

Ground Support Equipment

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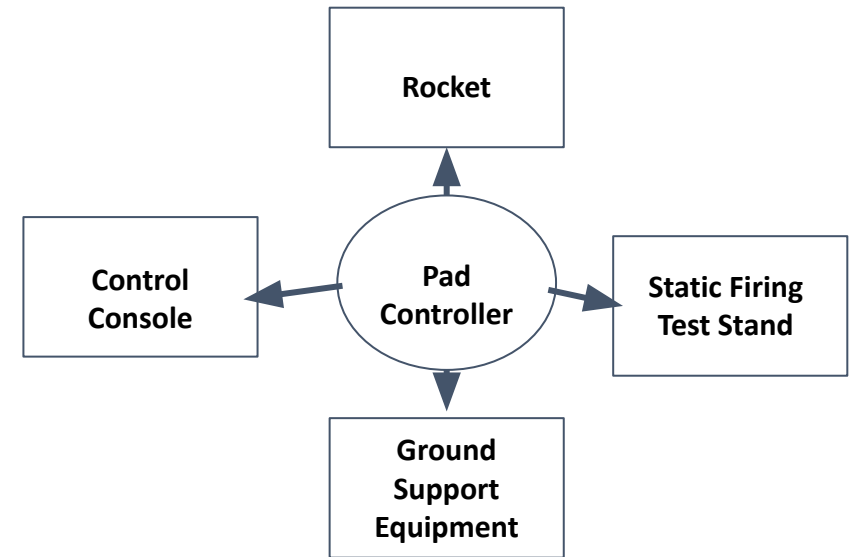
ACADEMIC-INDUSTRY
LIQUID ROCKET SYMPOSIUM **2023**



Control Console

- Displays Safety Critical Parameters to Operator
- Allows Operator to
 - Command Safety Critical Commands
 - Command Hazardous Commands
- Prevents Inadvertent Commands
 - Two-Step Commanding
- Interfaces with Pad Controller
- Safing Key
 - Enabled when installed
 - Disabled when removed

Pad Controller



- Interfaces Between
 - Control Console
 - Rocket
 - Static Firing Test Stand
 - Ground Support Equipment
- Commands and Monitors All Functions
- Safety Functions
 - Monitors Safety Critical Parameters
 - Commands Safety Critical Commands
- Commands hazardous commands
- Manages propulsion pressurant loading and unloading
- Manages rocket umbilical disconnect
- Safing key
 - Enables hazardous commanding when removed
 - Disables hazardous commanding when inserted

Computers and Components Overheat At High Temperatures ($>100^{\circ}\text{F}$)

- Use industrial grade components if possible
 - Rated from -40°F to 185°F
- Keep in the shade
- Paint boxes white for direct sunlight exposure
- Supply ventilation and fans
 - Gets heat out
- Supply cooling
 - Cold pack
 - Electric cooler

Pad Boxes Are Easily Damaged In Fires

- Protect in Steel Box
 - Plastic Melts and Burns
- Wrap Control Wires and Hoses in Fireproof Material

Safety Critical Parameter Monitoring

- Always monitor while crew is on the pad
- Propellant tanks
 - Safe approach pressure
 - Propellant tank pressures < 120-PSI

- Pressurant tank
 - Compression heating
 - Safe approach pressure and temperature
 - Pressure < rated pressure
 - Temperature < rated temperature

Always Allow Safety Critical Commands

- Commands:
 - Pressurant Off
 - Igniter Off
 - Main Valves Closed
 - Propellant Tank Vents Open

Hazardous Commands

- **Commands**
 - **Pressurant On**
 - Overpressure tanks and burst
 - **Igniter On**
 - Inadvertent ignition and fire
 - **Main Valves Open**
 - Inadvertent dumping propellant, fire, and explosion
- Always disable while crew is on the pad
- Disabled by safing key at pad controller
- Enabled by safing key at control console

Pyrotechnic Igniter Control

- Hazard Inadvertent Ignition and Fire
- Control Features
 - Check Function
 - Continuity

- Control Features
 - Prevent Inadvertent Ignition
 - Interrupt Power
 - Interrupt Return
 - Prevent Ignition due to Static Discharge
 - Short and Ground Power and Return

Safing Key

- Prevents inadvertent hazardous commands
- Same key interlock controls hazardous commands
 - Key enables control console
 - Key disables pad controller

Emergency Safing System

- Hardwired
- Operates independent of pad controller
 - Has an internal battery
- Commands all
 - Safety critical
 - Hazardous commands

Remote Emergency Depressurization System (REDS)

- Hardwired
- Operates independent of pad controller
 - Has an internal battery
- Only commands tank vents open to reduce tank pressures to safe levels