SAND2006-7301P

Power-free Pump Module (PPM)
and the
Power-free Gas Sampler (PGS)

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S. M. Thornberg and Jason Brown, 01825
844-8710

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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Outline

- Requirements/current status
- Approach
- Goals
- Power-free Pump Module (PPM)
- Power-free Gas Sampler (PGS)
- Conclusion

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Overview of the problem

Enhanced Surveillance Program seeks to maximize information extracted from warhead gases and predict material failures

Enhanced Gas Analysis for Diagnostics and Surveillance

Requirements:

Gas sampling of weapons is required during disassembly and inspection. One system requires leak testing of specific seals.

Current status:

The only qualified leak test and gas sampling carts use A/C power. (The only battery-powered sampler is not capable of performing the leak test operations nor able to meet moisture measurement specifications. It is also quite bulky and has numerous manual valves.)

Problem:

- Very difficult to qualify and use A/C-powered equipment for operations that connect to a weapon
- Lightning warnings cause much down-time (power down, disconnect, restart)
- Constraints are increasing, not decreasing.

Internal atmosphere provides the environmental boundary condition within which all non-hermetic materials and components age

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Approach

Start with a clean slate!

Design to meet safety and technical requirements

Learn from history. Keep the good features of the:

- **Blue goose**
- **W80 Field Portable Gas Sampler**
- **Phoenix**
- **Viper**
- **T-461**

Design to meet the challenges of production environment

Make operation as simple as possible

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Desired characteristics in new sampler

Goal	Benefit
Eliminate power (inc. batteries)	Can continue operations during lightning warnings
Simplify design	Easy to maintain, more reliable
Provide gas sampling capability	Able to meet requirements
Provide leak test capability	Able to meet requirements
Make valve operations simpler	Less chance for error and damaging manual valves
Move sampler preparation operations out of the bay	Save production-line time, reduce training for PTs
Define tolerance stack-ups during design phase	Ensure requirements can be met
Move preparation operations out of the bay	Save time, less training, keep gas operations with gas experts
Make design modular	Upgradeable, versatile

Description
Power-free Pump Module (PPM)

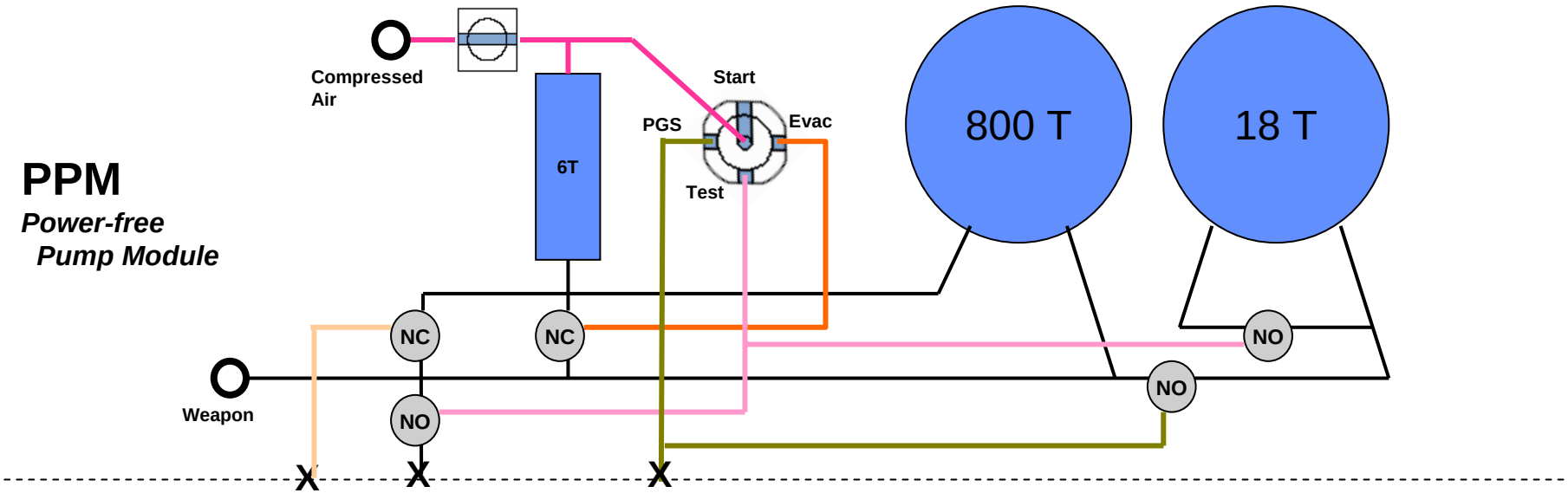
Connections:

- Weapon via WSPA
- Compressed air

Functions

- Provide a modest vacuum of <10 Torr
- Absolute pressure measurement
- Pressure-rise leak test (< 10^{-3} atm cc/s, depending on volumes)
- Provide interface to gas sampler module (PGS) from the weapon
- Pneumatically-operated manifold valves controlled through a simple multi-port ball valve

Schematic
Power-free Pump Module (PPM)



"Simplified" Procedure (already attached to weapon)

- Attach compressed air and turn CA valve to ON
- Turn valve to EVAC, wait xx minutes
- Turn valve to TEST, start timer
- After yy minutes, record pressure rise.
- (Repeat previous 3 steps as needed)

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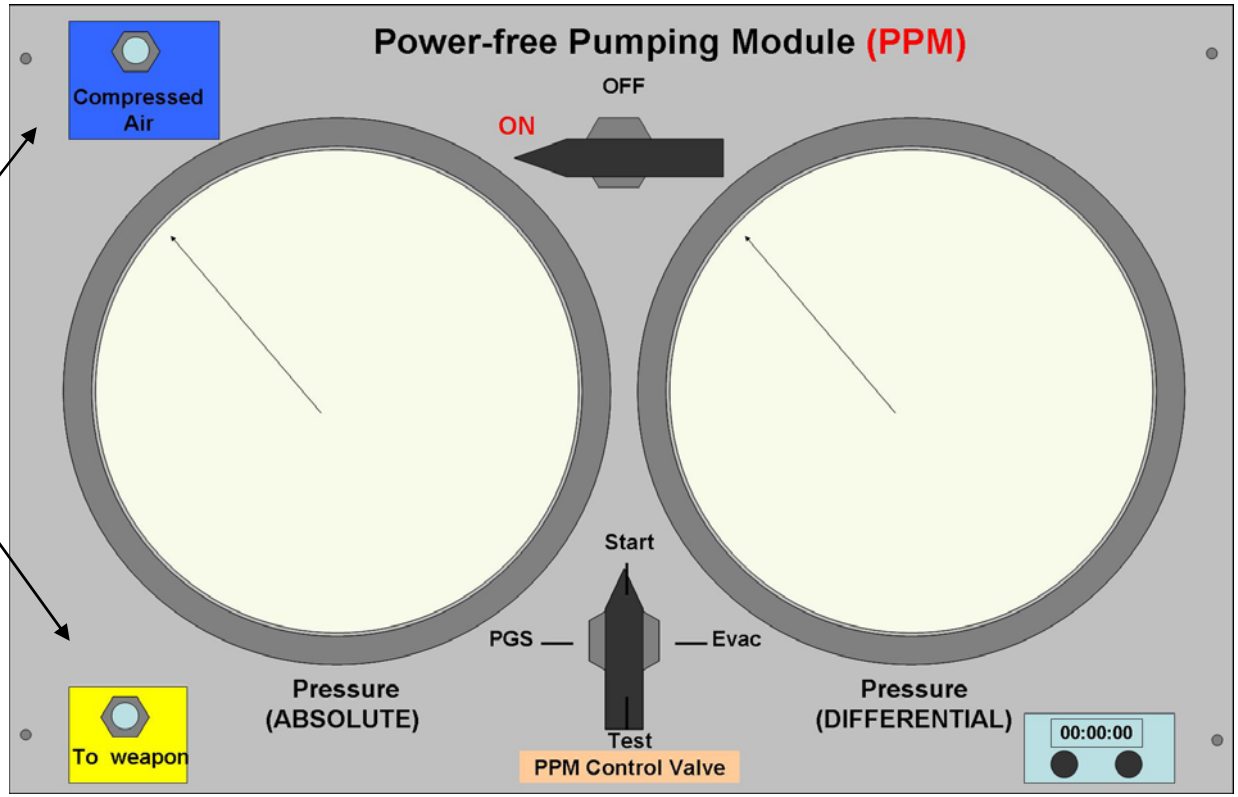
Operation Panel
Power-free Pump Module (PPM)

Only two connections are made in the bay.



Only two valves control all leak test operations.

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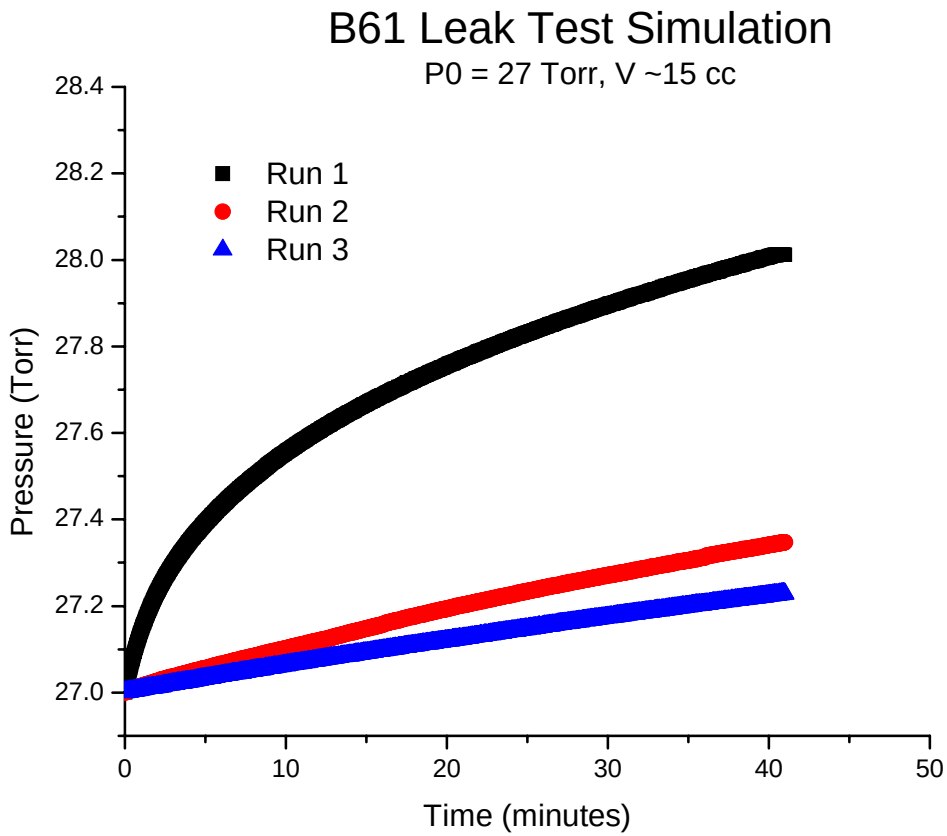
Prototype Results

Prototype results from many tests performed at Sandia and Pantex show this power-free approach viable.

The plot shows a leak test measuring outgassing in the 10^{-4} atm cc/s range.



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Thoughts about battery vs. dial gauges
Power-free Pump Module (PPM)

Battery gauges:

- Easy to read
- Battery gauges can provide great accuracy; however
  - Very costly (~$6,000 each)
  - Powered (C-cell)
- Require more justification in changing safety environment

Dial gauges

- Power-free
- More difficult to read correctly
- Larger than battery-powered gauges

Decision

- Battery-power may be OK now, but may not be in the future. SO, the decision is to go with the dial gauges (consistent with "Eliminate power").

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Description
Power-free Gas Sampler (PGS)

Connections (all under the panel):

- *None are made in the bay*
- In Gas Lab:
  - Two compressed air connects
  - One vacuum manifold connection

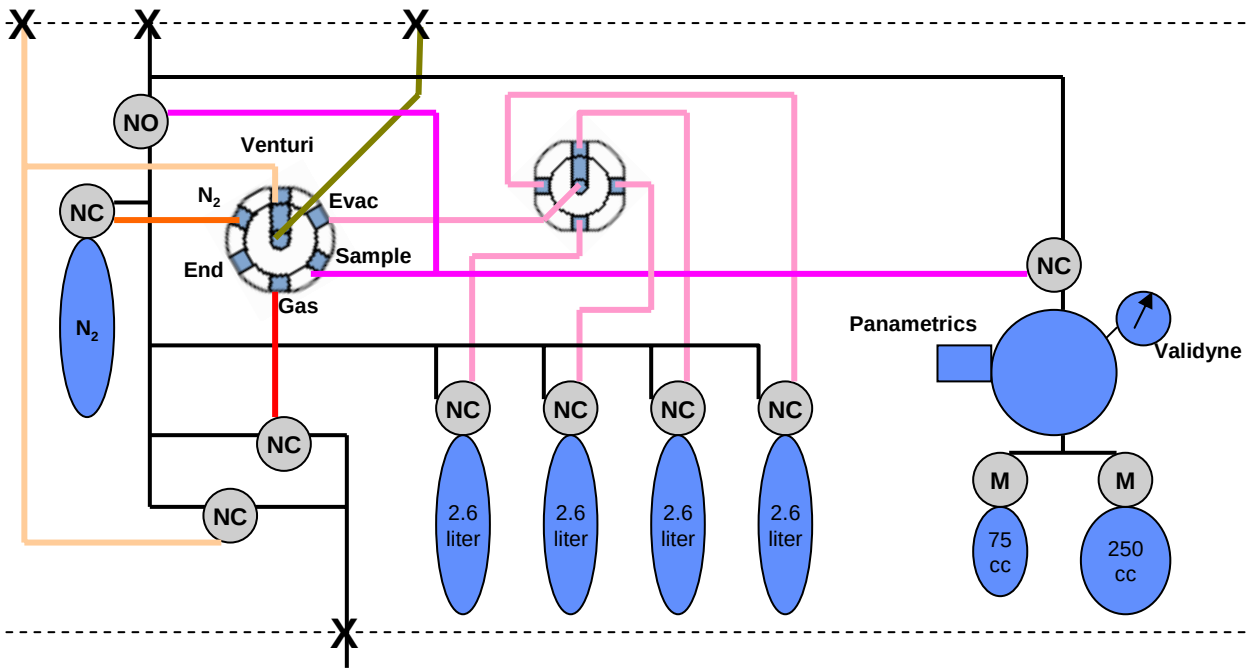
Functions

- Purge (clean N2) and evacuate the WSPA to weapon
- Provide mTorr vacuum prior to opening weapon purge valve
- Fill gas bottles (same sizes and types as before)
- Provide moisture/pressure measurement capability
- Provide weapon volume measurement
- Provide interface to special gas measurement (if needed)

Schematic
Power-free Gas Sampler (PGS)

PGS

Power-free Gas Sampler



Procedure (already connected leak-tight to weapon)

- **Purge and evacuate line to weapon (alternate N2 and VENTURI)**
- **Further evacuate line using 4 fixed, internal volumes (EVAC)**
- **Open the weapon valve and record pressure from PPM (SAMPLE). This also opens the moisture sphere and sample bottles.**
- **Close all (END)**

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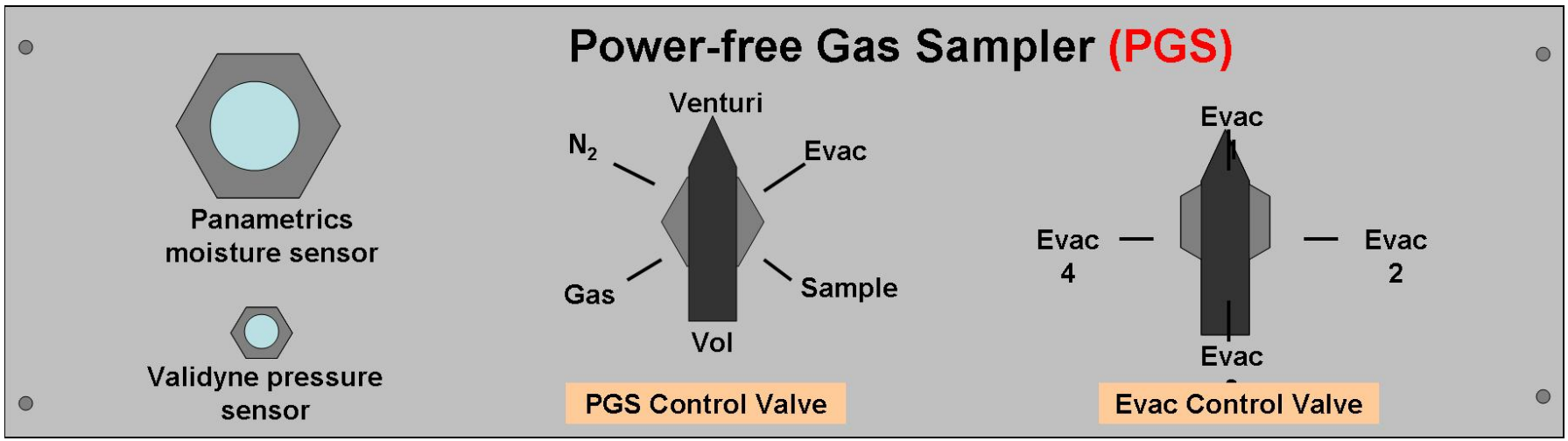
Operation Panel
Power-free Gas Sampler (PGS)



<u>Note:</u> No additional external connections needed in the bay!

- **Uses same size/type of gas sample bottles as before**
- **Panel is simple for bay operations**
- **Moisture/pressure readings can be taken in the bay after disconnecting from the weapon**
- **Only two valves control all sampling operations**

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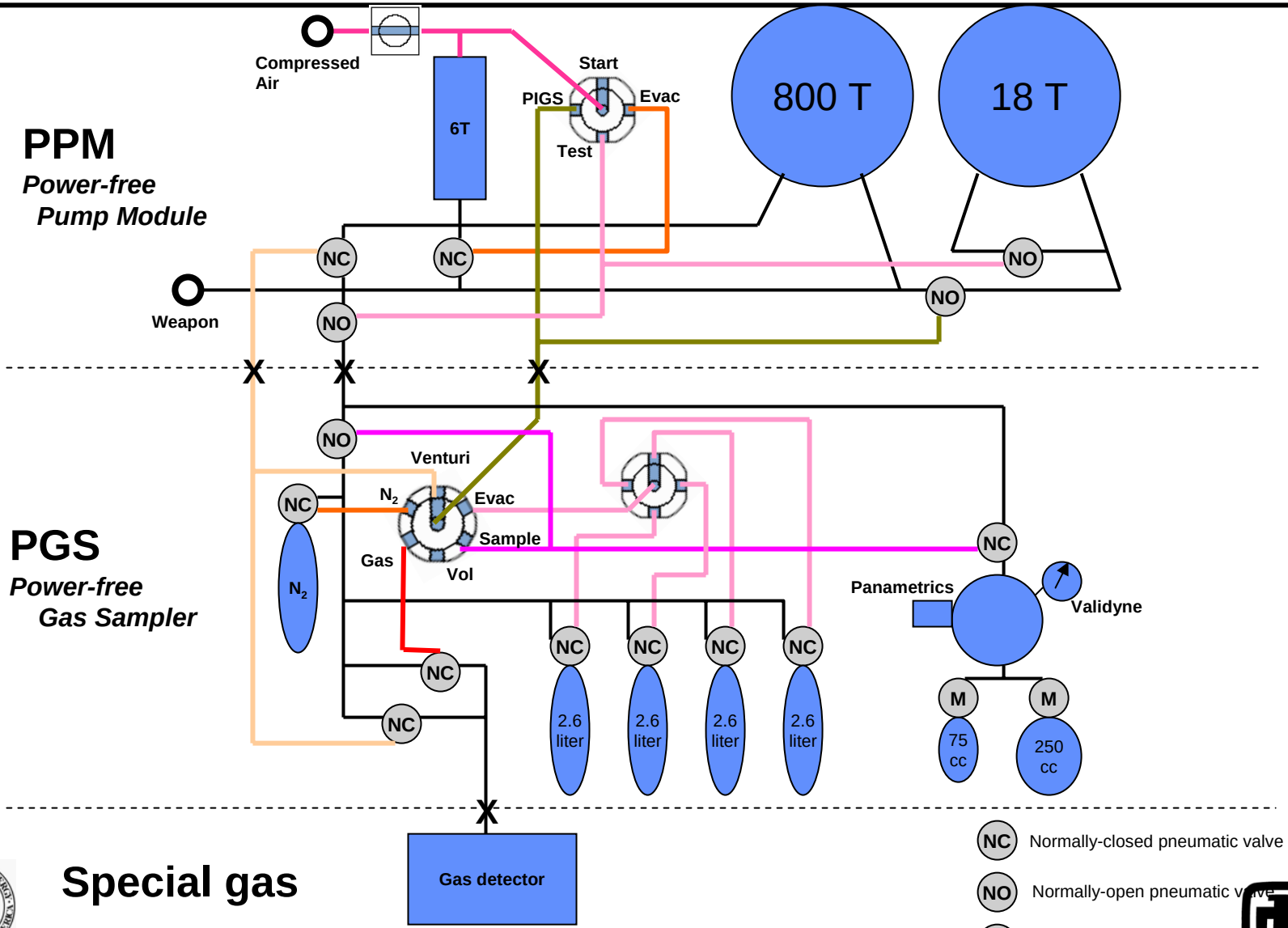
Combined Schematic
PPM and PGS



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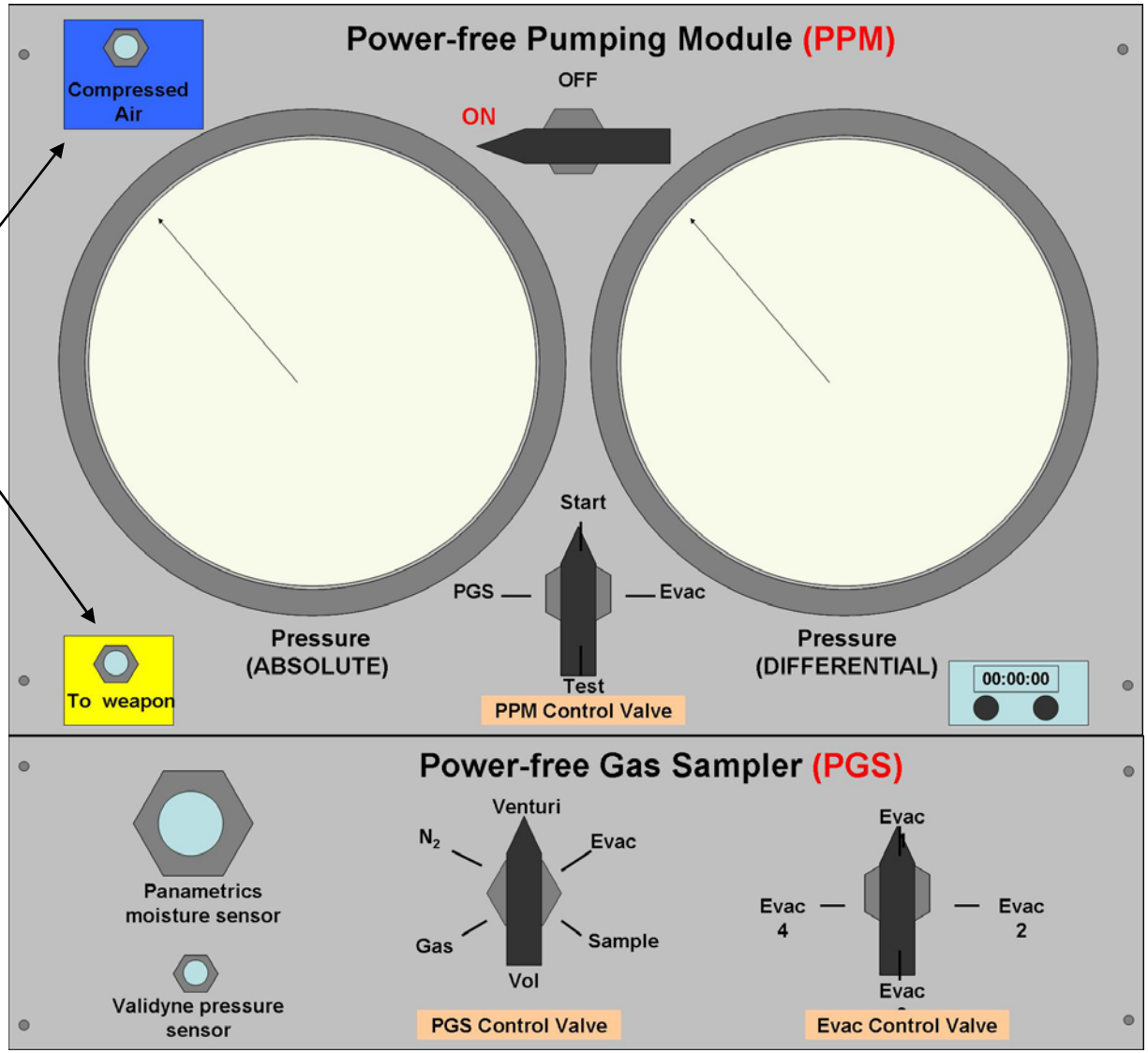
Combined Operational Panels
PPM and PGS

Only two connections are made in the bay.



Only four valves control all leak test and sampling operations.

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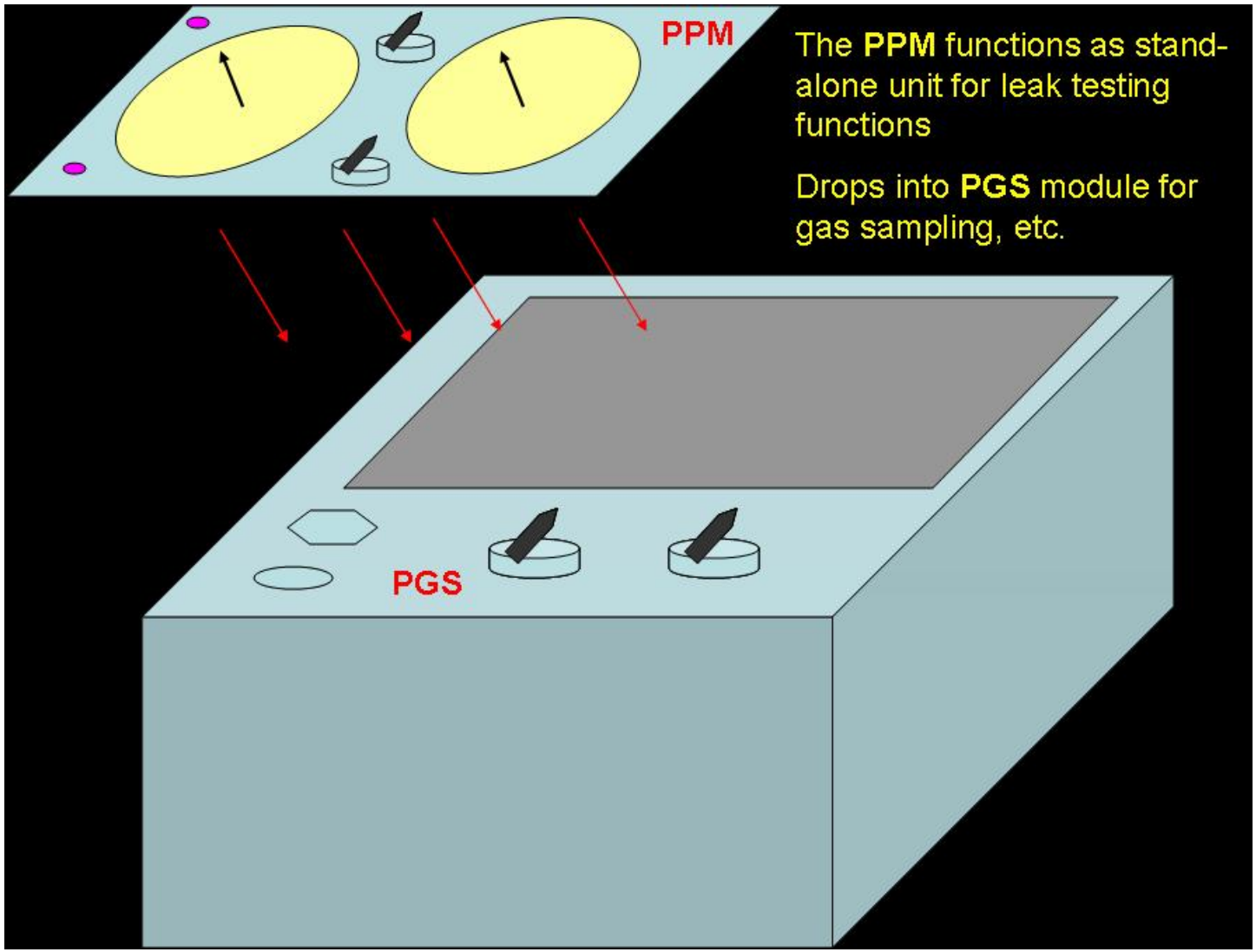
PPM and PGS modules form compact “box”



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Implementation of power-free leak detection and gas sampling has many benefits

Benefits/Impact:

- Decreased time for leak testing and gas sampling means greater throughput
- No A/C power means no down-time due to lightning warnings
- Less bay preparation (assembly, evacuation, sample bottle connection, etc.) means more time for production
- Simple design makes design easy to maintain and more reliable than complex instrumentation
- Uses already accepted gauges and sample bottles
- Smaller size, compact, self-contained
- Easy ball-valve operation/control of pneumatic vacuum valves

Enhanced Surveillance Program seeks to maximize information extracted from warhead gases and predict material failures

Enhanced Gas Analysis for Diagnostics and Surveillance

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