“Buy-Quiet” and “Quiet-by-Design”

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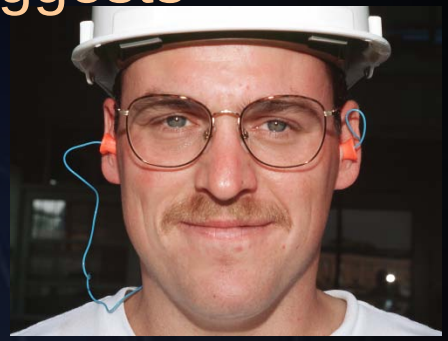
Why create a low-noise workplace?

- 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

Why can't we just wear earplugs?
(if hearing loss prevention was the only goal)

- Hearing protection isn't worn consistently
- HPD performance is difficult to quantify
  - Far less than the rating label (NRR) suggests
  - Highly dependent on individual fit
- Sometimes, no HPD offers enough protection
- Some employees will still incur hearing loss
- Hearing protectors can hinder communication



Buy/Design Quiet concepts

- Control the noise (not the exposure directly)
  - 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”
  - Owner assumes risks for in-house designs
  - QBD approach encompasses BQ purchases

NASA’s primary initial focus has been on BQ

Buy-quiet approach

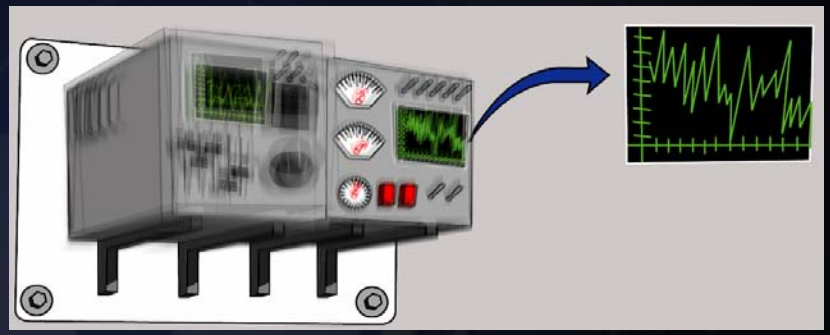
- Requestor specifies achievable noise *emission* criterion that supports noise *exposure* criterion
- Noise emission criterion (limit) language included in specification
- Vendor assumes burden of meeting spec
  - Submittal data required prior to purchase
  - Shop verification before shipment
  - Field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

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

Instead of fixing it “later”?

1. Low-noise designs reflect better engineering

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



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

4. Retrofit control is often impossible

if there are multiple, unique or expensive sources

“Low-noise” is good by all measures

- Cost effective
- Environmentally friendly
- Ergonomically superior
- Energy efficient
- Maintainable

Yes, but . . .

Won’t low-noise equipment cost more?

- 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

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

- Successful long-term Buy-Quiet programs result in significant cost savings over time
- Quantifying these costs is essential for effective Buy-Quiet program advocacy

Assessing the “cost of noise”

- Each exposure has a long-term cost
- These costs can be modeled and estimated for each equipment purchase scenario
- The following factors contribute
  - 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)
  - Other economic assumptions and factors

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

Benefits of *formalized* BQ process

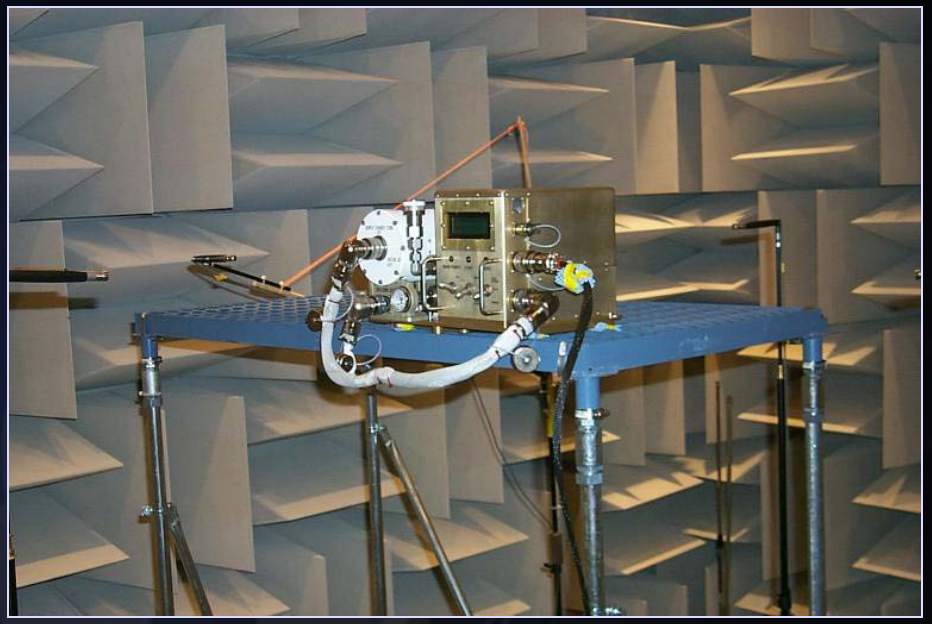
- A corporate policy sends a message
  - Manufacturers and vendors take note
  - Demand increases supply (e.g. IT/consumer)
- Publicly visible programs set a precedent
  - The existence of one program fuels others
  - Programs build on existing best practices
- Strong federal agency leadership is critical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

NASA BQ/QBD Precedent: International Space Station

- 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

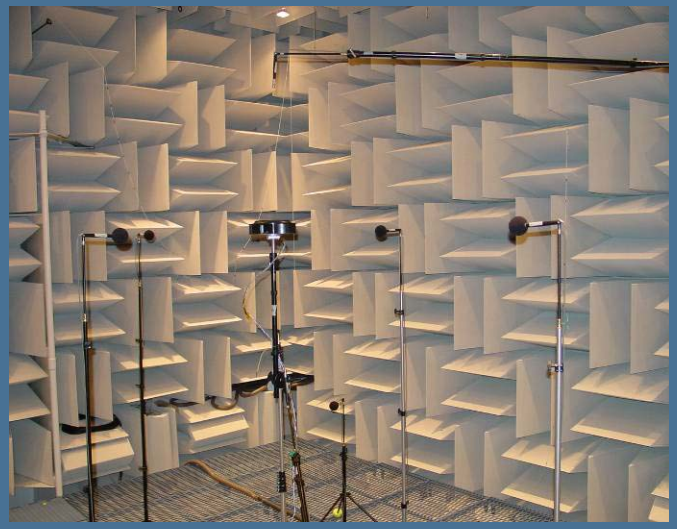
Noise emission budget sub-allocation

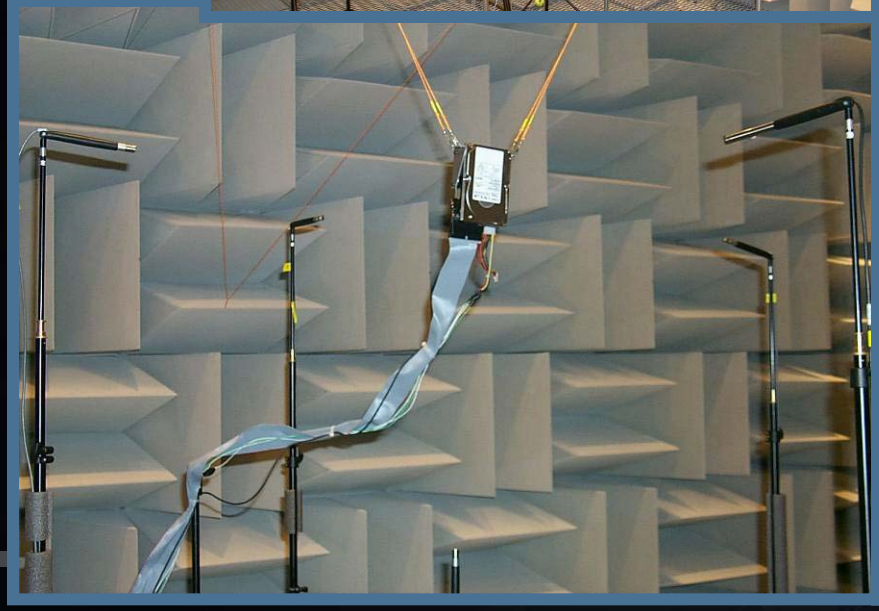
Rack → subsystem → source



“Buy-Quiet” in ISS payload context

Sound source testing

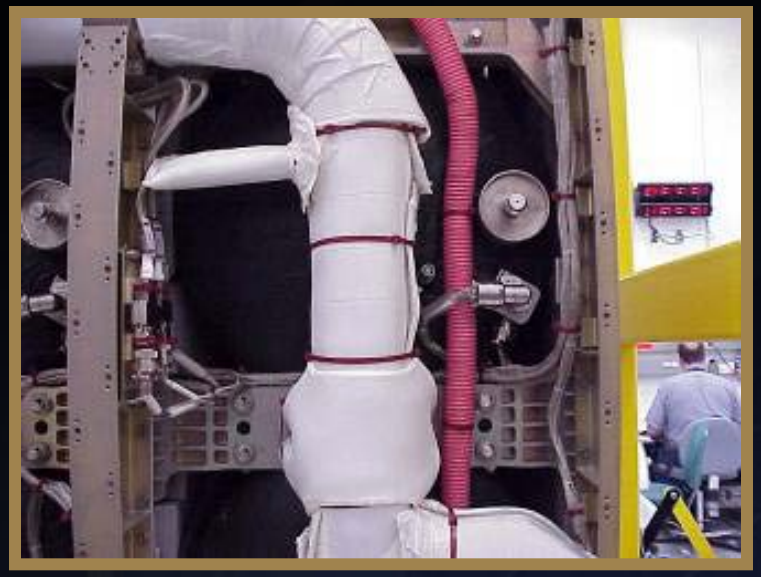




System-level subassemblies

Rack-level verification test

Retrofit noise control, ISS-style



Even rocket scientists need help

- NASA Acoustical Testing Laboratory (est. 2000)
- Provided services for payloads
  - Testing throughout development
  - Technical support
  - Design tools
  - Training courses
- ISS acoustics experience provides a model
  - Technology and process can be adapted
  - Lessons learned provide valuable advocacy

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
- Best practices approach is promoted for “non-hazardous” scenarios

Buy/Design-Quiet Program goals

- Establish a low-noise workplace
  - Reduce noise-induced hearing loss
    - Reduce financial cost of hearing loss
  - Improve safety, productivity and comfort
- Influence workforce to be proactive
  - Identify and purchase low-noise products
  - Design low-noise equipment and systems
- Harmonize with infrastructure and culture
  - NASA procurement regulations and vehicles
  - Site-specific operations and culture

NASA-wide BQ requirements

- 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

Implementation challenges

- 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

Center BQ program development

- Implementation must be site-specific
  - Organization, communications, and procedures
- Each EH&S organization assigned a lead
- HQ provided technical support
  - Series of six-month goals
  - Periodic (~6 mo) status review telecons
  - Webinar and conference-based training sessions
  - Frequent meeting presentations and updates
- Enforcement via HQ audit team site visits
  - Audit checklists mirror 6-month goals

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 want to know

- 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

NASA Buy-Quiet Process

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

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 Process Roadmap

- Web-based tool
- Developed for NASA; applicable externally
- Publicly available (Google: NASA Buy-Quiet Process Roadmap)
- Technical content by Nelson Acoustics; web application by Gelfand Design
  - Best practices from corporate, military, government programs
  - Manufacturer–provided data on availability and cost of low-noise equipment
  - Contributions from 20+ organizations

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Buy-Quiet Purchasing

NASA field centers and facilities are required to maintain site-specific "Buy-Quiet" programs that guide the identification, evaluation, and selection of low-noise products in a manner that is both consistent with NASA procurement policies and compliant with Agency-mandated hearing conservation directives.

Advocating for a low-noise workplace, including the implementation of a Buy-Quiet Program, is an important first step toward the goal of routine selection of low-noise equipment. Before implementing the ***Buy-Quiet Process Roadmap***, educate your stakeholders about the long-term benefits of a low-noise work environment using publicly available advocacy resources from other successful Buy-Quiet programs.

The NASA *Buy-Quiet Process Roadmap*

A Web-based ***Buy-Quiet Process Roadmap*** provides requestors with a guided path through the procurement process and provides flexibility for field centers to customize the resources for site-specific application. The ***Roadmap*** incorporates elements of several successful best-practices programs, based on a survey of industrial, government, and military organizations in the United States. A common factor in these programs, which has been adopted in the NASA ***Roadmap***, is a maximum equipment noise emission specification of 80 dBA. In addition to a stringent noise specification, the ***Buy-Quiet Process Roadmap*** incorporates field verification requirements as well as a means for estimating the cost of relevant noise exposure over a career, and it provides links to extensive online databases documenting typical noise emission for a wide variety of equipment types.

The ***Buy-Quiet Process Roadmap*** is intended primarily for use by NASA field centers and facilities. It is intended to be generic and flexible enough to apply to a broad range of industries and equipment classes, but it must be customized to meet the site-specific needs of each audience. Non-NASA organizations are invited to adapt the ***Roadmap*** to their operations but are cautioned that NASA does not provide technical support for the ***Roadmap*** or for any auxiliary resources associated with it.

Technical content for the Roadmap was developed for NASA by David Nelson of Nelson Acoustics. Amy Gelfand of Gelfand Design provided content editing and Web site design. The current (beta) version of the ***Roadmap*** is hosted on the Gelfand Design Web site at http://nasa.amygelfand.com.

Go to the Buy-Quiet Process Roadmap »

RELATED RESOURCES

- "Buy-Quiet" and "Quiet-by-Design" (Conference Presentation)
- Buy Quiet: On the Ground Experience at NASA (Conference Presentation)
- Why Buy Quiet? Understanding the Need (Conference Presentation)
- Development and implementation of policy-compliant site-specific Buy-Quiet programs at NASA (Conference Paper)
- A Buy-Quiet Program Incorporating Career-Cycle Noise Costs (Conference Paper)
- NASA Buy-Quiet Program Advocacy PowerPoint® slideshow presentation
- Considering an Engineered Noise Control Solution

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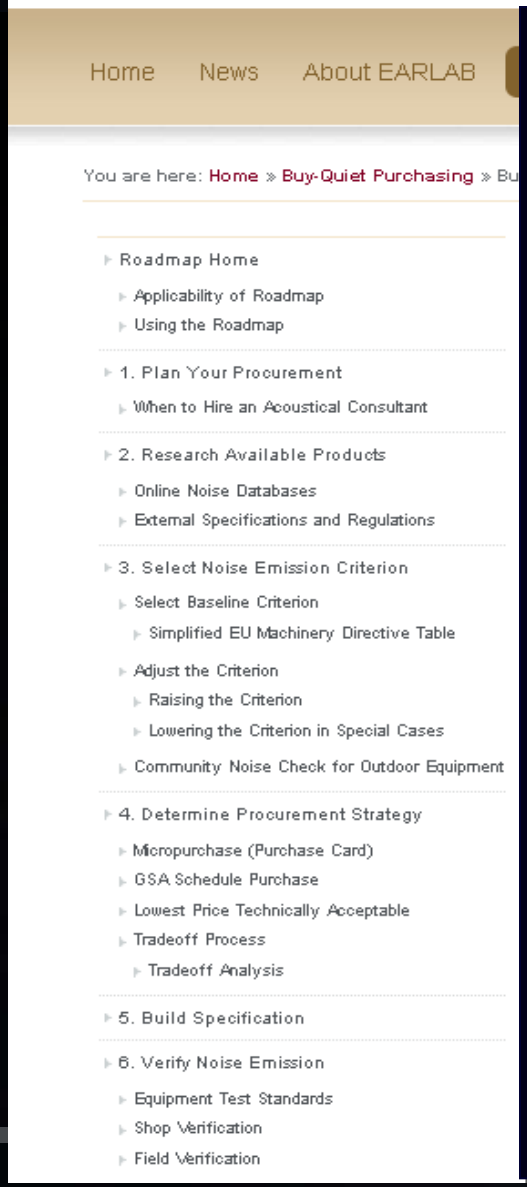


- Focused on hearing loss prevention
  - Also considers community noise impact
- Leads user through step-wise process
  1. Procurement planning
  2. Research available equipment
  5. Specification development
  6. Verify by test
- Includes key decision points for the user
  3. Noise emission criterion
  4. Simplest allowable procurement vehicle
  - ("Selection" is a procurement [CO] function)
- Includes customizable templates/forms
- Authorization forms promote *responsible* exceptions

NASA Buy-Quiet Process Roadmap
Government procurement features

- Default procurement vehicle is “tradeoff process”
  - Formalizes comparison of equipment differing in noise, cost
  - “Cost of noise” calculation calculates net present value of long-term exposure to each candidate product
  - Weigh purchase price against long term cost as part of selection process
  - (True $ = purchase $ + long-term noise exposure $)
- Simpler procurement vehicles allowed for low-risk cases, based on input data
  - Government commercial purchase card purchases
  - GSA schedule purchases
  - Lowest-price technically acceptable procurements

External visibility of *Roadmap*

- National Academy of Engineering *Technology for a Quieter America* report (2009)
- NoiseCon (2009), AIHce (2010), NHCA (2011)
- International Institute of Noise Control Engineering Buy-Quiet Symposium (Paris, 2011)
- INCE Product Noise Technical Committee voluntary product noise labeling initiative
  - Various Product Noise Rating (PNR) proposals
- NIOSH (DART) construction sector programs
- Cited on OSHA *Safety & Health Topics* site

Next up: Quiet-by-Design!

Quiet-by-Design

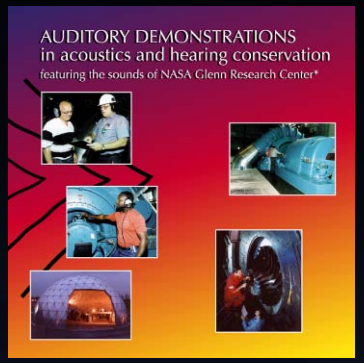
- Assume technical burden “in-house”
- Primary application: gas flow systems
  - Advanced engineering (gas dynamics, aeroacoustics)
  - Buy-Quiet *Roadmap* output provides criterion
- Applies to engineering of inhabited spaces
  - “Best-practices” architectural and engineering design
  - Requires understanding hearing loss prevention goals
- “Ground” equivalent of ISS Acoustics Program
  - Program and technical materials provide starting point
- Extension of Buy-Quiet Program implementation

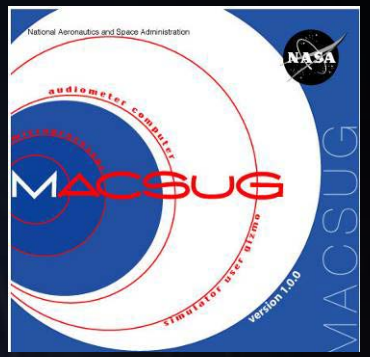
Getting there . . .

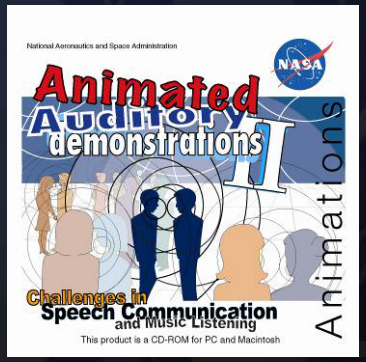
- Low-noise product design is possible
- Successful corporate programs do exist
- However . . .
  - Manufacturers must advertise quiet products
  - Corporate consumers (we) must be proactive
  - Voluntary product noise labeling needs support!
- The good news:
  - “Level playing field” promotes competition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

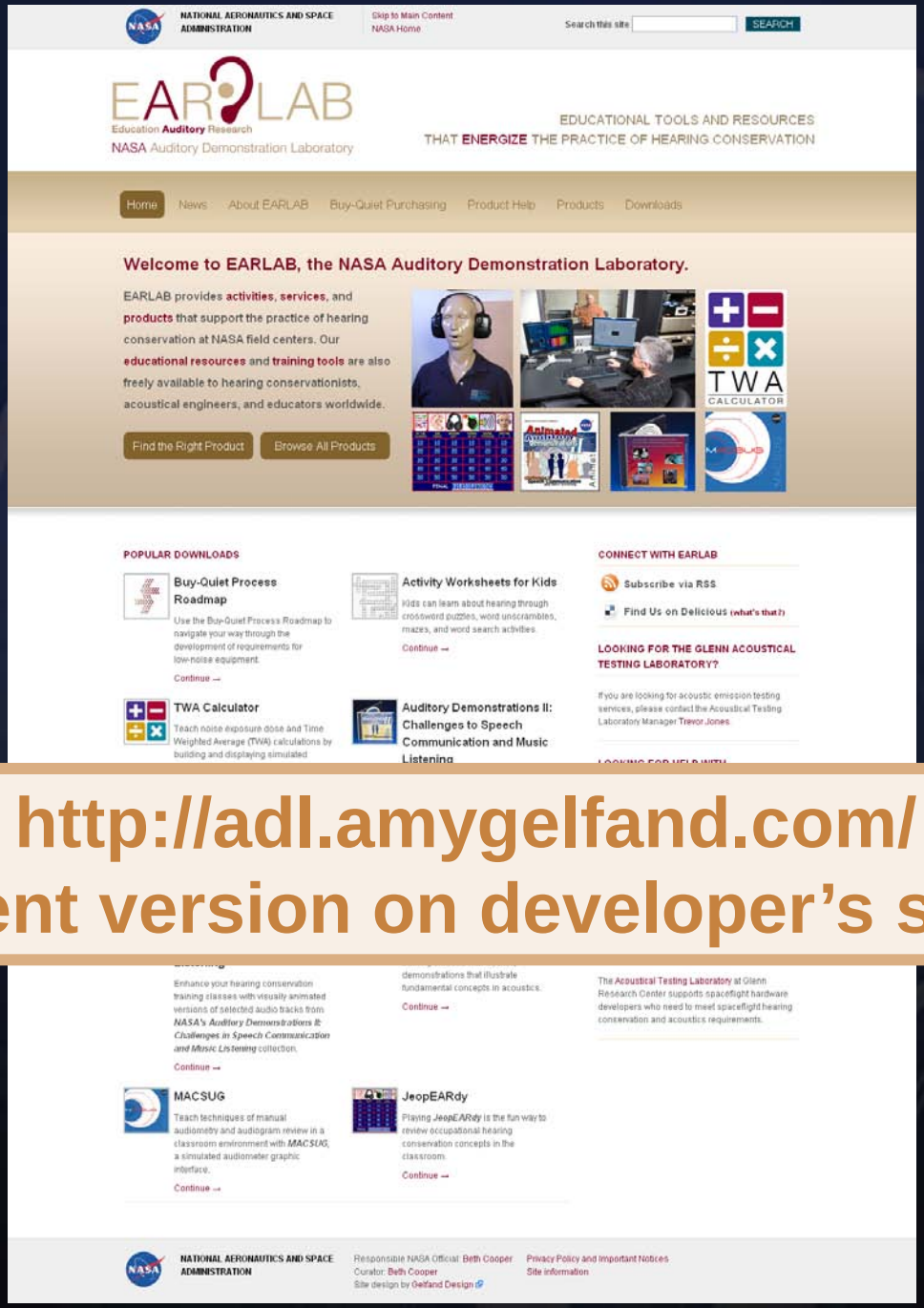
Publicly-available multimedia NASA resources for hearing conservation

- Demonstrations, trainers, and games
  - *Auditory Demonstrations in Acoustics and Hearing Conservation*
  - *Auditory Demonstrations II*
  - *ANIMATED Auditory Demonstrations II*
  - *JeopEARdy*
  - *MACSUG* audiometry and audiogram review software
  - *TWA Calculator* Noise Exposure Dose Trainer









http://adl.amygelfand.com/
(Current version on developer's server)