Buy-Quiet Programs

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Agenda

- Noise management background information
- Low-noise design experiences on ISS
- Buy-Quiet concepts and strategies
- Development of NASA's Buy-Quiet Program
- NASA's Buy-Quiet process and overview

After lunch: ***BuyQuietRoadmap*** tutorial

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Noise Management Hierarchy of Concerns

- Noise-induced hearing loss (NIHL)
- Other physiological effects
- Safety (audibility of critical signals)
- Community noise issues
- Speech intelligibility
- Productivity and work interference
- Work/living environment comfort
- Soundscape design or protection

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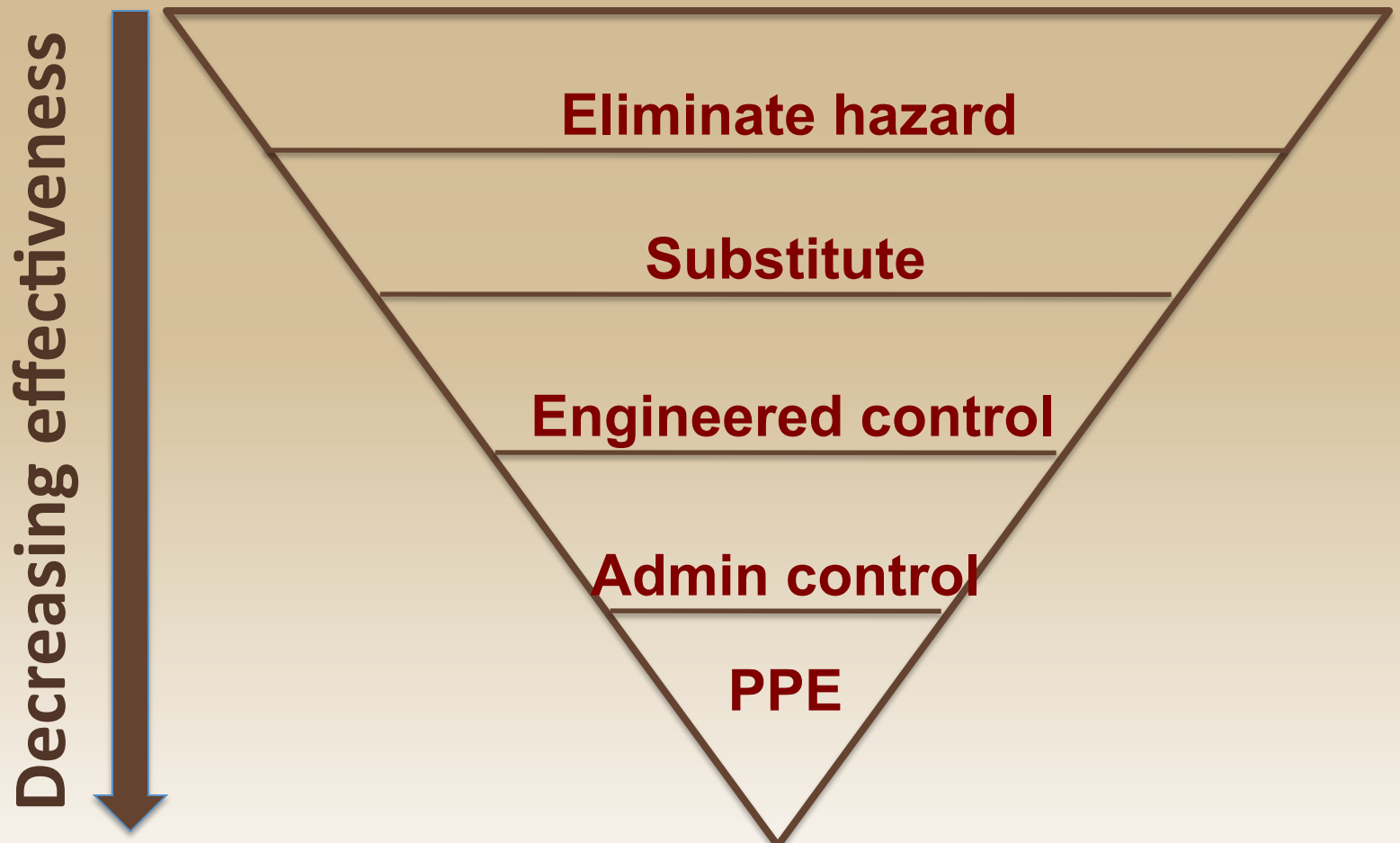
Noise Management Drivers

- Regulations and mandates (e.g., OSHA)
- Best practice guidance (e.g., NIOSH)
- Acknowledged standards (e.g., ANSI)
- Academic and professional publications (texts, position papers)
- Voluntary agency, industry, and corporate policies

Hierarchy of controls



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Engineering* approaches to noise management

- Low-noise design
  - Product noise emission
  - Buy-Quiet and Quiet-by-Design Programs
- Retrofit engineered noise control
- Architectural acoustics (standard best practice)
  - Design of new and renovated facilities
  - Provide use-appropriate interior environment
  - Ensure compatibility with exterior environment

**Requires qualified professional (specialist/consultant)*

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International Space Station noise exposure scenario

- Interior surfaces lined with noise-emitting equipment
  - Science experiment payloads
  - PC-sized or larger
  - Continuous operation
- Higher-noise sources operate intermittently
- Crew exposure is 24/7
  - Home = office = lab

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Familiar challenges

- Competing interior ambient sounds
- Intruding noise from adjacent spaces
- Reverberation (typically excessive)
- Listening while wearing HPDs
- Listener hearing loss

Challenges act independently and in combination

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Communication challenges

- Multiple noise sources
- Native language
- Body orientation
- Few facial cues
- Few contextual cues
- Hearing protectors
- Multiple alarm signals
- Other stressors

Managing noise on-orbit

- Communication on orbit is directly related to mission success and safety
- Communication-related performance effects can be translated into cost impact
- Lower ambient noise levels are required for communication than for preventing NIHL (and both goals are served)
- Retrofit controls are VERY expensive
- Low-noise design is critical!

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Structureborne noise affects science data

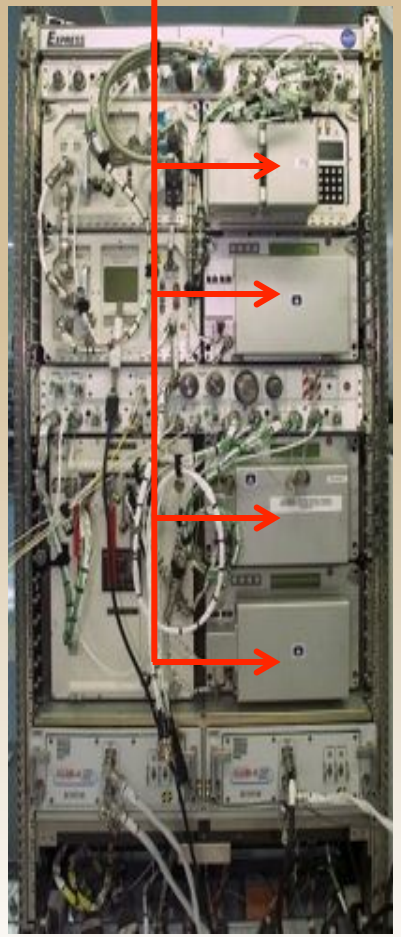
Buy/Design Quiet efforts for ISS

- Motivated by Shuttle noise problems
- Environmental noise level targets established
- Equipment noise emission limits issued
  - Exposure goals considered but . . .
  - Focus on (conservative) *communication* goals
- Payload developers expected to comply
  - Stringent and competing requirements
  - Pre-launch verification by test
- Successfully reduced on-orbit noise levels and crew exposures

Primary noise source: fans

- Variety of fans used
- Historically, not selected for noise characteristics
- Flow paths often aggravate noise
- Mufflers and enclosures routinely employed
- Waivers often granted if limits not met

ISS Payload Fan Mufflers



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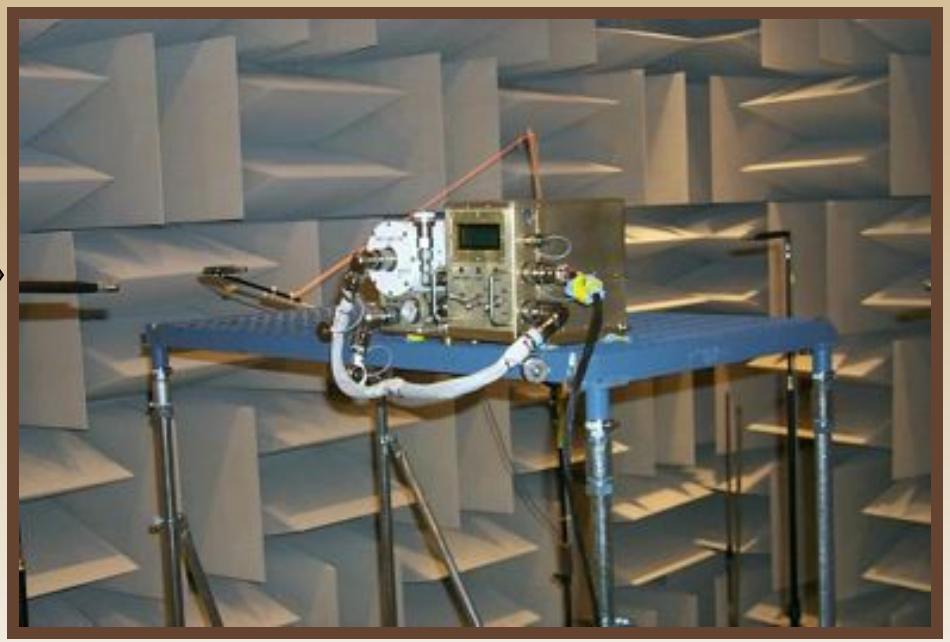
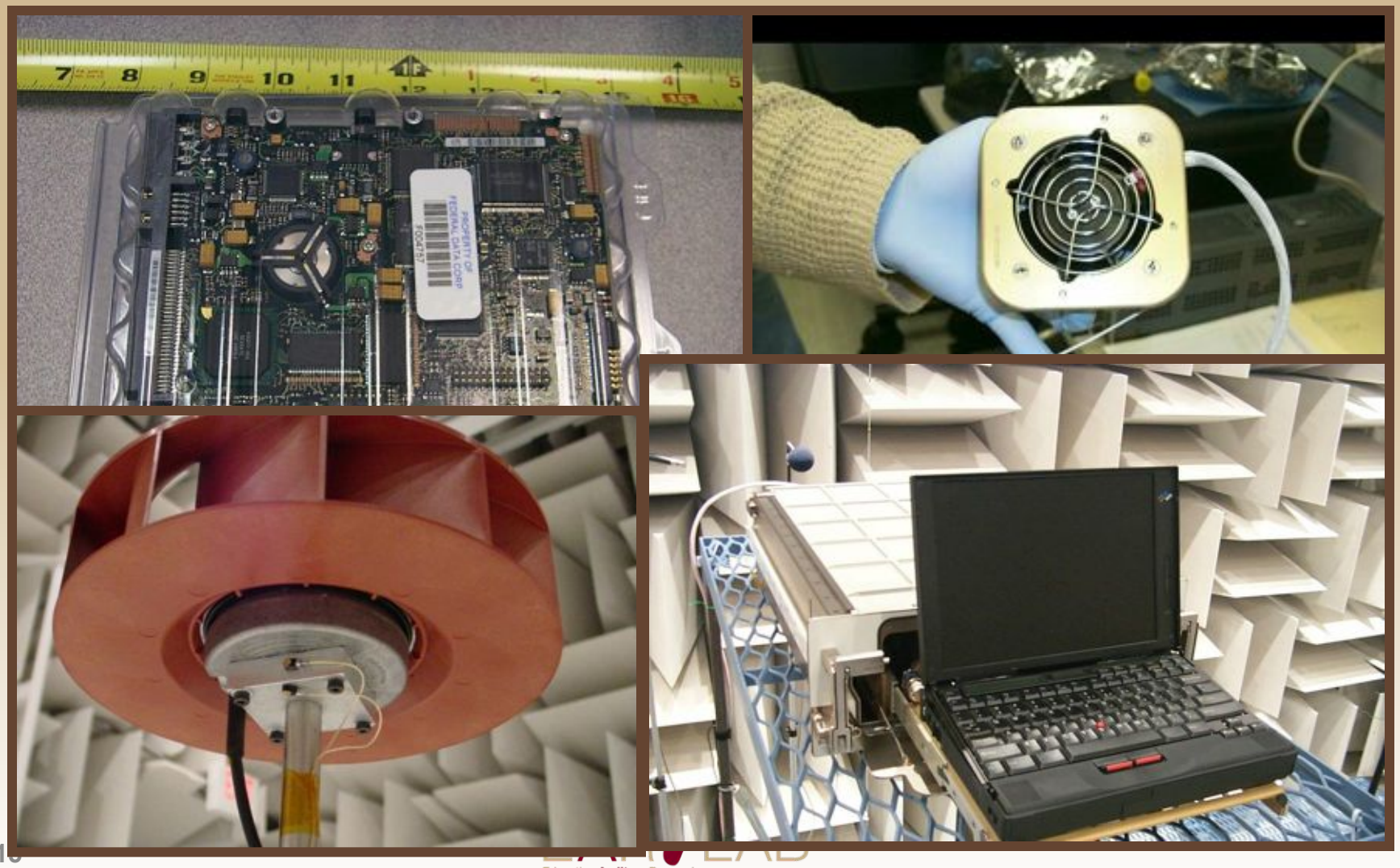
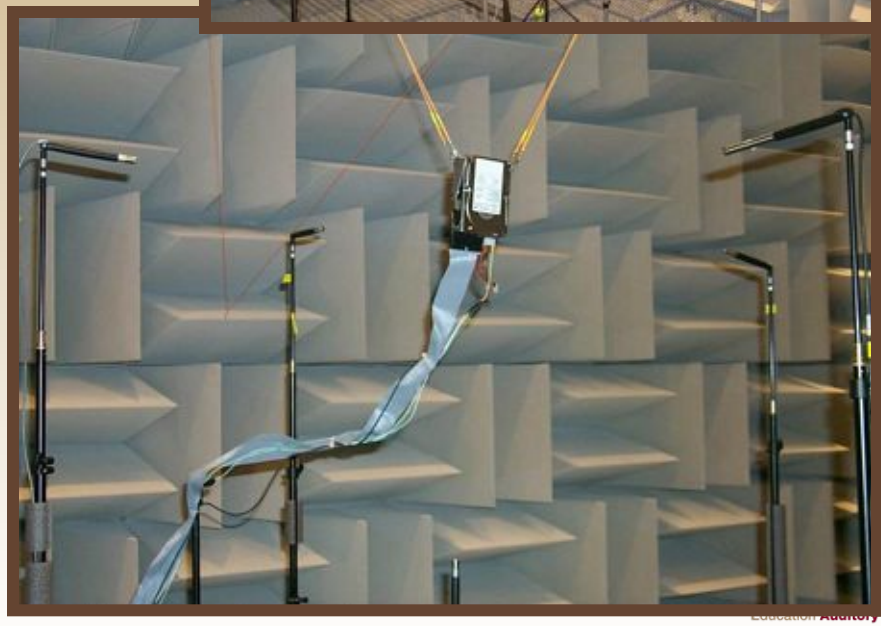
Noise emission budget sub-allocation
Rack ➡ subsystem ➡ source

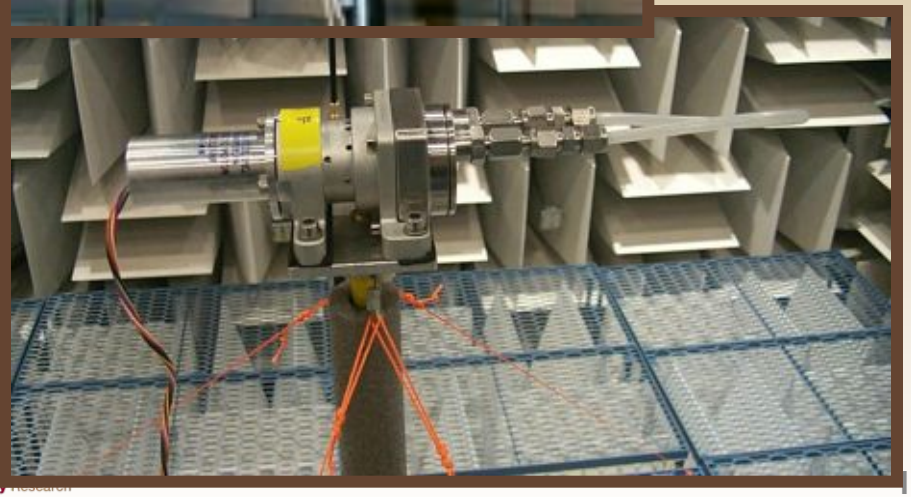


“Buy-Quiet” in ISS payload context



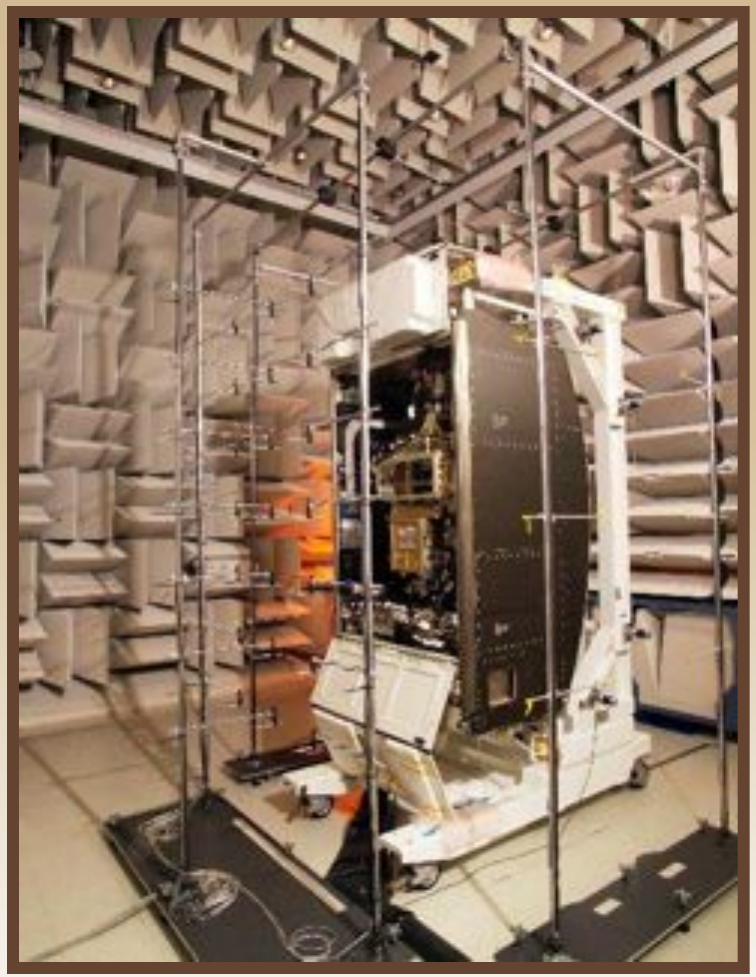
Sound source testing





System-level subassemblies

Rack-level verification test per ISO 11201



Retrofit noise control, ISS-style

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Managing occupational noise exposure

NASA Hearing Loss Prevention for Ground Support Employees

- Best-practices field center programs dictated by agency-wide policy (exceeds OSHA requirements)
  - 85 dBA TWA criterion level
  - 3 dB exchange rate
  - 82 dBA TWA action level
  - HPD requirements based on instantaneous sound level (not TWA exposure)
- Triennial field center program audits by HQ
- Voluntary best-practices approach encouraged for non-hazardous applications (e.g., interior and community noise)

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Why create a low-noise workplace (on earth)?

- Lower risk of noise-induced hearing loss
  - And . . . reduced cost of hearing loss claims
  - Reduced hearing conservation program costs
- Better speech intelligibility
  - Between employees, w/ or w/o hearing protection
  - PA system and radio communication
- Increased safety
  - Increased alarm audibility
  - Increased concentration
  - Reduced fatigue
- More productive, comfortable environment

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Buy/Design Quiet concepts

- Control the noise (not the exposure)
  - Controlling the noise controls the exposure
- Buy-Quiet (BQ)
  - Buy equipment that is “low-noise”
  - Manufacturer assumes financial and design risk
- Quiet-by-Design (QBD)
  - Design systems that are “low-noise” (typically gas flow)
  - Owner assumes risks for in-house designs
  - QBD approach encompasses BQ purchases
- *NASA’s focus to date has been on BQ vs. QBD*

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Buy-quiet approach

- Requestor specifies achievable noise *emission* criterion that supports noise *exposure* criterion
- Noise emission criterion (limit) language included in specification
- Vendor assumes burden of meeting spec
  - Submittal data required prior to purchase
  - Shop verification before shipment
  - Field verification after installation
- Noise considered during "research" if no formal specification is issued
  - (e.g., commercial purchase card and GSA purchases)

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Why is it so important to buy (design) quiet equipment?

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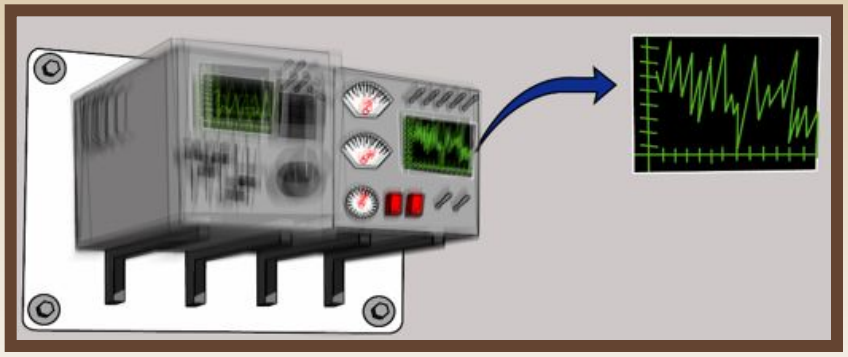
Instead of fixing it “later”?

1. Low-noise designs reflect better engineering

- Noise is usually a waste byproduct
  - Wasted energy = wasted $$
- Noise indicates an inefficient process
- Noise induces harmful vibration
  - Human exposure
  - Equipment damage
  - Data interference



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2. Manufacturer-supplied (OEM) controls are superior to retrofit

because they work properly, are more maintainable and are almost always less expensive.

3. It makes economic sense

to buy quiet equipment if you are (and you should be)
also investing in retrofit controls

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Retrofit engineered noise control solutions can cost 10 – 15 times as much as the premium on low-noise purchases (about 5 – 10%)

4. Retrofit control is often impossible

if there are multiple, unique or expensive sources

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Won't low-noise equipment cost more? (Industrial/hazardous noise realm)

- Consider the long-term cost of a hearing loss prevention program
  - **Required retrofit noise control solutions**
  - Noise exposure monitoring
  - Audiometric monitoring
  - Audiogram review and follow-up
  - Hearing conservation training
  - Personal hearing protective devices
  - Recordkeeping
  - Program management

- Many studies have assigned HCP costs from $400/WYE to $400K/employee/lifetime

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Won't low-noise equipment cost more?

- . . . plus the costs of inevitable hearing loss
  - Workers' Compensation claims
  - Lifetime medical follow-up
  - Hearing aids and batteries
  - (Excludes secondary medical and quality-of-life costs)

- Successful long-term Buy-Quiet programs result in significant cost savings over time
- Quantifying these costs is essential for effective Buy-Quiet program advocacy
  - Much work in progress worldwide to quantify

Assessing the "cost of noise"

- Each exposure has a long-term cost
- These costs can be modeled and estimated for each equipment purchase scenario
  - Equipment noise emission level vs. criterion
  - TWA exposure
  - Number of exposed employees
  - Probable number and size of hearing loss claims, based on statistical and demographic data
- NASA's analysis: http://buyquietroadmap.com/buy-quiet-purchasing/advocacy/the-cost-of-noise/

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Applying "cost of noise" approach when goals are other than HLP

- Environmental noise in communities
  - Home and property values
  - May also affect businesses and places of worship
- Interior (self-generated) non-hazardous noise
  - Highly use-dependent
  - Cost of communication interference (productivity)
  - "Consumer" product noise emissions are market driven
- Noise in parks
  - Visitor experience
  - Impact on wildlife

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Is “low-noise” equipment available?

- Most manufacturers can offer manufacturer-supplied controls for nominal product
  - “On-skid ” enclosure if no “low-noise” design
  - Low-noise designs increasingly common

- Some vendors won’t quote low-noise products unless formally requested
- Formal specifications level the field

NASA BQ/QBD Vision:

Noise emissions intentionally considered

- Noise-related consequences of all purchase and design decisions are anticipated and evaluated
  - Long-term cost of each option is quantified
  - *Informed* decisions are made
  - Noise-related impacts are properly accommodated
- Approaches to "non-hazardous" noise
  - Best-practices architectural acoustics

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Comparison of Buy-Quiet Program Strategies

	Scope of purchases	Customers/ specifiers	Strategies
NASA	Unrestricted	Numerous	Determine appropriate sound emission criterion for each purchase
NIOSH	Small (power tools)	Multiple but finite (construction contractors)	Facilitates adoption of corporate position; encourages pre-approval of expenditures based on cost-benefit level; assigns a noise emission sound level to all tools in inventory
NYC	Small (construction equipment)	One (NYC government)	Pre-qualifies specific equipment
Large private industry	Very small	One	Collaborative design process with single manufacturer for major manufacturing equipment

Comparison of Buy-Quiet Strategies

Strategy	Advantages	Challenges
Pre-qualification of equipment (OK/not OK)	Simple for end user (Y/N decision)	•Burden on program owner to pre-qualify all equipment a priori. •Subject to availability and accuracy of data. •Concerns with legitimacy of self-reported data •and test method rigor.
Purchase-specific criterion (Best available)	•Can be applied to any purchase –virtually unlimited within scope of "cost-of-noise" model •After first purchase of an item, may pre-sanction future like purchases for limited period	•More complicated for end user. •Monitoring and enforcement complicated for program owner.
Partner with vendor	•Design will meet specific goal •Contributes to state of the art •Vendor investment in success	Design complexity, high price threshold

NASA-wide BQ requirements

- Evolved from mid-90s work at GRC
- Added to NASA Procedural Requirement NPR 1800.1 in 2006
- Each NASA site must:
  - Include noise emissions with technical and performance criteria when purchasing or designing new equipment that is "expected to produce noise which is approaching hearing conservation levels of 80 dBA and higher."
- Noise emissions shall be considered equally with all other requirements.
- Initial policy language intentionally broad

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Implementation challenges for NASA sites

- Diversity in operations, culture across 15 sites
- Responsibility distributed throughout Center
- Advocacy and training are major tasks
  - Technical content outside EH&S scope of practice
  - Purchasers (requestors) unsure how to comply
  - Centers have multiple contractors and tenants
  - Stakeholders are unfamiliar or skeptical (or both)
- Contractor compliance must be monitored
  - Can only "suggest" without a contract requirement
- Senior management enforcement is critical

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Benefits of *formalized* BQ process

- A corporate policy sends a message
  - Manufacturers and vendors take note
  - Demand increases supply (e.g. IT/consumer)
- Publicly visible programs set a precedent
  - The existence of one program fuels others
  - Programs build on existing best practices
- Strong federal agency leadership is critical to the success of all programs!
  - NASA and NIOSH (DART) leading
  - NIOSH and others are based on ***Roadmap***

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Center BQ program development

- Implementation must be site-specific
  - Organization, communications, and procedures
- Each EH&S organization must assign a lead
- HQ provides limited technical support
  - Progress goals and objectives
  - Periodic status reviews
  - Webinar and conference-based training sessions
  - Meeting presentations and updates
- Most coordination via email
- Enforcement via HQ audit team site visits
  - Audit checklists mirror expected progress goals

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Intermediate goals in development of site-specific programs

1. Identify lead and EH&S internal team
2. Modify site-specific policy document
3. Conduct awareness briefings
4. Assemble cross-functional team
5. Develop detailed internal procedures*
6. Include Contractor organizations
   (Modify onsite support service contracts)
7. Conduct "how-to" briefings on procedures

**Turning policy into specific procedures presented challenges for Field Center programs*

Field Centers asked hard questions

- What are other companies, government agencies, and the military doing about this?
- Do manufacturers make low-noise equipment, and how much more does it cost?
- How to navigate the process of locating, evaluating, purchasing, and verifying the performance of low-noise equipment?
- And, just how quiet *should* each product be??

BQ corporate surveys

- Solicited information on corporate programs
  - 60 individual (corporate, military, federal) contacts
  - ANSI S Committees
  - AIHA Noise Committee
  - Institute of Noise Control Engineering members
  - ORC Occupational Health and Safety Network
  - NIOSH *Prevention through Design* project
- Compiled detailed data on 10 programs
  - Most programs use 80 dBA noise emission limit
  - Most programs involve partnerships with major suppliers to develop custom equipment/systems

BQ Manufacturer surveys

- Solicited information on low-noise equipment
  - 60 individual manufacturer contacts
  - INCE Product Noise Technical Committee
  - ANSI S Committees
  - National Academy of Engineering “Technology for Quieter America” project
- Compiled detailed data from 11 manufacturers re: design/marketing
  - Most estimate 10% - 20% markup for “quiet” equipment

Needed: a self-contained Buy-Quiet process resource

- Help NASA sites effectively implement policy
- Provide education, guidance and tools
  - Applicable beyond NASA and contractor programs
- Assume visible leadership role in BQ/QBD
  - Join NIOSH, Federal agencies, Armed Services
  - Set example for corporate programs
  - Encourage publication of noise emission data
  - Support voluntary product noise labeling (INCE)
- Contribute to the state of the art
  - Program models and resources

NASA Buy-Quiet Roadmap

- Online tool
- Developed for NASA; applicable externally
- Publicly available: http://buyquietroadmap.com
- Technical content by Nelson Acoustics
  - Web application and maintenance by Gelfand Design
- Result of multi-year project effort
- Incorporates contributed best practices and data
- Currently externally hosted by Nelson Acoustics

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Buy-Quiet Process Roadmap

Key external contributors

- Baltimore Aircoil
- United Technologies
- Caterpillar
- Cisco
- Honeywell
- Hewlett Packard
- Ingersoll Rand
- Toro
- Carrier
- ExxonMobil
- Colgate Palmolive
- Trane
- 3M
- Becton Dickinson
- General Motors
- Air Force
- Navy
- National Park Service
- NIOSH

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Buy-Quiet Program History

- mid-1990s – first NASA Buy-Quiet program initiated at Glenn Research Center
- 2006 – Agency-wide requirements established
- 2007 – all field centers began implementation
- 2009 – ***Roadmap*** beta site available
- 2010 – ***Roadmap*** upgraded and harmonized with NASA procurement regulations
- 2012 – New Buy-Quiet website available

NASA Buy-Quiet Process Overview

1. Requestor researches and identifies achievable noise ***emission*** criterion that supports noise ***exposure*** criterion
2. Determine appropriate procurement vehicle*
3. Noise emission criterion (limit) language included in specification
4. Submittal data required prior to purchase
5. Selection considers cost and noise emission
6. Shop verification test before shipment
7. Field verification test after installation

*allows for "simplified" acquisition strategies

Current status of site-specific programs

1. BQ lead and EH&S internal teams identified
2. Site-specific policy document modified
3. Awareness briefings conducted
4. Cross-functional team established
5. Contractor organizations included
   (Must modify onsite support service contracts)
6. Developing internal procedures for incorporating Roadmap
7. Use and provide feedback on Roadmap

HQ support focus shifting to monitoring procurements and feeding experiences back into Roadmap

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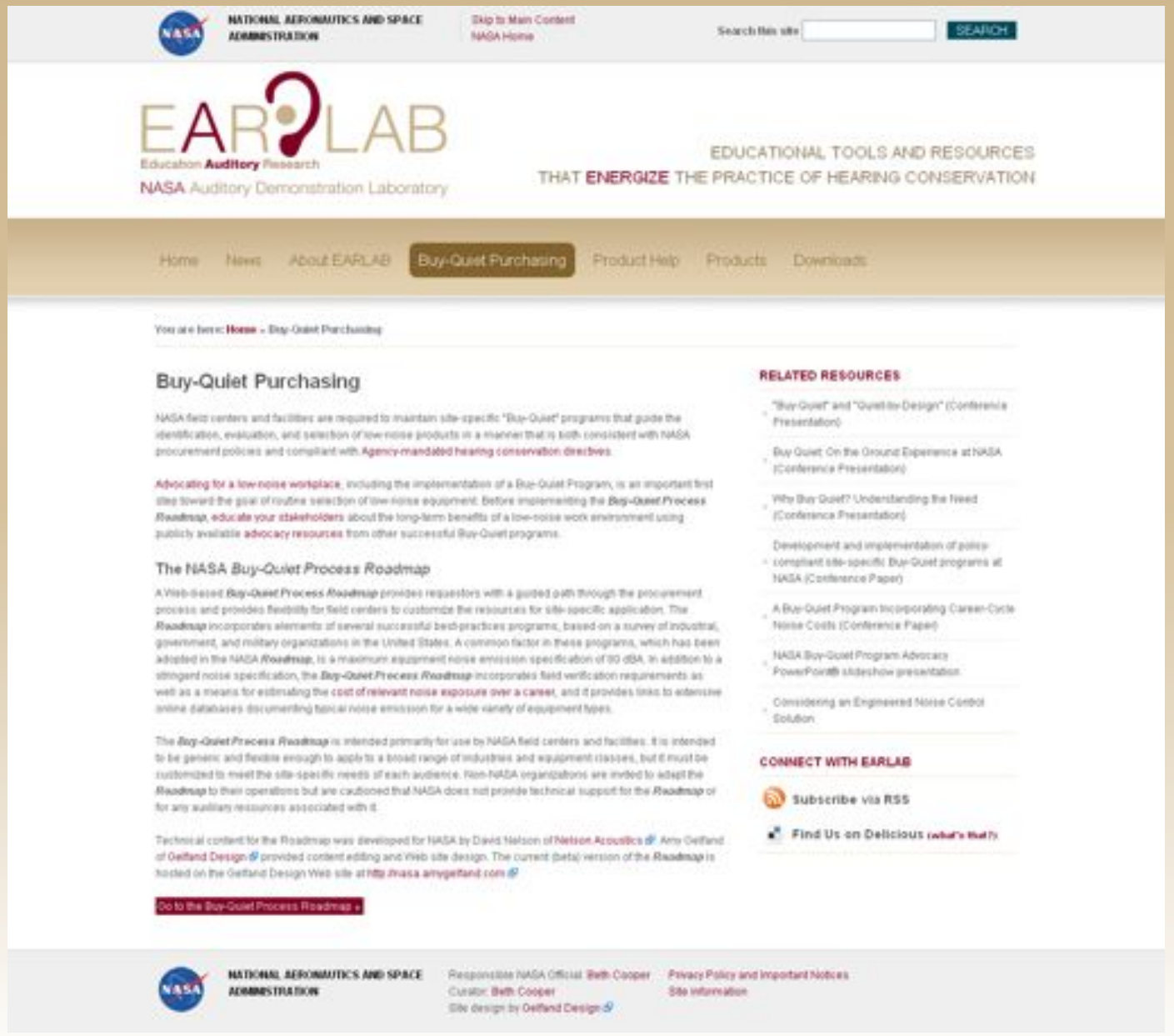
http://buyquietroadmap.com



Getting there . . .

- Low-noise product design is possible
- Successful corporate programs do exist
- However . . .
  - Manufacturers must advertise quiet products
  - Corporate consumers (we) must be proactive
  - Voluntary product noise labeling effort needs our support!
- The good news:
  - "Level playing field" promotes competition
  - Demand will increase supply and control costs
  - Resources, models and help are available!

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Questions and Discussion

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