged, robust fuel structure deters use as an improvised weapon such as a dirty bomb

- **Innovative pellet design as first line of containment is a paradigm shift in safety for nuclear power**

- Standard industrial regulations could apply, significantly reducing manufacturing/safety/O&M/regulatory costs
- Pellets minimize consequences to the environment and population from events affecting structural integrity of reactor or causing release of contamination



*Kinetic impact testing of TRISO simulants is an element of Project Pele*



# Whole of Government Approach

- **Interagency collaboration is crucial in order to achieve Project Pele. This includes:**
  - Department of Energy and Nuclear Regulatory Commission are providing technical support, design/safety advice, and guidance on reducing current and future licensing risk
  - Department of Energy is providing reactor safety oversight and authorization, and through an interagency agreement is providing an extension of Price-Anderson nuclear indemnification
  - Army Corps of Engineers has technical lead on NEPA Environmental Impact Statement
  - NNSA is providing Pele with enriched uranium from its stockpile
  - NASA and Department of Energy are developing, jointly with SCO, a commercial-scale TRISO facility



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# Current Status

- **Design development is proceeding rapidly**
  - Three teams have developed a Preliminary Engineering Design (“50% design”)
  - Final engineering designs are due by March 2022, allowing construction to begin in mid-2022
  - Army Mobile Reactor Advisory Council (AMRAC) is assisting technical requirement development
  - Design efforts aided through SME team centered at Argonne National Laboratory



- **Safety oversight and legal indemnification provided through IAA with DOE:**
  - Safety Design Strategy (SDS) is completed and approved by DOE safety officials
- **Development of NEPA Draft Environmental Impact Statement (DEIS) is underway**
  - Targeting release of DEIS in late-2021
  - Final Record of Decision (ROD) is required before reactor components can be purchased
- **Uranium secured through interagency agreement with NNSA**
  - HEU from Y-12 will be downblended to HALEU
- **TRISO fuel capabilities have been re-established at BWXT**
  - Can provide fuel for DoD, space, and commercial nuclear reactors



# *Strategic Game-Changer*

- **Nuclear power has the opportunity to offer resilient, reliable energy for key missions success in both remote and strategically important locations within the United States**
  - Mobile nuclear power will allow a transformation in capabilities for the future warfighter
- **Pele would be a pathfinder to advanced nuclear reactors in the commercial sector**
  - Commercial nuclear reactors, which provide the majority of zero-carbon energy in the United States, are all direct descendants of U.S. Navy reactors
- **Nuclear power has significant technical and regulatory challenges which must be addressed**
  - e.g. regulatory regime, safety/environmental procedures, industrial supply chain, levelized cost of electricity, CONEMPs, technical requirements, and training

*It is necessary to demonstrate a full prototype nuclear reactor in order to determine the feasibility of future technology transition*