Remote Radiography Facility

SAND2018-2797C

- Sandia's Radiography Department operates a remote facility for handling large, DU-containing test items containing large amounts of high-explosives.

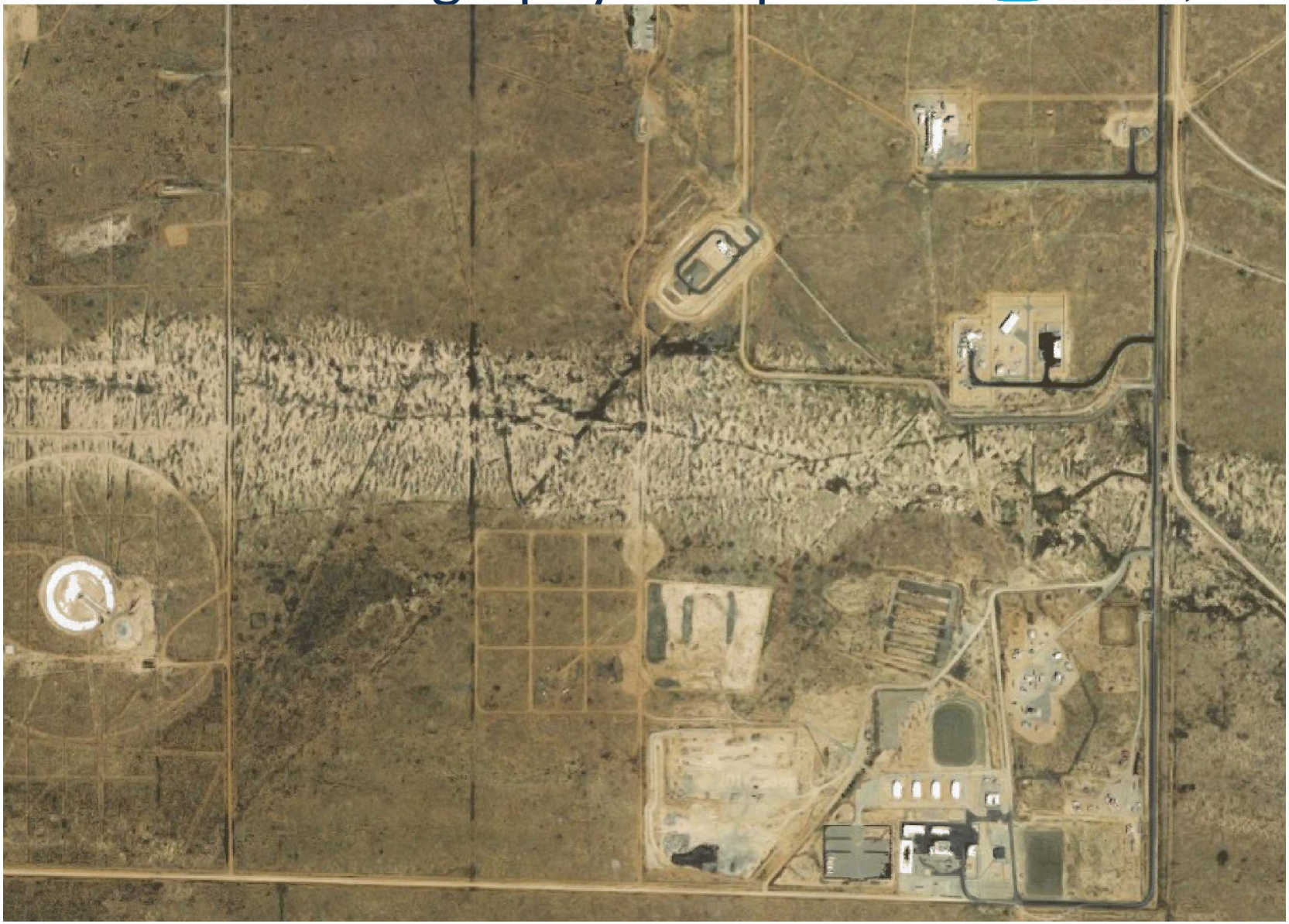
- The facility currently houses a 6 MeV LINAC and smaller radiography devices.

- Spring of 2017 evaluations for installing a 9 MeV LINAC began.

TA-3 & the Radiography Compound

Sandia National Laboratories

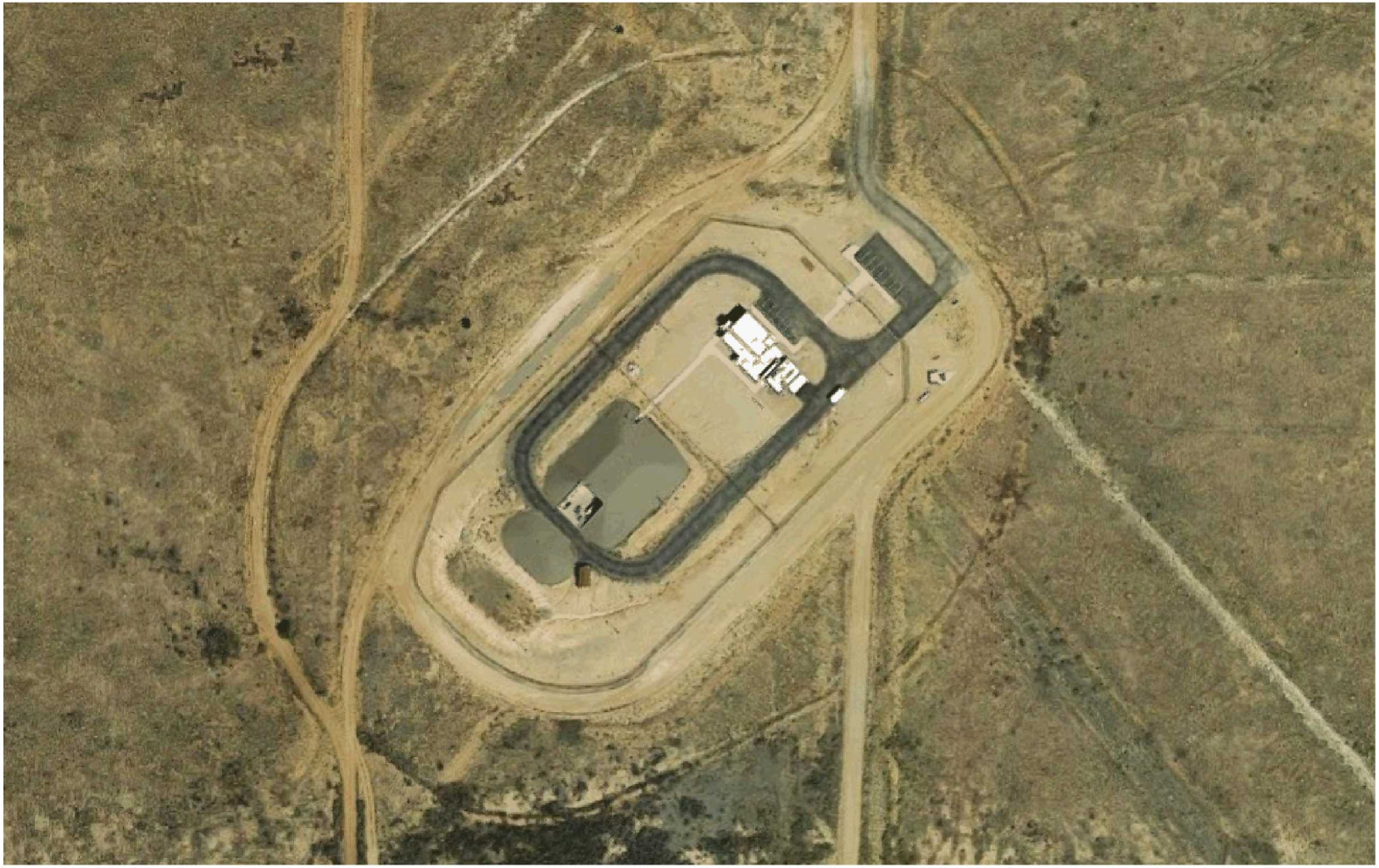
ENVIRONMENT SAFETY & HEALTH



TA-3 Radiography Compound

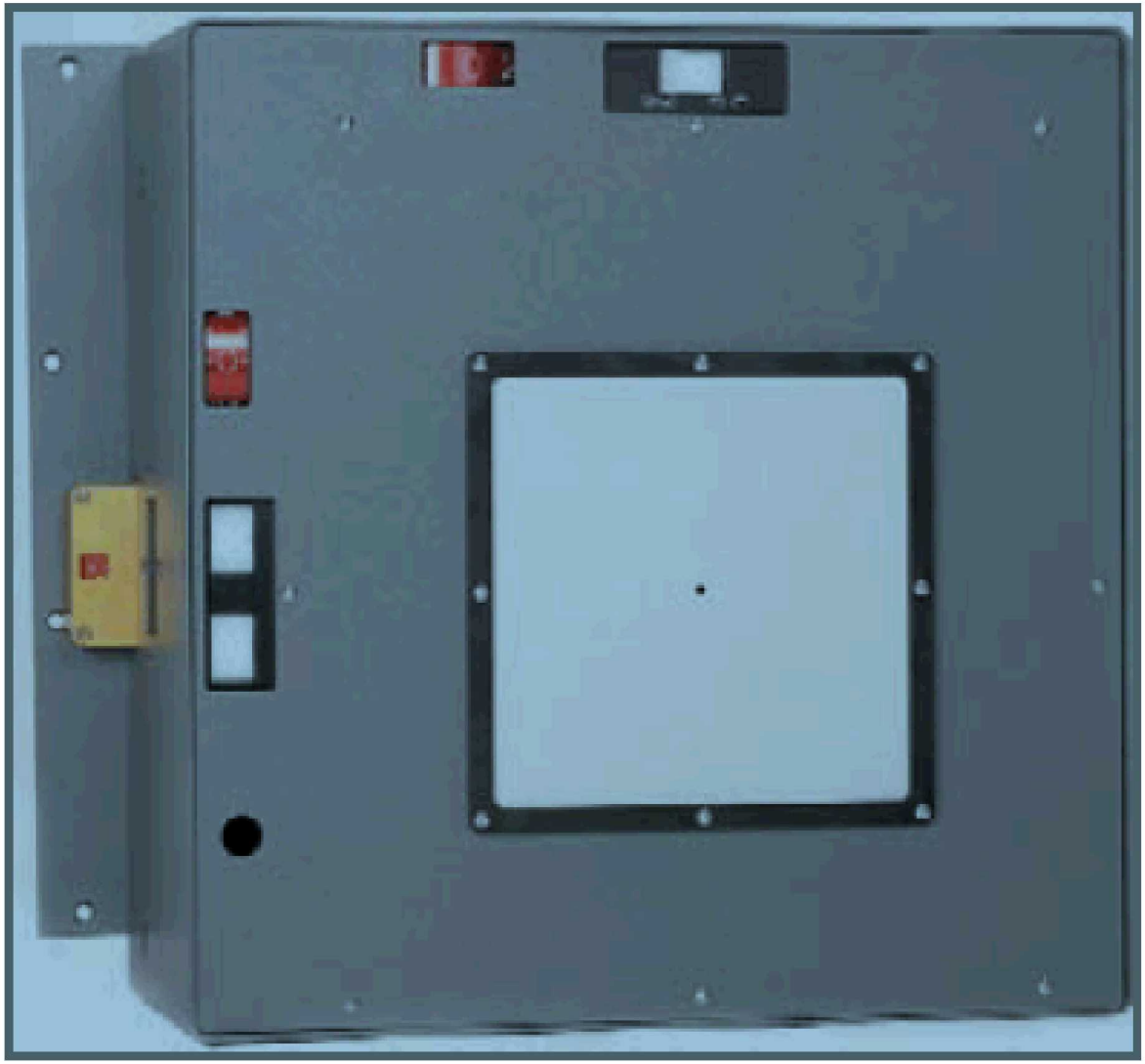
Sandia National Laboratories

ENVIRONMENT SAFETY & HEALTH



Picture of Varex 6/9 MeV LINAC

External Collimator



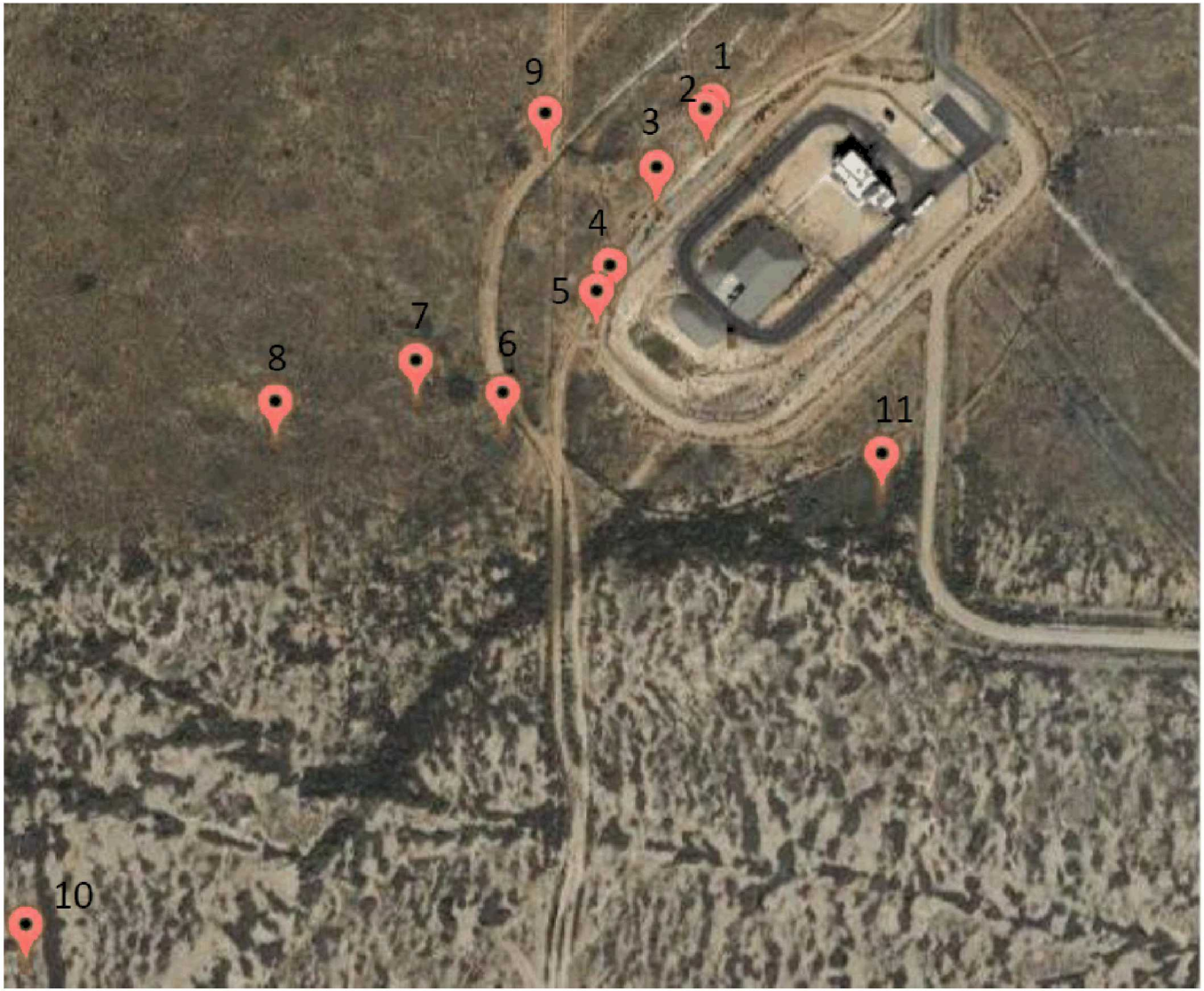
Varex 6/9 MeV LINAC Information

- Capable of operating at 6 or 9 MeV
- Variable pulse rate
- Can produce 3,200 R/minute at one meter
- Equipped with a 5-inch thick tungsten collimator
- Oak Ridge estimated their 9 MeV LINAC would produce ~1E9 neutrons/second (comparable to a Thermo 14 MeV neutron generator)
- Capable of C/T operation

Skyshine Estimate

- The Radiography Department did not want a radiation area extending outside their compound fence.
- A Hesco 6 MeV LINAC in the radiography high bay was operated at full output, uncollimated while RCTs mapped skyshine outside the radiography compound.
- RCTs searched for locations where the Hesco output scaled to the Varex 9 MeV output would be a Radiation Area boundary.
- Locations were mapped using GPS coordinates.
- The results indicated additional shielding was needed and the Varex beam should not shine above the beam stop.

Hesco 6 MeV LINAC Skyshine



Varex 6/9 MeV Skyshine

- During startup if the Varex 6/9 MeV LINAC, operators ran it at the lowest pulse rate, at 6 MeV with the collimator almost closed.
- RCTs surveyed the compound fence line during operation.
- The collimator could not be opened more than seven degrees without creating a radiation area outside the compound fence line.
- The LINAC is restricted to this configuration until additional shielding is installed.

Photonuclear Effects

- (gamma, n) reactions occur in heavy elements when the Varex 6/9 MeV LINAC is operated at 9 MeV.
- Photoneutrons are produced in the tungsten collimator by photons exceeding 8.1 MeV.
- W-181 will be produced.
- W-181 decays with a 121.2 day half-live via electron conversion.
- W-181 may be undetectable with field instruments.
- The collimator is controlled as radioactive material due the certainty of W-181 production.

Photoneutron Effects

- No neutron radiation detected at the radiography facility compound fence line
- A rem ball placed where a maze entered the high bay read 200 mrem/hr.
- The tungsten collimator read 14,000 cpm with a RadeyeSX / SHP380 AB probe immediately after 9 MeV operation decreasing to 4,500 cpm in five minutes.
- Concern about nearby ferrous metals becoming volumetrically activated. (Coupons installed on collimator)
- Vender technicians unaware their equipment produced radioactivity.

Photofissioning

- 6.1 MeV photons cause uranium to fission
- Pantex experience with its 9 MeV LINAC and plutonium showed no detectable increase in external radiation.
- DU photofissions less readily than plutonium
- Sandia does not expect contact handling issues with its DU parts. (DU parts will be surveyed after irradiation.)
- Experience with the 20 MeV, Hermes-III accelerator shows that short-lived fission products in DU decay to undetectable levels with field instruments in ~2-days.
- Some groups will not allow irradiation of their DU parts at >6 MeV.

Operational Impacts

- Shielding must be increased
- Collimator must be managed as radioactive material
- Volumetric activation of metals in irradiation high bay to be monitored
- Radiography must now management in the radioactive material.
- Photofissioning of DU parts a concern