Noise Control The Role Of Noise Control in Systems Engineering
Disclosures

- There are no conflicts of interest or financial interests to report.
- The views expressed herein are my own and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.
Topics

• Operational Noise
• Hearing Protection
• Noise Propagation/modeling
• Noise Control Techniques
Hazardous levels of noise: Afloat and Ashore
Ships are loud places to work!
How well do you have to hear to do your job?
VA Disabilities

PERCENT OF ALL DISABILITIES FY2012

- Tinnitus
- Limitation of flexion, knee
- Lumbosacral or cervical strain
- Limitation of motion of the ankle
- Migraine
- All others
- Hearing Loss
- Post Traumatic Stress Disorder
- Scars, general
- Degenerative arthritis of the spine
- Residuals of foot injury

57.8%
USMC Hearing Aids Dispensed

Ref: R. Clifford (per comm)

Total Number

Hearing Aids: 158
Age: 38.2

Hearing Aids: 6
Age: 29.1

Hearing Aids Dispensed: 158
Age: 29.1
Hearing Protection Effectiveness

Labeled vs. Field Values

- **Laboratory**
- **Field**

Ref: E. Berger, SAFE 02
Hearing Protection - Acoustic Performance

- Maintained HPD
- Safety Glasses Intrusion
- DC Old Ear Seal

Attenuation (dB)
Ear Plug Performance

Match PPE to Noise Exposure
Advanced Hearing Protection for LCS 1

**Solution**

- Developed prototype solutions, using Air Force developed custom molded earplugs and commercial state of the art hearing protection.

- New processes for custom molded earplug deployment are being developed through a Lean Six Sigma Project and will be implemented throughout Navy platforms. LCS 1 (NAVSEA) and CVN 69 (NAVAIR) are the initial deployments.

- Teamed with NAVAIR in flight deck variant of custom molded earplugs (SBIR project)

**Description of Need**

- Required double hearing protection have deficiencies for Navy applications in high noise environments, including engine rooms and flight decks resulting in noise induced hearing loss.

- Operational Scenarios frequently require communication in high noise environments which compromise speech intelligibility and mission effectiveness.

- Uniform compatible pouch improves accessibility.

**Benefits**

- Deployment of custom molded earplugs will result in:
  - Sailor Buy-in
  - More Effective Hearing protection
  - Lower Noise induced hearing loss/tinnitus
  - Reduced communication errors
  - Situational Awareness
  - Tactical Effectiveness

Legacy foam earplugs are difficult to consistently fit and achieve full protection.
Auditory Profiles

Ref: L. Wells
Auditory Warfighter Performance

Effects of Augmented Hearing Protection/ Enhancement Devices (HPEDs) on Auditory Detection and Identification

Ref:  J. Clasing, Virginia Tech

<table>
<thead>
<tr>
<th></th>
<th>Good Hearing</th>
<th>Poor Hearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to Identify Target</td>
<td>40 sec</td>
<td>90 sec</td>
</tr>
<tr>
<td>Incorrect Command Heard by Gunner</td>
<td>1%</td>
<td>37%</td>
</tr>
<tr>
<td>Correct Target Identification</td>
<td>98%</td>
<td>68%</td>
</tr>
<tr>
<td>Enemy Targets Killed</td>
<td>94%</td>
<td>41%</td>
</tr>
<tr>
<td>Wrong Target Shot</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>Tank Crew Killed by Enemy</td>
<td>7%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Ref:  Tank Gunner Performance and Hearing Impairment (Garinther & Peters, Army RD&A Bulletin 1990, Jan-Feb 1-5)
Surface Combatants (S0229) & Submarines Have a Legacy of Acoustic Quieting (Time & Money Investments)
Noise-Induced Hearing Loss Portfolio

Systems Approach for an Integrated 6.1 / 6.2 / 6.3 Program

**Source Noise Reduction**
- Shipboard noise assessment
- Shipboard noise path validation
- Jet noise Reduction
- Laboratory modeling/ scale tests of jet noise reduction

**Incidence, Susceptibility & Evaluation**
- Assessment tools
- Hearing loss simulator
- Modeling Tools

**Personal Protective Equipment (PPE)**
- Shipboard PPE
- 3D Digitization for “Prescription” Ear Plugs
- In-Ear Dosimetry

**Medical Prevention & Treatment**
- Cell regeneration
- Pharmacologic interventions and drug delivery
- Blast interventions

**Modeling Tools**

**Hearing loss simulator**

**Assessment tools**

**Shipboard PPE**

**3D Digitization for “Prescription” Ear Plugs**

**In-Ear Dosimetry**

**Underwater comms & hearing protection**

**Blast interventions**
Technology Development

Technology Opportunities & User Needs Identified

• Process entry at Milestones A, B, or C (or within phases)

A

B

C

IOC

FOC

Concept & Technology Development

System Development & Demonstration

Production & Deployment

Operations & Support

Pre-Systems Acquisition

(Systems Acquisition
(Engineering Development, Demonstration, LRIP & Production))

Operations & Deployment

OT&E

Requirements documents

Requirement

Relationship to Requirements Process

MNS

ORD

ICD Initial Capabilities Development Document

CDD Capabilities Development Doc.

CPD Capabilities Production Doc.
Integrated Ship Specification: T-AGOS 23

T-AGOS 23 vs. T-AGOS 19
Post Construction Comparison at 3 knots

Yankaskas
Acoustic Modelling

• Acoustic modeling tool - Designer NOISE™
  – Continued to add features/technology
    • Redesigned GUI
    • Additional source elements
    • HVAC module updates
    • Updated treatment algorithms
  – Validated on CVN and LHD
    • Better understanding of F18 and JSF source levels
    • Better understanding Airborne and structureborne transmission paths

• Novel treatments for noise control
  – Validated effectiveness of spray-on treatment on CVN
  – Identified replacement treatment for CVN island acoustic shielding

• Noise control methodologies
  – Applied to marine vehicle
  – Reclamation powerplants
HVAC - Construction
HVAC – High Velocity

Acoustic Insulation Compromised by a Larger Fan
GT EXHAUST

• PROBLEM
  – Recirculation evident

• SOLUTION
  – Smooth flow
Flow Control
GT Intake and Exhaust

- **Problem:**
  - Inefficient design with much turbulent flow

- **Solution**
  - Use CFD to design smooth flow
LCS 1 Noise Overages

01 Level

Main Deck
Location Risk: Airborne Noise Levels

Flag Galley
Captain’s Galley
Chaplain’s Complex
03 level Wardroom Galley

Sound levels
- > 84 dB
- 80 ≤ 84 dB
- 70 ≤ 80 dB
- 65 ≤ 70 dB
- ≤ 65 dB
- not estimated
Acoustic Holography

SR-03-96-0-L
Run5 – Cat 2 Launch – Hornet (F-18C)
800-2500 Octave Band

dB (dBA) (Pa)
100.
99.4
98.8
98.2
97.6
97.
96.4
95.8
95.2
94.6
94.
Innovative Treatments: Tech21 Temp-Coat

Thermal Advantages of the TEMP-COAT System

Un-coated section of the steam catapult trough
- Temperature of steel plate is 109°F
- Thermal Transfer entering ship envelope can escape into interior of vessel at damages area of lagging
- Allows potential for condensation to develop
- Personnel discomfort due to high heat buildup in rooms in which catapult passes

Coated section of the steam catapult trough
- Temperature of steel plate is 82.2°F
- Adheres directly to substrate blocking thermal transfer from entering the ship envelope
- Allows the ability to significantly curb or stop condensation aiding the fight against Corrosion Under Insulation
- Reduces temperatures in spaces
Sources of Noise are well known!

The usual acoustic culprits:

- Fans
- Ventilation
- Motors
- Pumps
- Propellers
Surface Combatants (S0229) & Submarines Have a Legacy of Acoustic Quieting (Time & Money Investments)
Engagement Required

• Advocacy for noise control
• Noise Control is Systems Engineering
  – Requires less acoustic treatment (i.e. weight)
  – Less maintenance (DD 963)
  – Fuel savings
  – Readily accomplished in design
• Vigilance on instruction revisions
• Hearing preservation vice hearing conservation
Questions ?