# HRF Rack Acoustic Closeouts

Acoustic Working Group
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# Issue

- Crews have expressed concerns with the design of the closeouts used to seal gaps on the HRF Rack.
- Culbertson has mentioned that closeouts are cumbersome to apply and tend to fly away when removed.
  - Closeouts were tethered to rack by the increment 2 crew to help flying away.

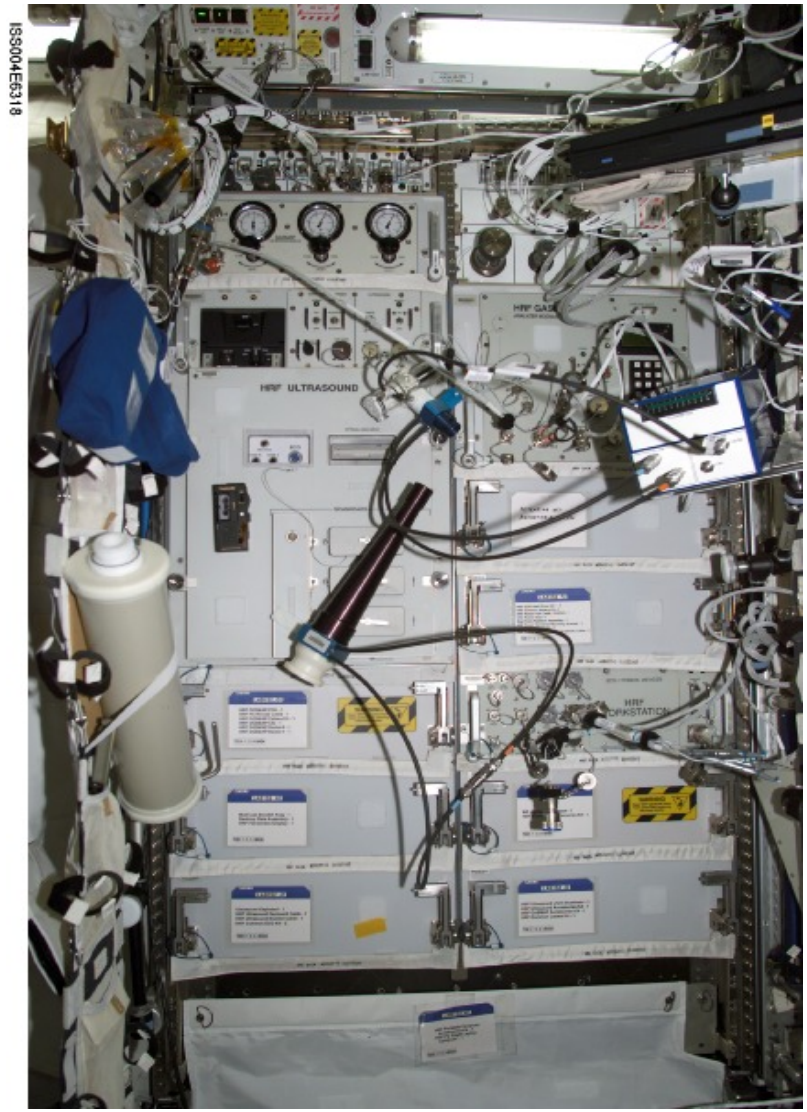
# Background

- HRF Rack is modular with sub-rack instruments/drawers that can slide in/out of the rack
- Based on initial studies of the HRF acoustics, majority of noise is transmitted out the front of the HRF Rack
- HRF Rack developed a unique abatement methodology including:
  - Changes to fan operational speeds
  - Interior Abatement (Foam and Barrier liner)
  - Exterior Abatement (Acoustic Closeouts)

# HRF Integrated Rack 1

Launch

On-Orbit, I4



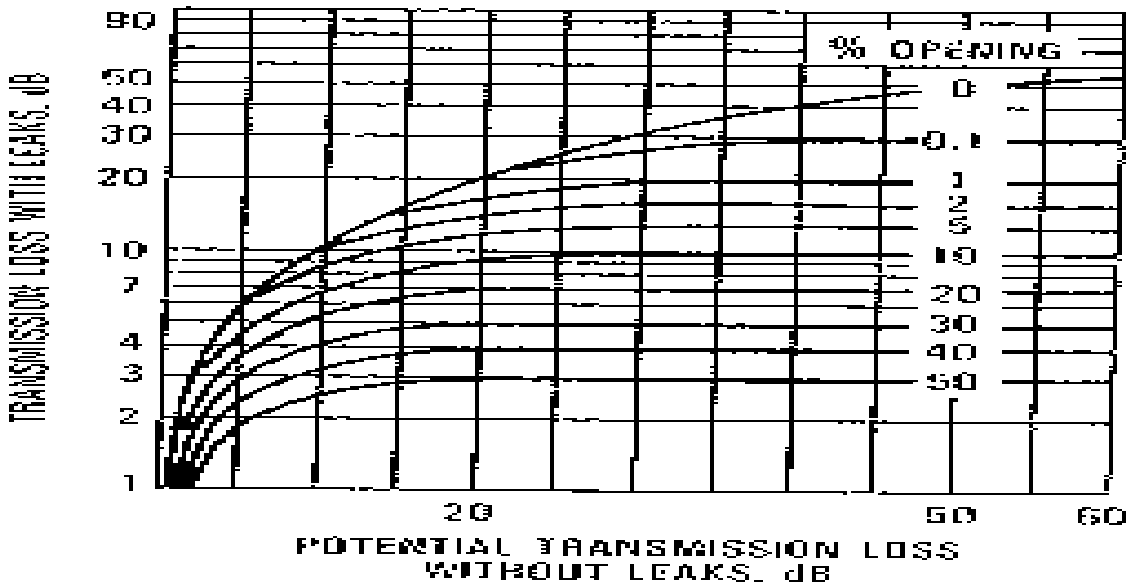
# Relation between Acoustics and "Gaps"

- Noise follows paths of least resistance
  - Similar to gas or fluid
- Ideal abatement would be a sealed cover for face of rack
- Small openings allow for large amounts of noise to "leak" out
  - Significant transmission loss even at 1% opening

# Transmission Losses Vs. Percent Openings.

**EFFECT OF OPENINGS IN COMPLETE ENCLOSURES OR PARTITIONS**

If sound is allowed to pass unabated through openings in partitions, the sound transmission loss (TL) of the partition may be significantly reduced. Examples are access ports, openings for wiring or plumbing, door seals, and wall/ceiling panel seals.




**Theoretical Effect of Openings in Walls**

Example:

A 100 sq ft (9.3 m²) partition without openings has a TL rating of 40 dB at a given frequency. Cutting a 1 sq ft (0.093 m²), or 1%, opening in that partition will reduce TL to about 20 dB unless the opening is acoustically treated.

# HRF Rack Gaps

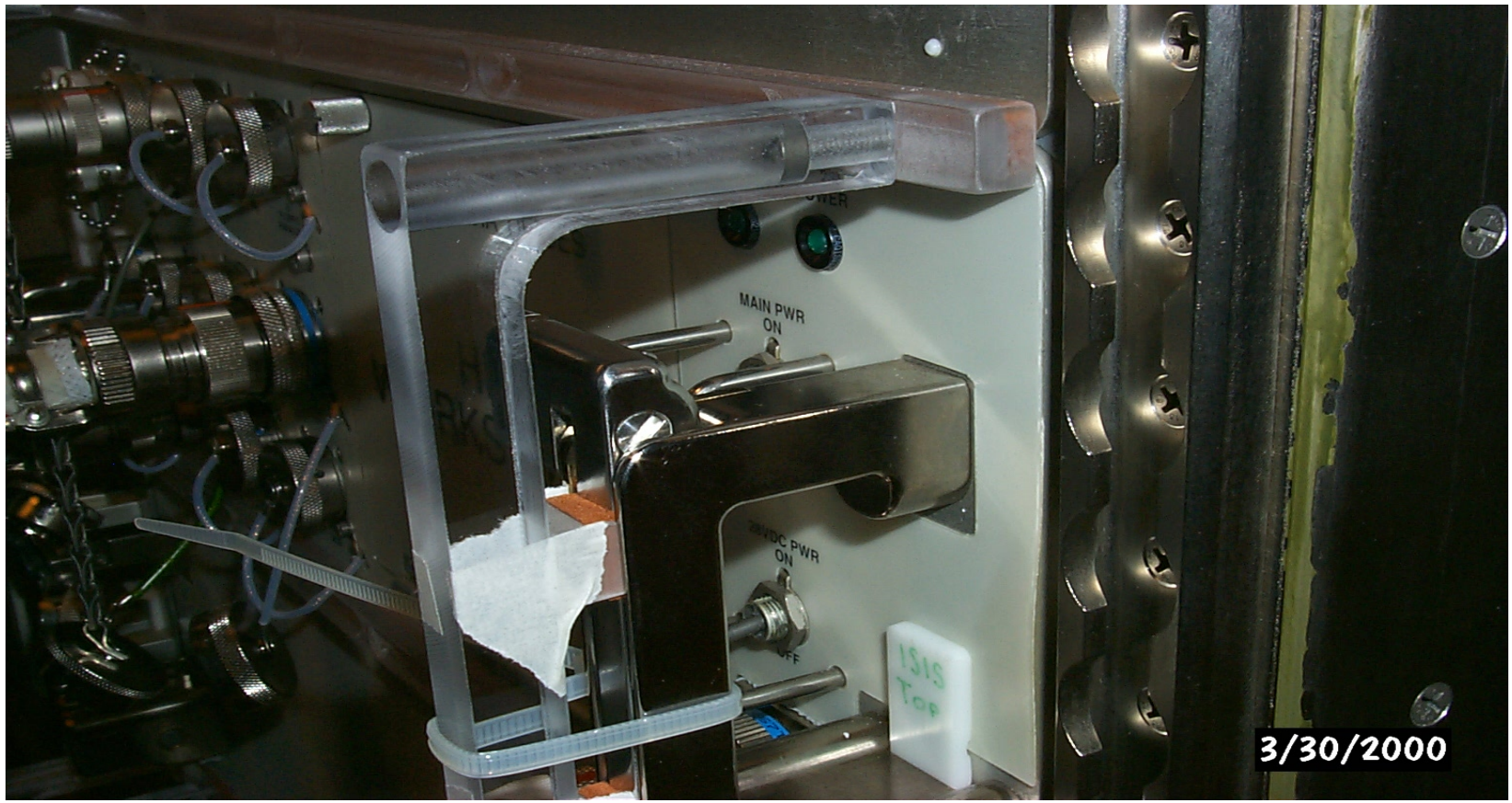
# HRF Design to Minimize effect of Gaps

- Not practical for HRF to place a large acoustic blanket across the front of the HRF Rack
- Instead HRF
  - Placed gasket material on the rack center and side posts
  - Closed all gaps on front panels of HRF hardware
  - Closed all gaps between hardware with items like the acoustic closeouts
- The purpose of the acoustic closeouts
  - Prevent sound transmission through air gaps between payload front panels
  - Prevent sound transmission through air gaps underneath payload handles

# Design Development of Acoustic Closeouts

- HRF evaluated multiple designs
  - Hard Acoustic Closeouts (permanent and removable)
  - Soft Acoustic Closeouts
  - Drawer Gaskets
- Design was reviewed and approved by HRF CCB
- Final design choice was a combination of
  - Soft removal closeout used on HRF drawers fronts
  - Hard semi-permanent design for the handle gaps

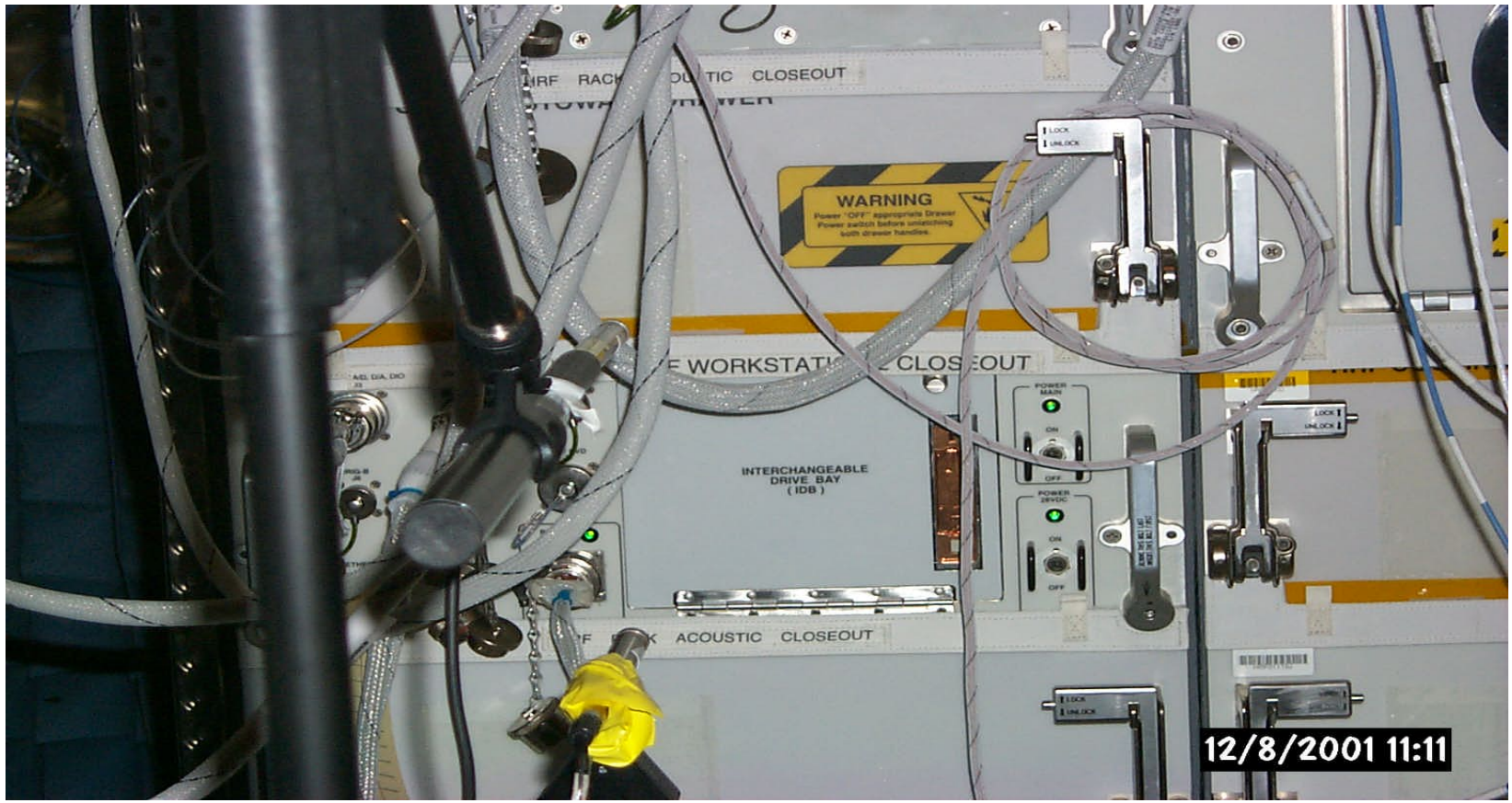
# HRF Prototype Acoustic Closeouts.  Proof of Concept



# Flight Design Specification

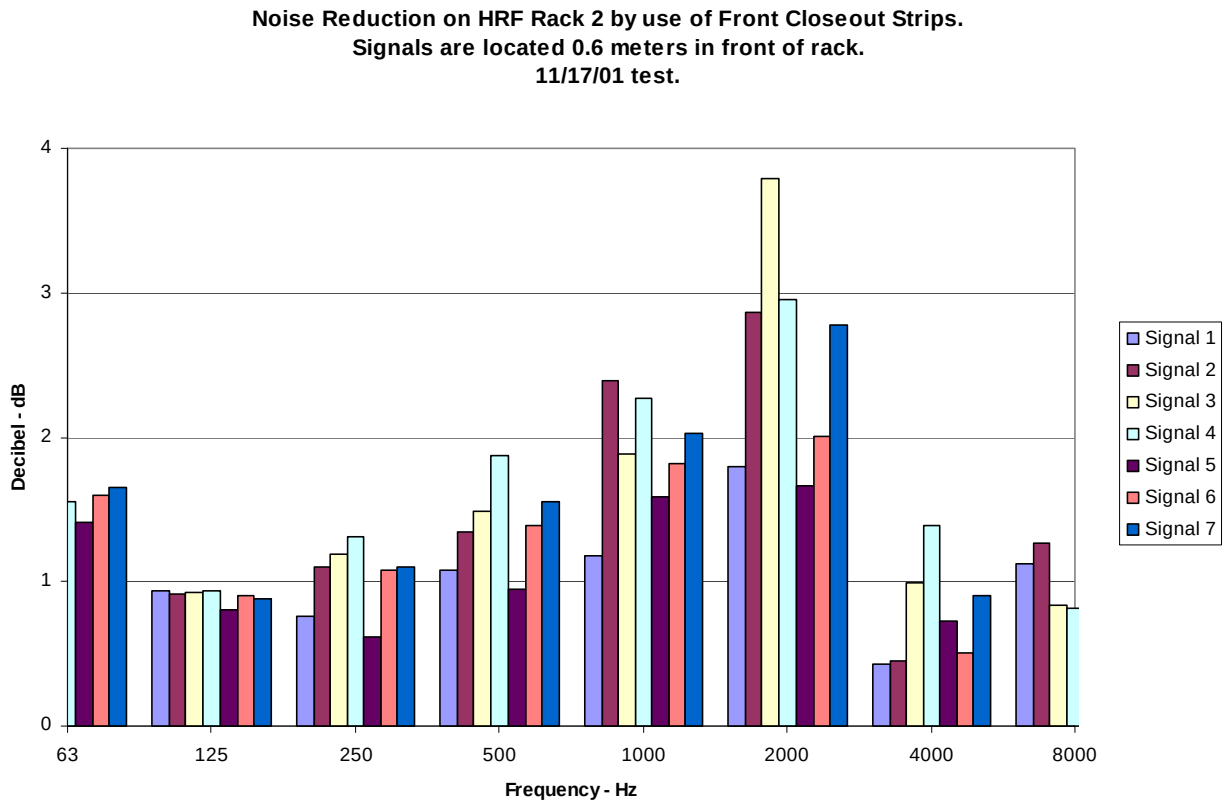
- Acoustic closeouts utilize 0.05 inch thick silicon rubber acoustic barrier material
- Made from soft-goods materials to facilitate easy removal and re-attachment
- Utilizes Hook and Loop fasteners for easy removal and attachment
- Smallest soft-goods design possible and yet still maintain acceptable tolerances
- Secondary benefit, debris prevented from entering HRF Rack

# HRF Flight Acoustic Closeout



# HRF Flight Acoustic Closeout (close-up)

# HRF Closeout Reductions by Frequency



# Conclusions and Recommendations

- HRF Acoustic Closeouts provide a measurable acoustic benefit
- With minimal transfer of HRF sub rack hardware, leave closeouts as they are
- *Alternate Options for discussion*
  - Modify existing/future design to be more crew friendly
  - Permanently attach closeout to frequently accessed items
  - Request that crew evaluate design and provide inputs