

## Background and Applications

Los Alamos National Laboratory (LANL) is a prestigious government-funded facility dedicated to national security, with a particular focus on the development and maintenance of the U.S. nuclear stockpile.

- Interlocks prevent malicious attacks and requires a trained user to operate effectively
- This prototype is not application-specific, and can be adapted to diverse scenarios
- Potential use case: secure nuclear waste barrels during transit to disposal sites

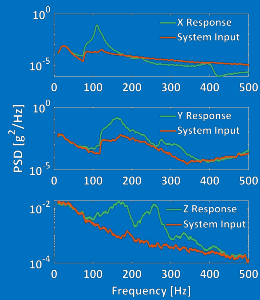
## Design Requirements and Specifications

General	Security	Non-Operating Conditions
✓ Size < 6" x 6" x 6"	✓ 8-bit security	✓ IP55 dust and water ingress
✓ 100 total cycles over 10-year lifetime	✓ At least 1 mechanical input and 1 electrical input	✓ Withstands up to 50g shock
✓ Operates between 20-100° F	✓ Device translates a locking pin	✓ Withstand over-the-road transport vibration
✓ Fail-safe must be reset under 10 mins	✓ Incorporates a fail-safe upon any incorrect input	✓ Withstands a static load of 250 lbs. on any axis

## Requirements Testing and Characterization

### Vibration Testing

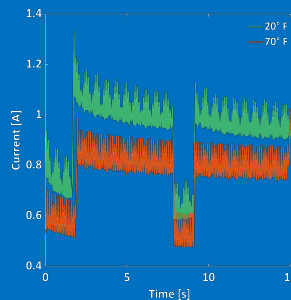
- Device response vs. input frequencies as set by MIL-STD-810G for over-the-road transport



- Visible system resonance during each testing axis
- System remained operational and experienced no visible damage

### Current Characterization

- Measured current over time before and after each qualification test
- Plots compared to show changes in trends

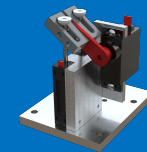


- Higher current caused by increased oil viscosity and lessened resistance in electrical components
- Current pattern remained consistent

## Design Overview

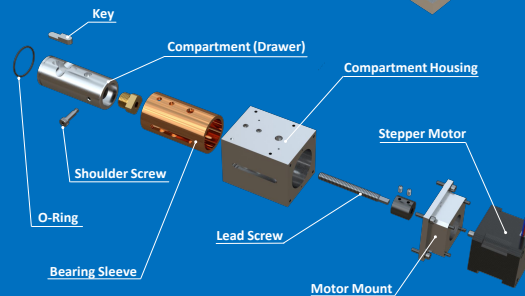
- Final form factor of 4" x 5" x 5"
- 6061 aluminum enclosure fastened together with 24 button head screws
- 4 major subassemblies
- 37 custom machined components
- 5.8 lbs. total
- Externally powered
- Water and dust resistant
- Capable of 50-bit security (1 in one quadrillion chance of guessing key)

### Probe Assembly

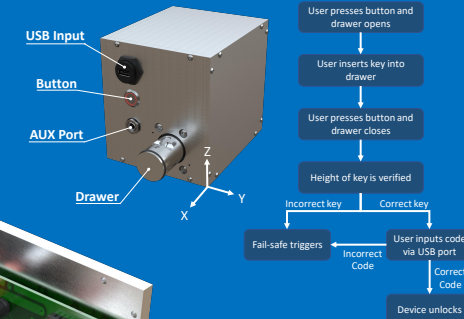


- Measures key heights with two linear potentiometers
- Capable of 50-bit security through 0.005" height measurements

### Compartment Assembly



## User Operation Sequence



### Fail-safe

- Sear rotates, releasing shear pin
- Activation locks drawer and compartment together
- Easily resettable by trained user



### Spring loaded shear pin

### Custom PCBA



- Voltage regulation to enhance performance
- Arduino Micro for control logic
- Tuned motor driver for faster drawer actuation
- Latching relay failsafe

## Next Steps and Impact

- Decrease form factor to 3" x 3" x 3"
- Weld panels for increased tamper resistance
- Integrated current sensing for problem diagnosis
- Encoders/ limit switch to determine drawer location
- Internally powered
- LANL is excited with this design and eagerly anticipates the diverse range of future applications it will enable