



**Savannah River
National Laboratory™**

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Mk-18A Target Recovery Program

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*2019 National Transportation Stakeholders Forum
June 2019*

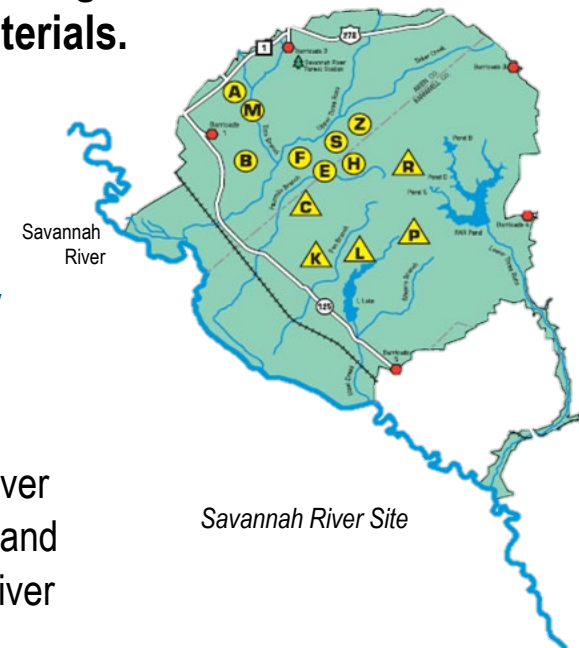
SRNL-STI-2019-00XXX

Savannah River Site Overview



SRS is a key DOE site responsible for environmental stewardship and cleanup, waste management and disposition of nuclear materials.

- ~803 square kilometers
- SRS workforce: Approximately 10,000
 - DOE-SR and DOE-NNSA
 - **Savannah River National Laboratory**
 - **Savannah River Nuclear Solutions (M&O Contractor)**
 - Other contractors include Savannah River Remediation, Centerra SRS, Parsons, and the University of Georgia (Savannah River Ecology Laboratory)
- **Total Site budget approximately \$2.4 billion**



As seen from space, SRS is an island of green in the deforested landscape.



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DOE National Laboratory System



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SRNL

at a glance

Core Competencies

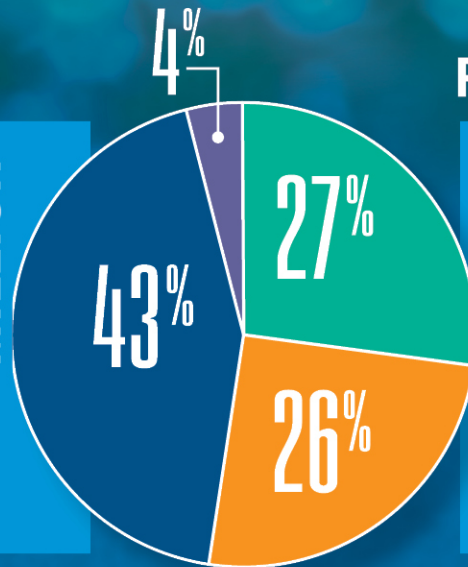
- ▶ Environmental Remediation and Risk Reduction
- ▶ Tritium Processing, Storage and Gas Transfer Systems
- ▶ Nuclear Materials Processing and Disposition
- ▶ Nuclear Materials Detection, Characterization and Assessment

980
Workforce

518
Engineers
and
Scientists

198
Ph.Ds

\$249 MILLION
FY 2017 Overall
Lab Budget



Program Areas

- ◀ Environmental Stewardship
- ◀ National Security
- ◀ Nuclear Materials Management
- ◀ Secure Energy Manufacturing

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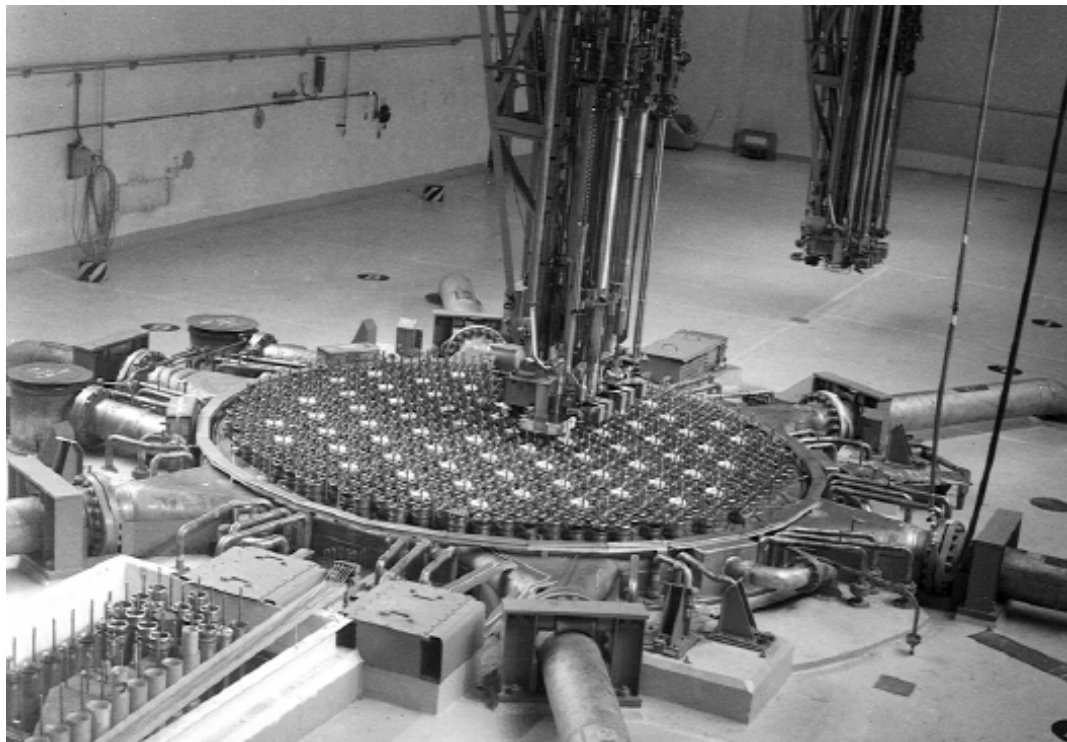
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What is a Mk-18A?

- The Mk-18A targets were part of a campaign to use the high-flux characteristics of K Reactor in an effort to produce isotopes for the benefit of mankind
- Plutonium-242 targets were loaded into the reactor to produce Californium-252, but an unintended byproduct of this high-flux irradiation was Pu-244 (as well as Cm-244, Cm-246, and Cm-248 among other isotopes/fission products)
- Cm-246/248 is a feedstock for HFIR Cf production (@Oak Ridge National Lab)



Why Not Just Go Make Pu-244?

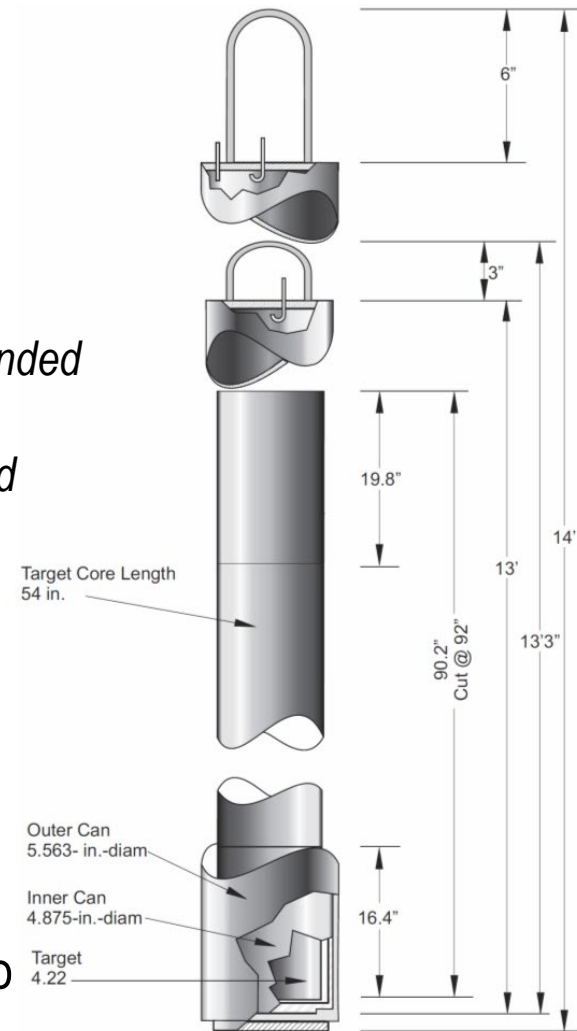
105	Db 246 7.5e-11s	Db 247 1.86e-10s	Db 248 4.73e-09s	Db 249 1.03e-08s	Db 250 1.17e-07s	Db 251 8.65e-07s	Db 252 3.77e-05s	Db 253 0.000179s	Db 254 0.0135s	Db 255 1.6s	Db 256 1.6s	Db 257 1.5s	Db 258 20s	Db 259 0.51s	Db 260 1.52s
104	Rf245 1.41e-09s	Rf246 1.18e-12s	Rf247 2.14e-08s	Rf248 1.61e-10s	Rf249 1.62e-05s	Rf250 9.73e-09s	Rf251 0.000442s	Rf252 2.14e-05s	Rf253 0.013s	Rf254 2.3e-05s	Rf255 1.68s	Rf256 0.0064s	Rf257 4.7s	Rf258 0.012s	Rf259 3.2s
103	Lr244 4.72e-08s	Lr245 3.3e-07s	Lr246 1.78e-05s	Lr247 3.15e-05s	Lr248 0.0492s	Lr249 0.0244s	Lr250 0.191s	Lr251 0.101s	Lr252 0.36s	Lr253 1.49s	Lr254 13s	Lr255 22s	Lr256 27s	Lr257 0.646s	Lr258 4.1s
102	No243 2.97e-06s	No244 1.01e-08s	No245 0.00288s	No246 1.16e-05s	No247 0.0857s	No248 0.0172s	No249 5.4e-05s	No250 5.6e-06s	No251 0.93s	No252 2.27s	No253 1.62m	No254 51s	No255 3.1m	No256 2.91s	No257 24.5s
101	Md242 0.00163s	Md243 0.00738s	Md244 0.724s	Md245 0.35s	Md246 1s	Md247 1.12s	Md248 7s	Md249 24s	Md250 52s	Md251 4m	Md252 4.8m	Md253 12m	Md254 28m	Md255 27m	Md256 1.283h
100	Fm241 0.00073s	Fm242 0.0008s	Fm243 0.18s	Fm244 0.0033s	Fm245 4.2s	Fm246 1.1s	Fm247 29s	Fm248 36s	Fm249 1.6m	Fm250 33m	Fm251 5.3h	Fm252 1.058d	Fm253 3d	Fm254 3.24h	Fm255 20.07h
99	Es240 8.19s	Es241 8s	Es242 43.5s	Es243 21s	Es244 37s	Es245 1.1m	Es246 7.7m	Es247 4.55m	Es248 27m	Es249 1.703h	Es250 8.6h	Es251 1.375d	Es252 1.291y	Es253 20.47d	Es254 275.7d
98	Cf239 39s	Cf240 57.6s	Cf241 3.78m	Cf242 3.49m	Cf243 10.7m	Cf244 19.4m	Cf245 45m	Cf246 1.487d	Cf247 3.11h	Cf248 333.5d	Cf249 351y	Cf250 13.08y	Cf251 898y	Cf252 2.645y	Cf253 17.81d
97	Bk238 2.4m	Bk239 1.51m	Bk240 4.8m	Bk241 4.6m	Bk242 7m	Bk243 4.5h	Bk244 4.35h	Bk245 4.94d	Bk246 1.8d	Bk247 1380y	Bk248 9y	Bk249 320d	Bk250 3.212h	Bk251 55.6m	Bk252 1.8m
96	Cm237 3.97m	Cm238 2.4h	Cm239 2.9h	Cm240 27d	Cm241 32.8d	Cm242 162.9d	Cm243 29.1y	Cm244 18.11y	Cm245 8500y	Cm246 4760y	Cm247 1.56e+07y	Cm248 3.48e+05y	Cm249 1.069h	Cm250 9700y	Cm251 16.8m
95	Am236 3.6m	Am237 1.227h	Am238 1.633h	Am239 11.9h	Am240 2.117d	Am241 432.6y	Am242 141y	Am243 7370y	Am244 10.1h	Am245 2.05h	Am246 39m	Am247 23m	Am248 3.13m	Am249 44.1m	Am250 43.9s
94	Pu235 25.3m	Pu236 2.858y	Pu237 45.2d	Pu238 87.7y	Pu239 2.41e+04y	Pu240 6561y	Pu241 14.29y	Pu242 3.74e+05y	Pu243 4.956h	Pu244 8.11e+07y	Pu245 10.5h	Pu246 10.84d	Pu247 2.27d	Pu248 48.3m	Pu249 1.58m
93	Np234 4.4d	Np235 1.085y	Np236 1.54e+05y	Np237 2.14e+06y	Np238 2.117d	Np239 2.356d	Np240 1.032h	Np241 13.9m	Np242 5.5m	Np243 1.85m	Np244 2.29m	Np245 2.29m	Np246 14.5s	Np247 27.7s	Np248 6.11s
92	U 233 1.59e+05y	U 234 0.0055s	U 235 0.72s	U 236 2.34e+07y	U 237 6.75d	U 238 99.2745s	U 239 23.45m	U 240 14.1h	U 241 45.6m	U 242 16.8m	U 243 3.04m	U 244 2.66m	U 245 29.2s	U 246 22.6s	U 247 7.54s
91	Pa232 1.32d	Pa233 26.98d	Pa234 6.7h	Pa235 24.1m	Pa236 9.1m	Pa237 8.7m	Pa238 2.3m	Pa239 1.8h	Pa240 20.1s	Pa241 32.3s	Pa242 6.77s	Pa243 7.18s	Pa244 2.59s	Pa245 2.77s	Pa246 1.18s
90	Th231 1.063d	Th232 100	Th233 22.3m	Th234 24.1d	Th235 7.1m	Th236 37.3m	Th237 4.7m	Th238 9.4m	Th239 35.4s	Th240 33s	Th241 7.08s	Th242 5.76s	Th243 2.81s	Th244 2.49s	Th245 1.3s
89	Ac230 2.033m	Ac231 7.5m	Ac232 1.983m	Ac233 2.417m	Ac234 44s	Ac235 49s	Ac236 7.51s	Ac237 10.5s	Ac238 2.87s	Ac239 3.05s	Ac240 1.13s	Ac241 1.34s	Ac242 0.684s	Ac243 0.704s	Ac244 0.396s

- Plutonium-244 is made from neutron bombardment of Pu-239
- Pu-243 has a half life of ~5 hours, so it is not likely to be made in a ordinary power reactor in significant forms (need very high flux)
- Since there are no reactors readily capable of replicating production of Pu-244, getting these materials now, before they are permanently dispositioned, is imperative



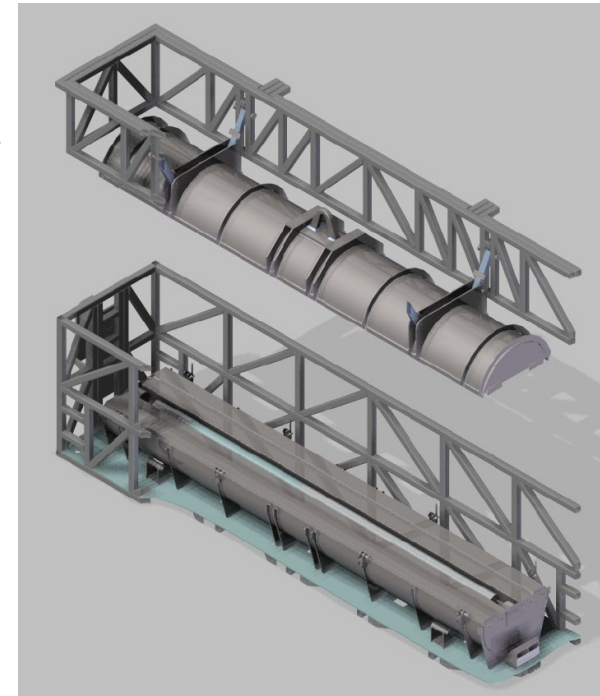
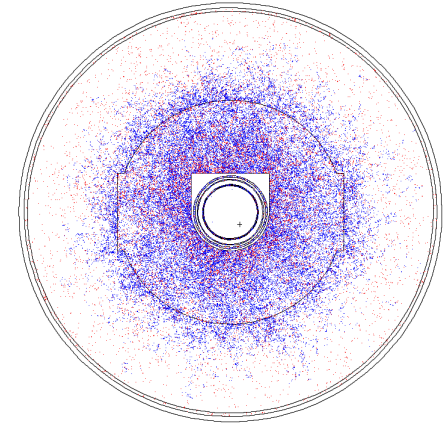
Onsite Transfer

- **65 Mk-18A Targets stored in L-Basin will be transferred onsite to SRNL**
 - The target assemblies are currently stored in L-Basin in a double-J-Can configuration
 - Radiological concerns
 - *The Mk-18A Targets were subjected to irradiation for an extended period and they are still very “hot”*
 - *Thus, there is a need for shielding material to be incorporated into the transfer package*
 - *However, there is not a criticality concern (low mass of fissile material)*
 - Transfers will be made “one-at-a-time” due to MAR restrictions at SRNL
 - A new, onsite-only transfer cask was designed and built to perform this task



Cask Design Parameters

- In addition to utilizing existing facilities without significant modifications, there are other parameters that have been considered:
 - SRNL overhead track crane has a 10-Ton (maximum) lift capacity
 - The bare target can not be exposed to personnel at any time (must provide shielding)
 - *Contact dose of the worst case target is roughly 2,500 Rem*
 - The cask and shield must interface with the shielded cell facility
 - The cask and shield must integrate with the Documented Safety Analyses (DSA) for each facility
- Neutron Radiation and Gamma Radiation must both be shielded
 - The Mk-18A Cask utilizes stainless steel for gamma shielding and Borated Polyethylene for neutron shielding



Mk-18A at SRS L-Area



Mk-18A Cask Table

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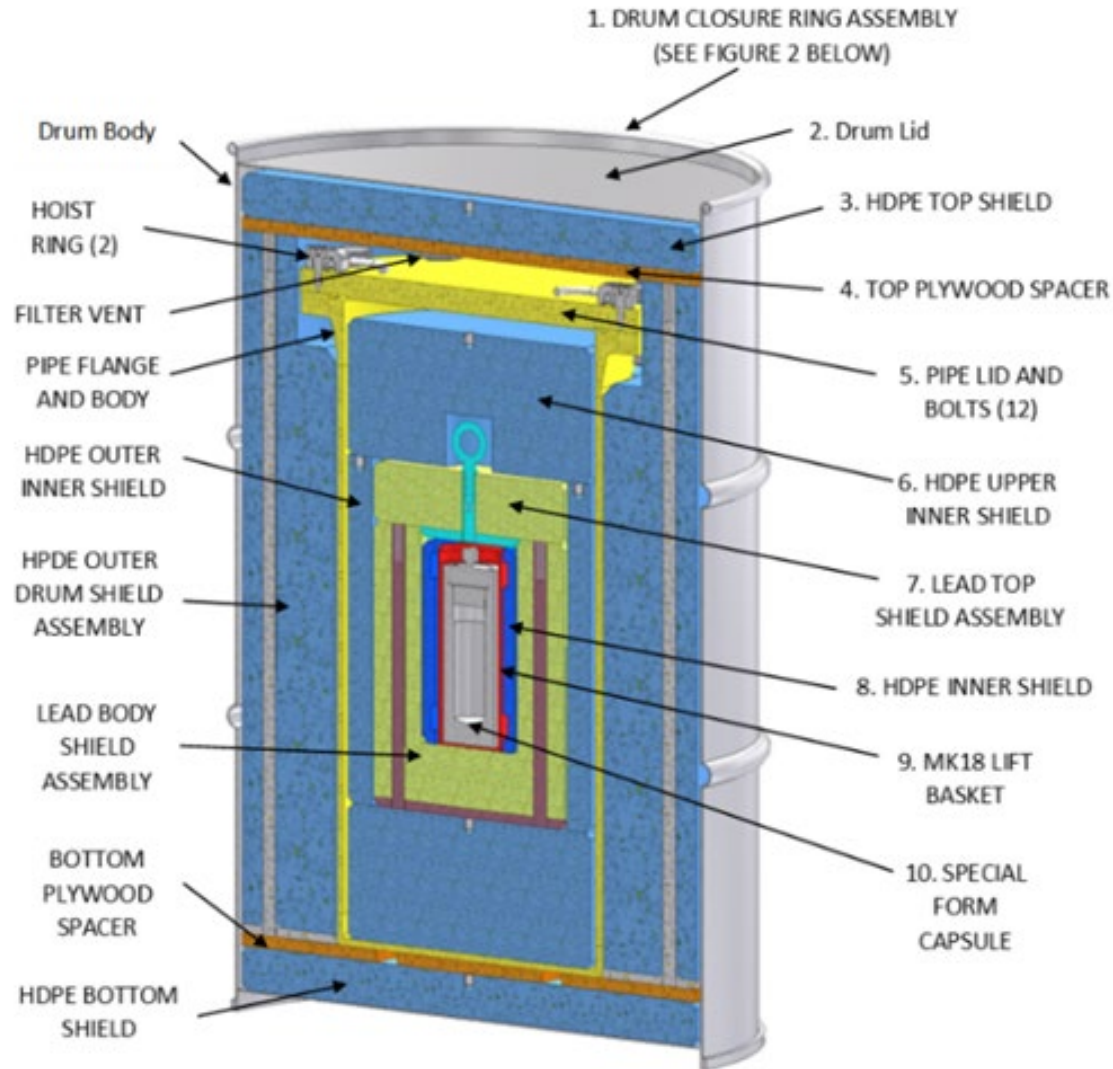
Mk-18A Modified Robotic Loading Arm



Animation of Mk-18A Onsite Transfer

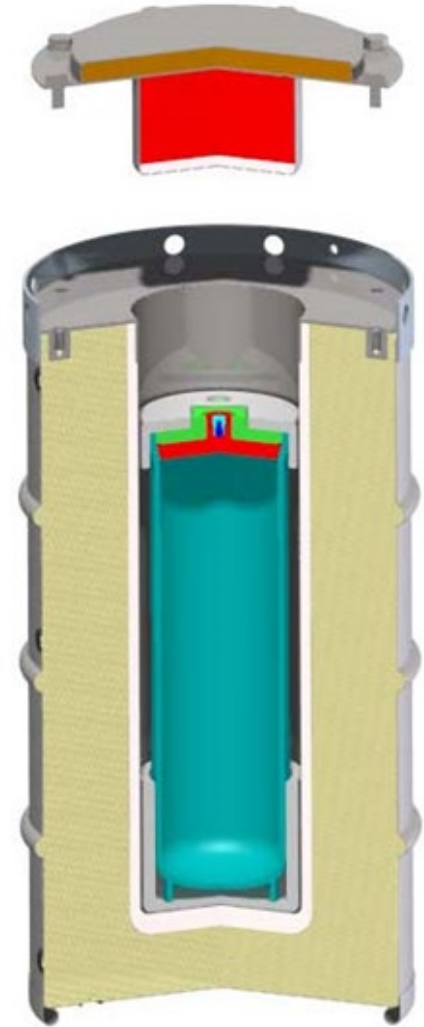


Mk-18A Type-A Shipping Package



9977 Shipping Package

- Shipments of Plutonium from SRNL to ORNL
- Widely utilized in the DOE Complex for Plutonium and other nuclear materials



Questions

