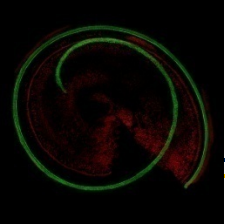


Noise Control The Role Of Noise Control in Systems Engineering

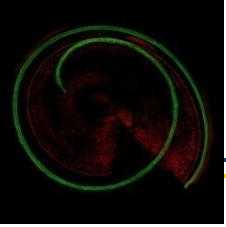


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703-696-6999



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.

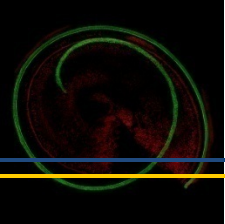


Topics

- Operational Noise
- Hearing Protection
- Noise Propagation/modeling
- Noise Control Techniques

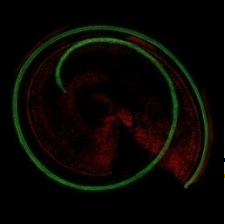
Hazardous levels of noise: Afloat and Ashore





Ships are loud places to work!



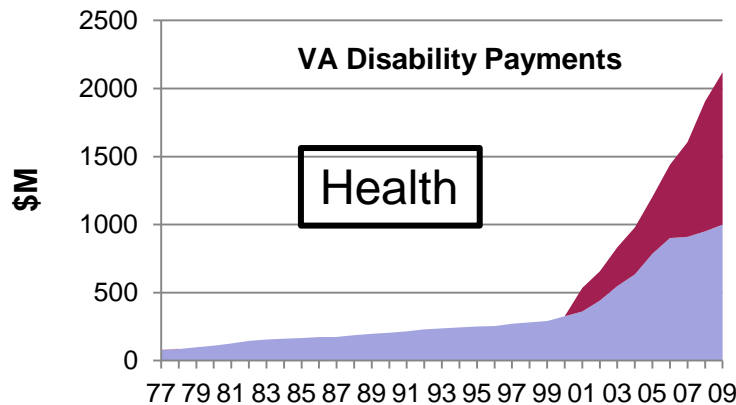
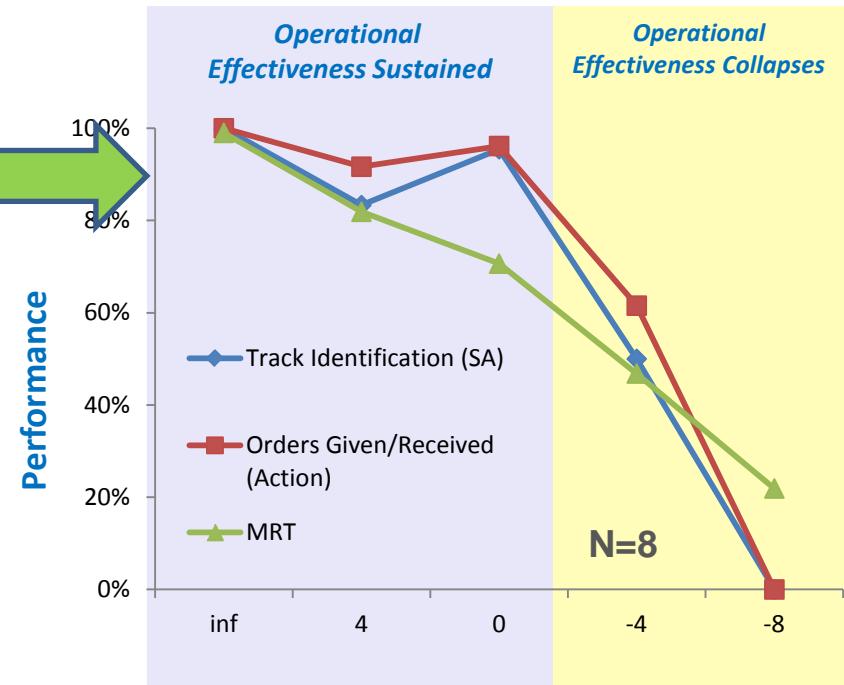
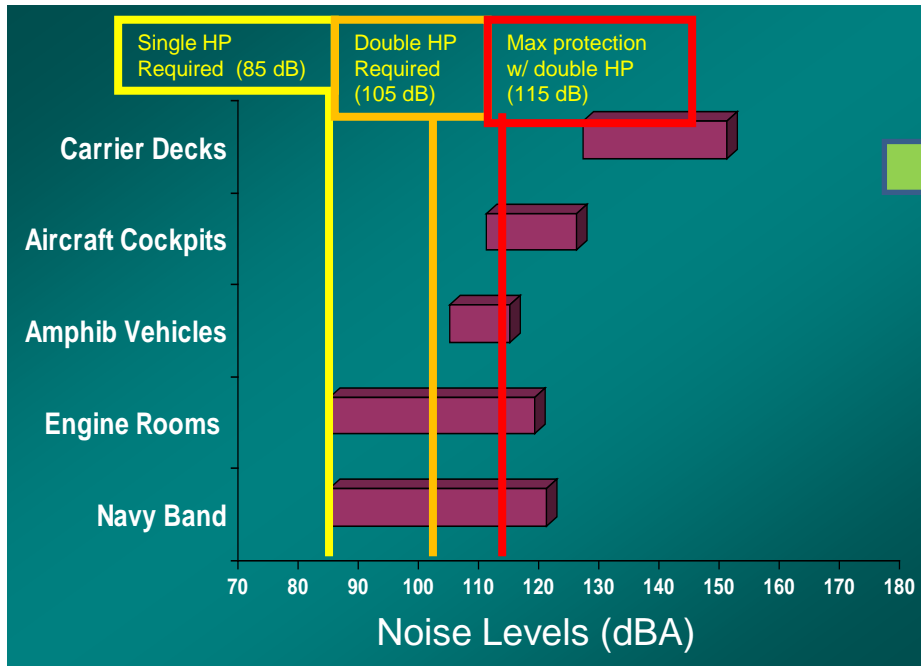


How well do you have to hear to do your job?



Noise-Induced Hearing Loss

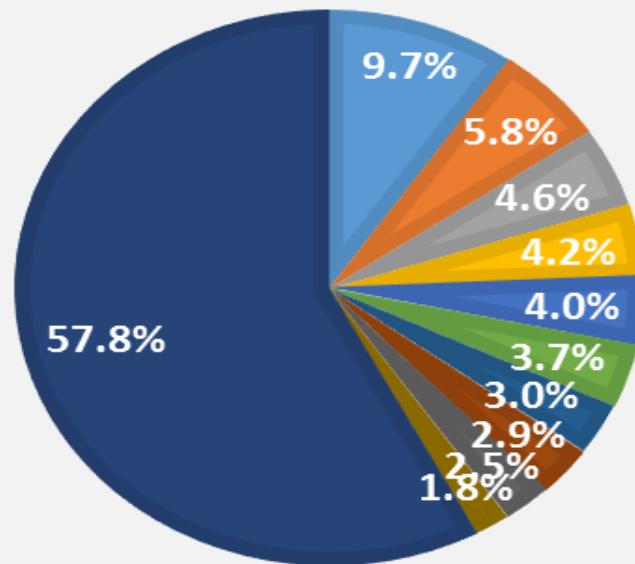
Hazardous Noise Exposures Impact



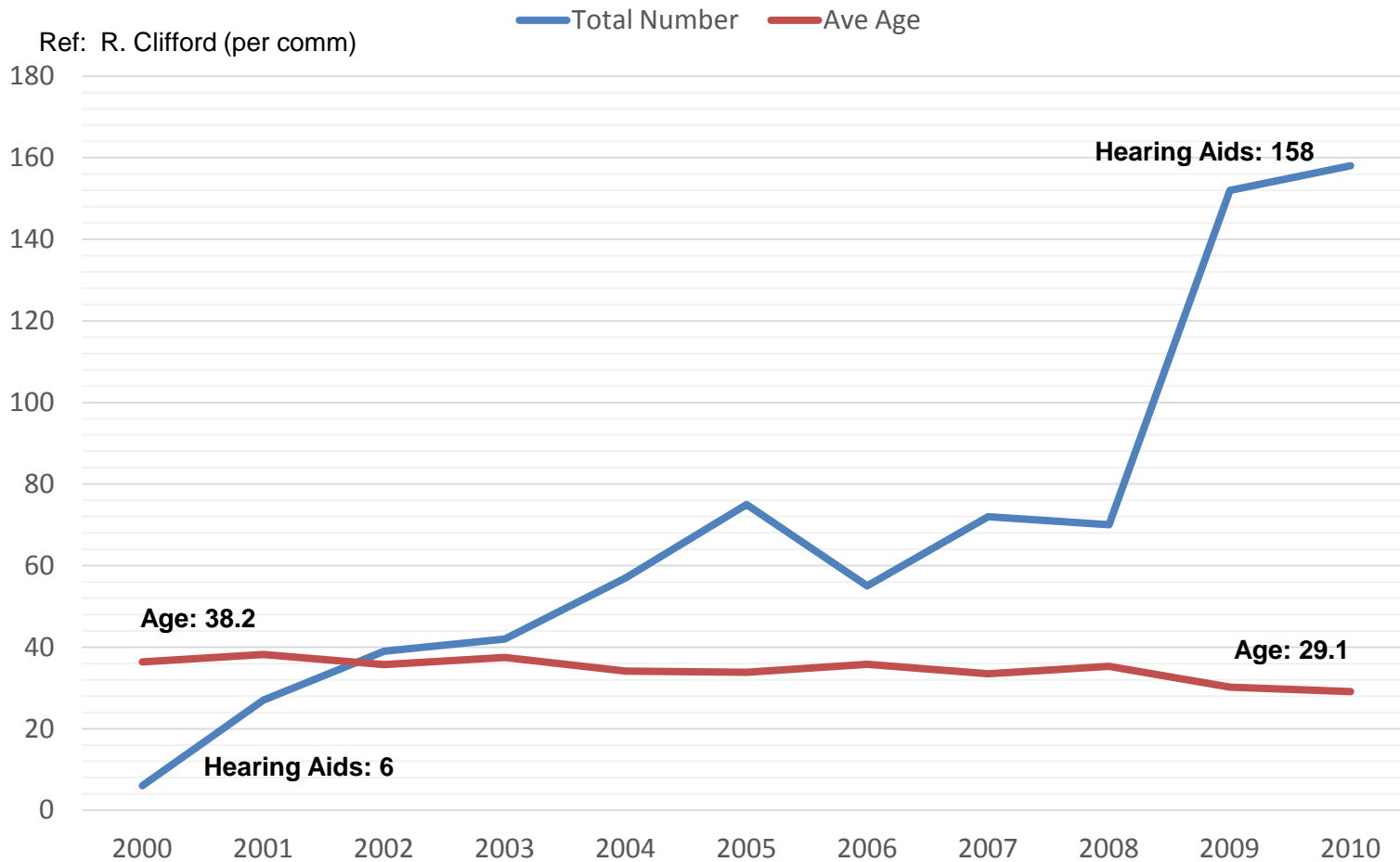
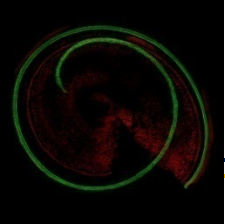
VA Disabilities

PERCENT OF ALL DISABILITIES FY2012

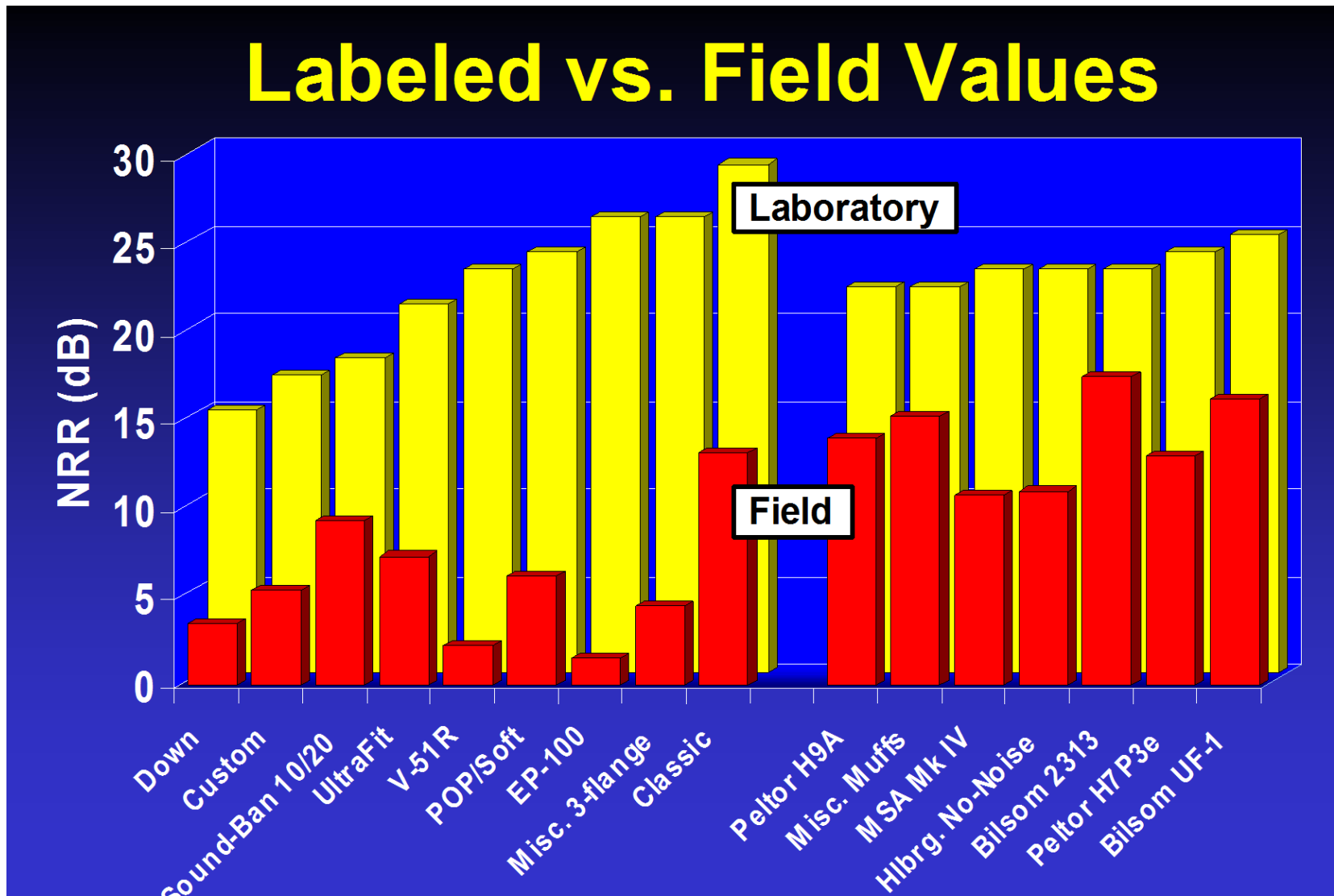
- Tinnitus
- Hearing Loss
- Limitation of flexion, knee
- Post Traumatic Stress Disorder
- Lumbosacral or cervical strain
- Scars, general
- Limitation of motion of the ankle
- Degenerative arthritis of the spine
- Migraine
- Residuals of foot injury
- All others

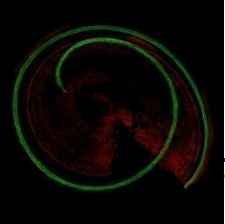


USMC Hearing Aids Dispensed

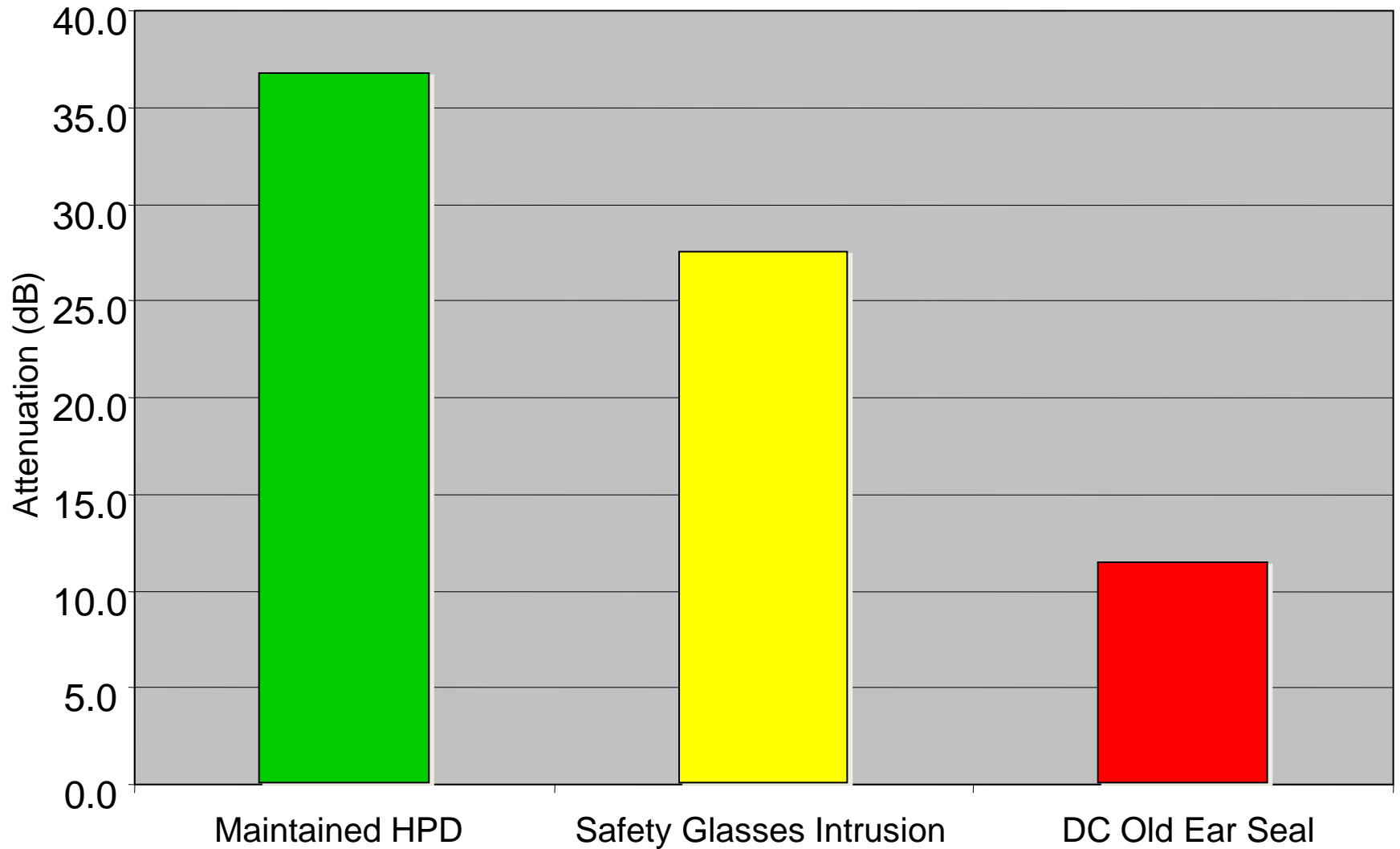


Hearing Protection Effectiveness

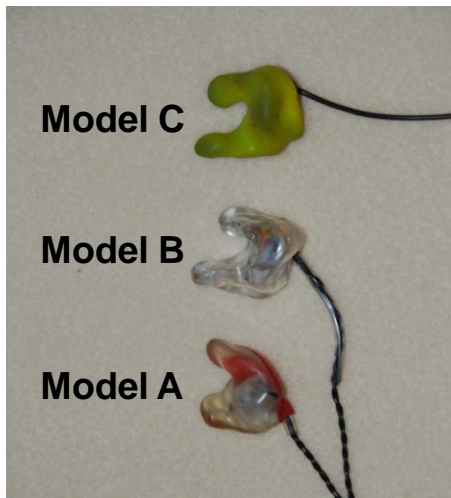
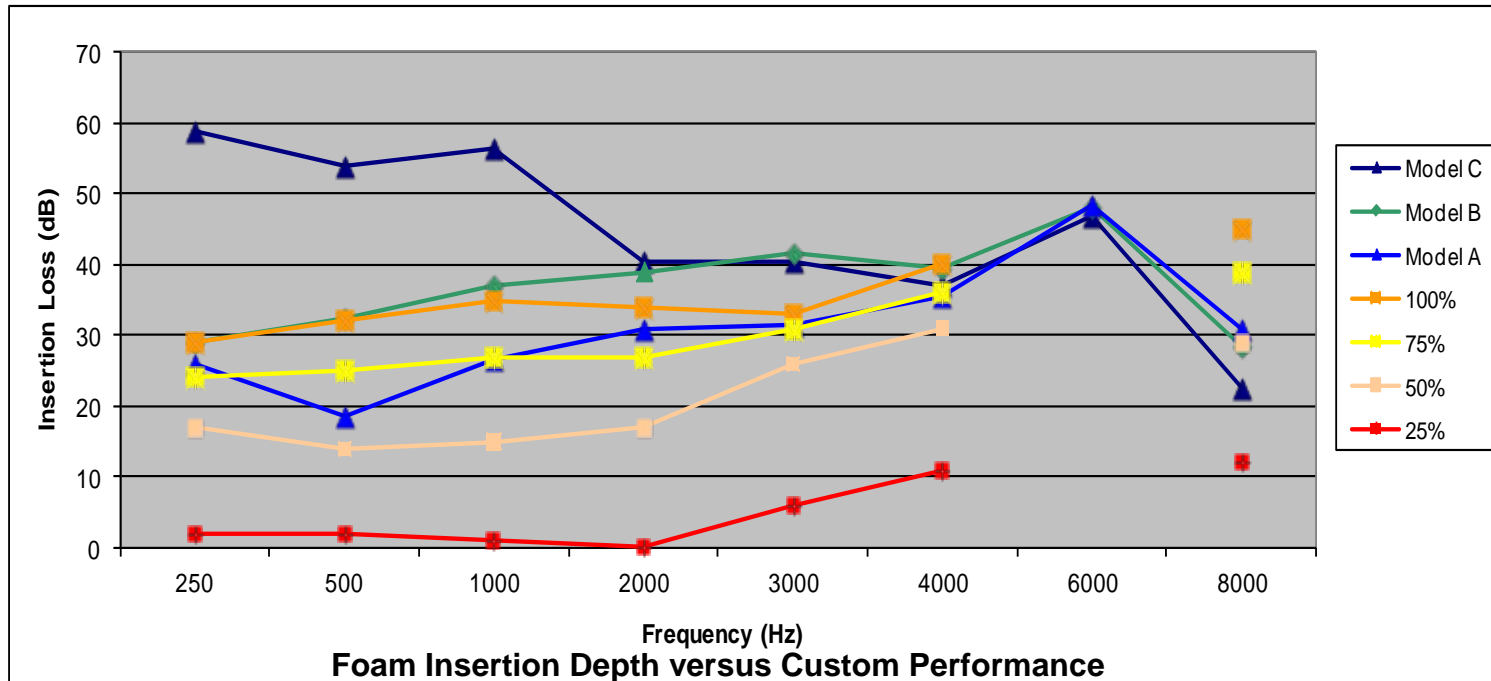
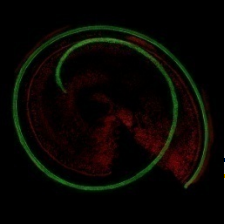




Hearing Protection - Acoustic Performance



Ear Plug Performance



Match PPE to Noise Exposure

Advanced Hearing Protection for LCS 1



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.

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)

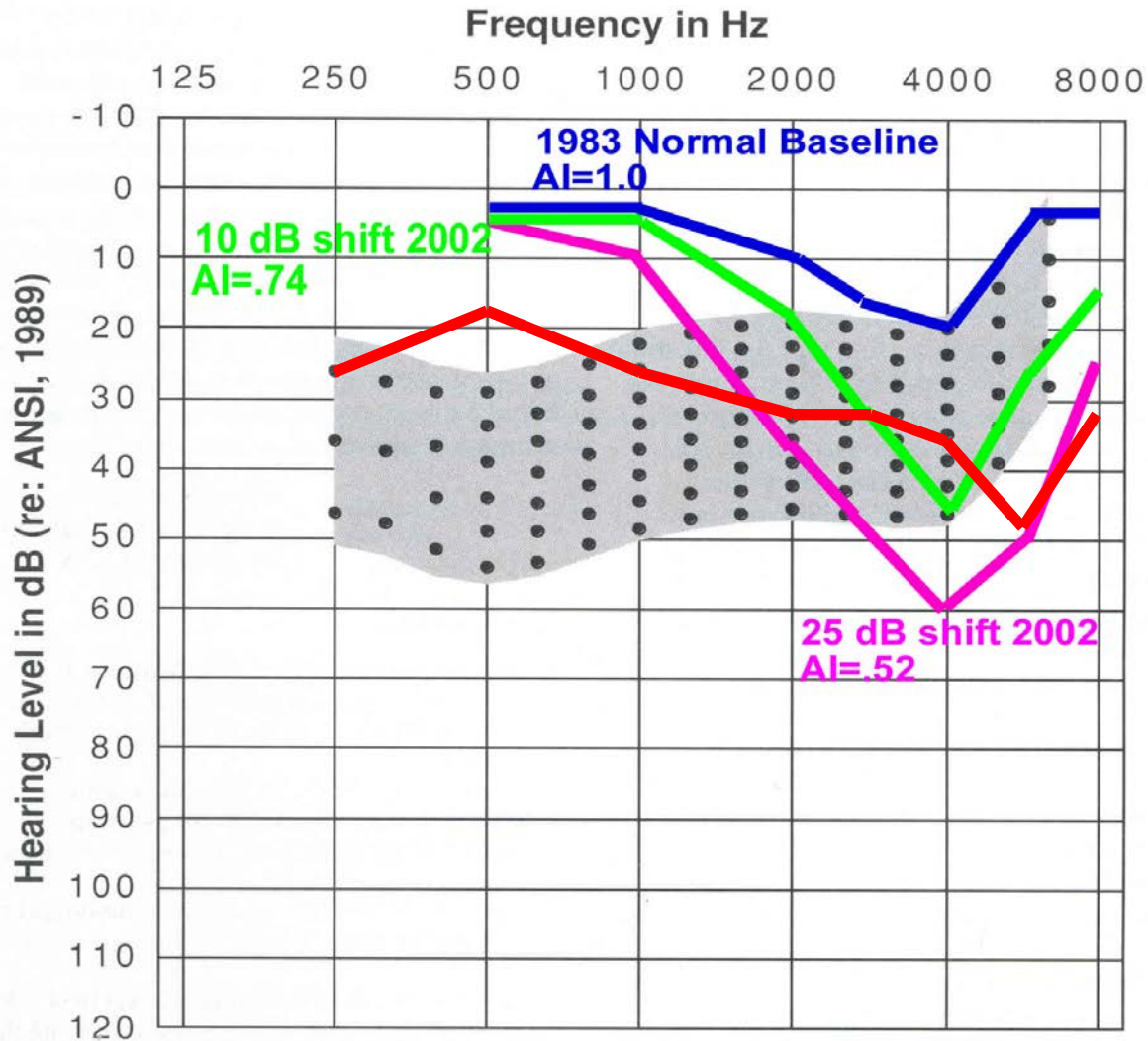
Benefits

- 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

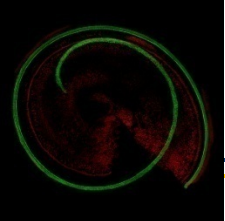
Legacy foam earplugs are difficult to consistently fit and achieve full protection.



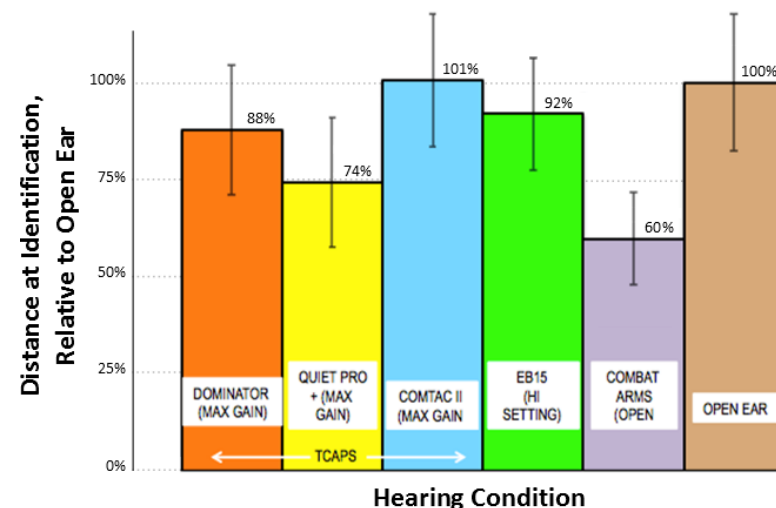
Auditory Profiles



Auditory Warfighter Performance



Identification, Gunshot
(Larger percents are better.)



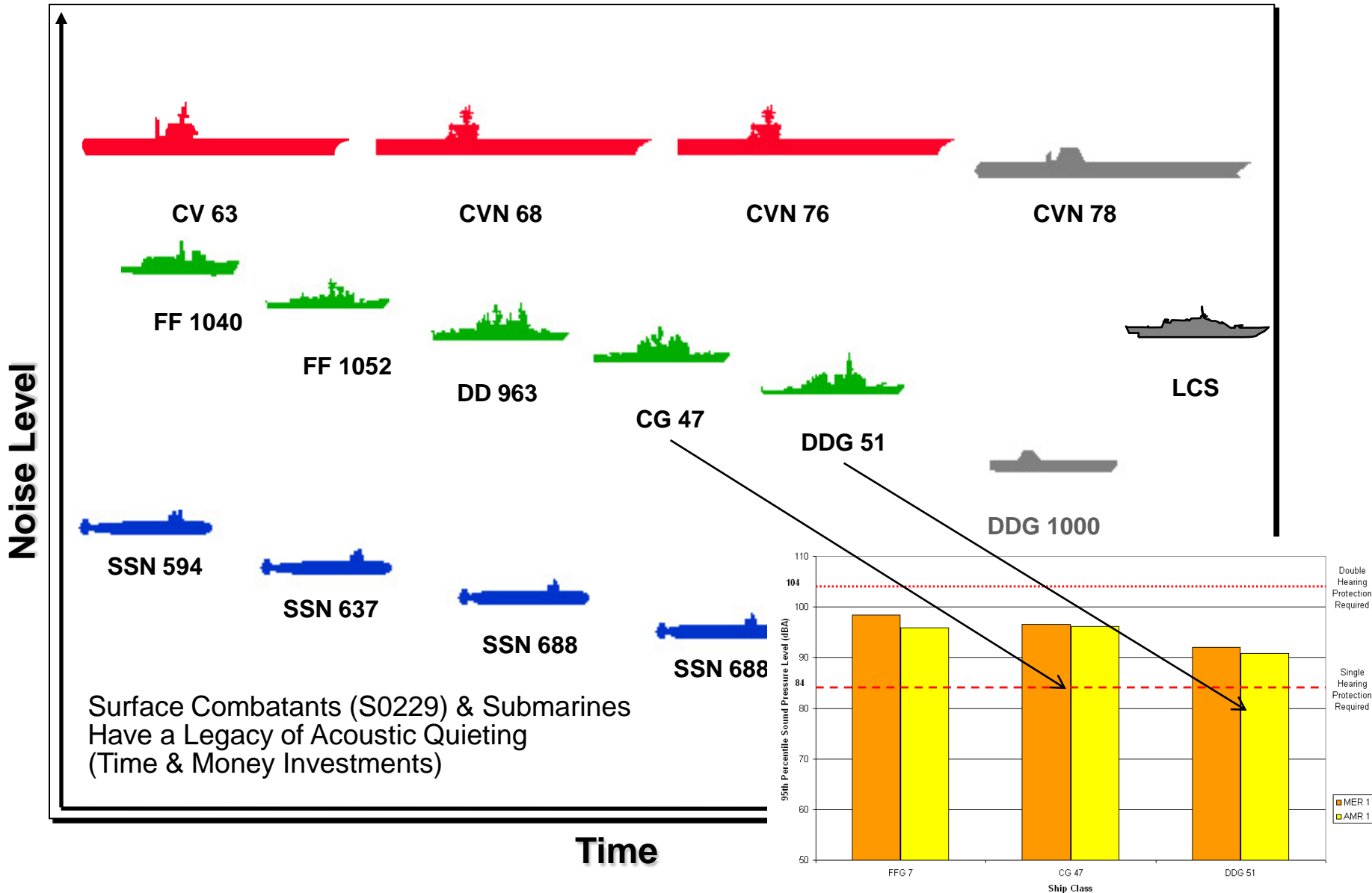
Effects of Augmented Hearing Protection/ Enhancement Devices (HPEDs) on Auditory Detection and Identification

Ref: [J. Clasing, Virginia Tech](#)

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

Ref: [Tank Gunner Performance and Hearing Impairment](#)
(Garinther & Peters, Army RD&A Bulletin 1990, Jan-Feb 1-5)

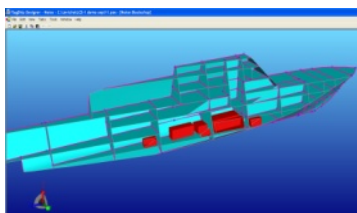
Hazardous Noise Control



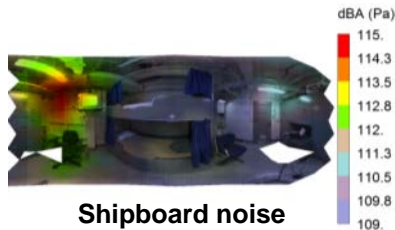
Noise-Induced Hearing Loss Portfolio

Systems Approach for an Integrated 6.1 / 6.2 / 6.3 Program

Source Noise Reduction

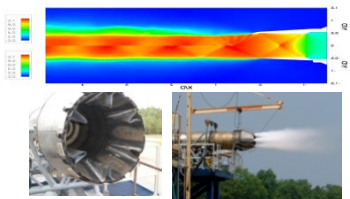


Shipboard noise assessment



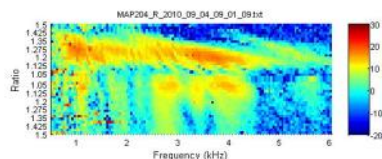
Shipboard noise path validation

Jet noise Reduction



Laboratory modeling/ scale tests of jet noise reduction

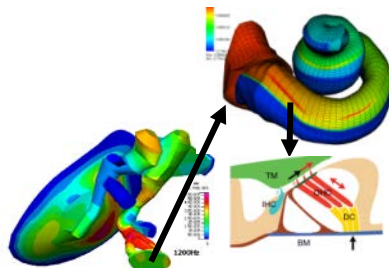
Incidence, Susceptibility & Evaluation



Assessment tools



Hearing loss simulator

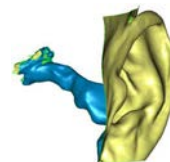


Modeling Tools

Personal Protective Equipment (PPE)



Shipboard PPE



3D Digitization for "Prescription" Ear Plugs

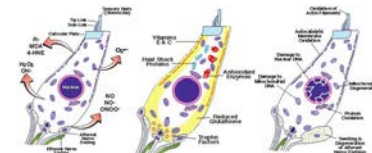


In-Ear Dosimetry



Underwater comms & hearing protection

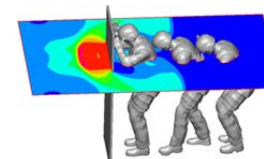
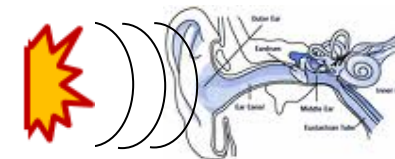
Medical Prevention & Treatment



Cell regeneration

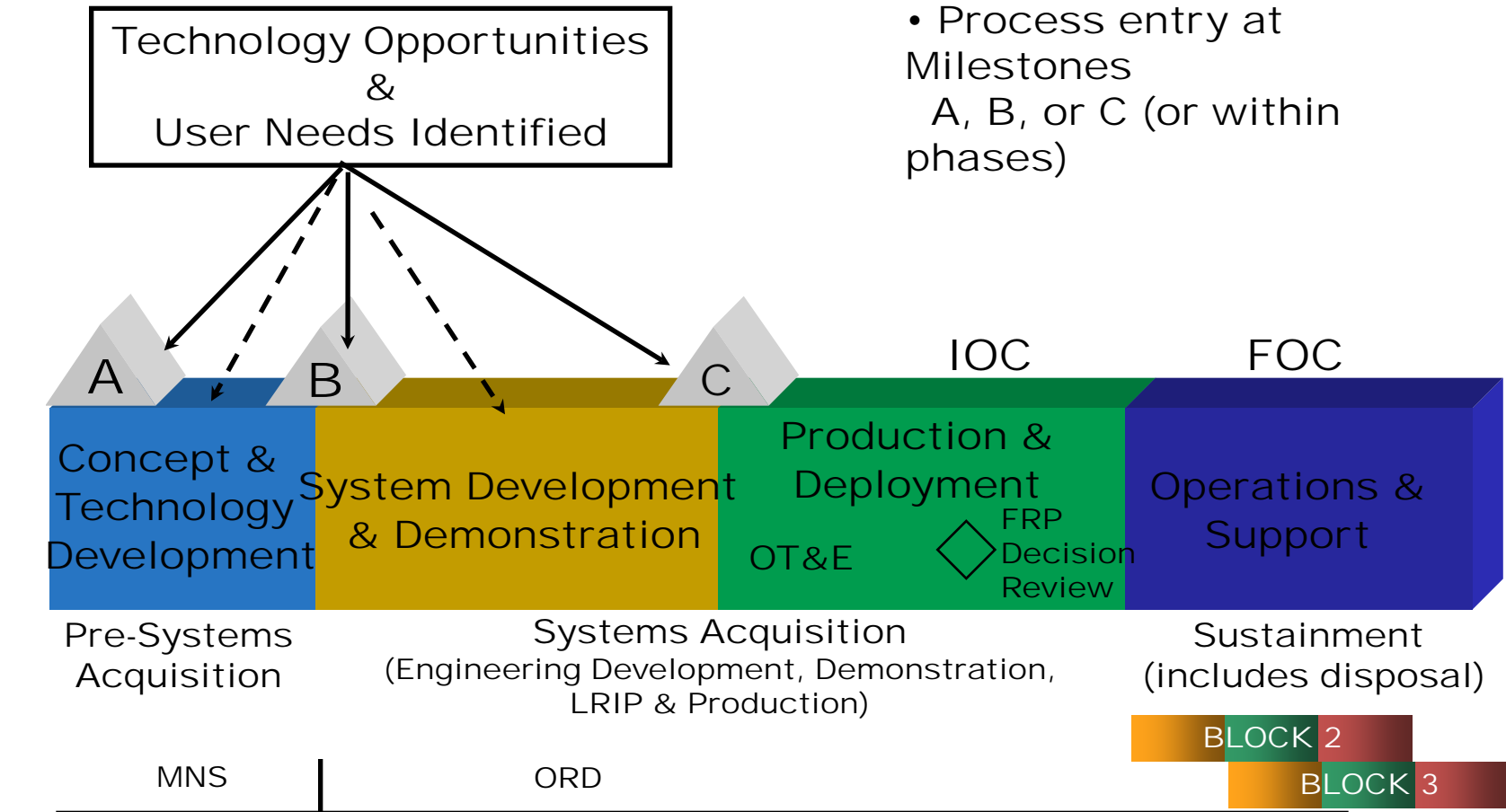


Pharmacologic interventions and drug delivery

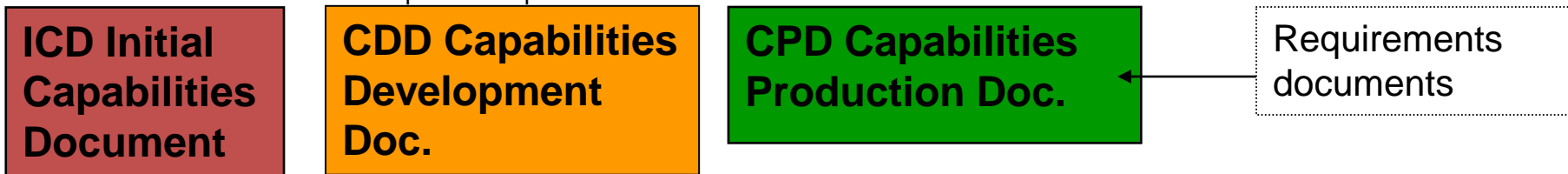


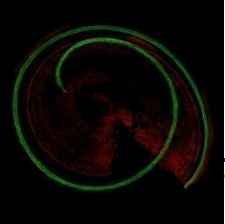
Blast interventions

Technology Development



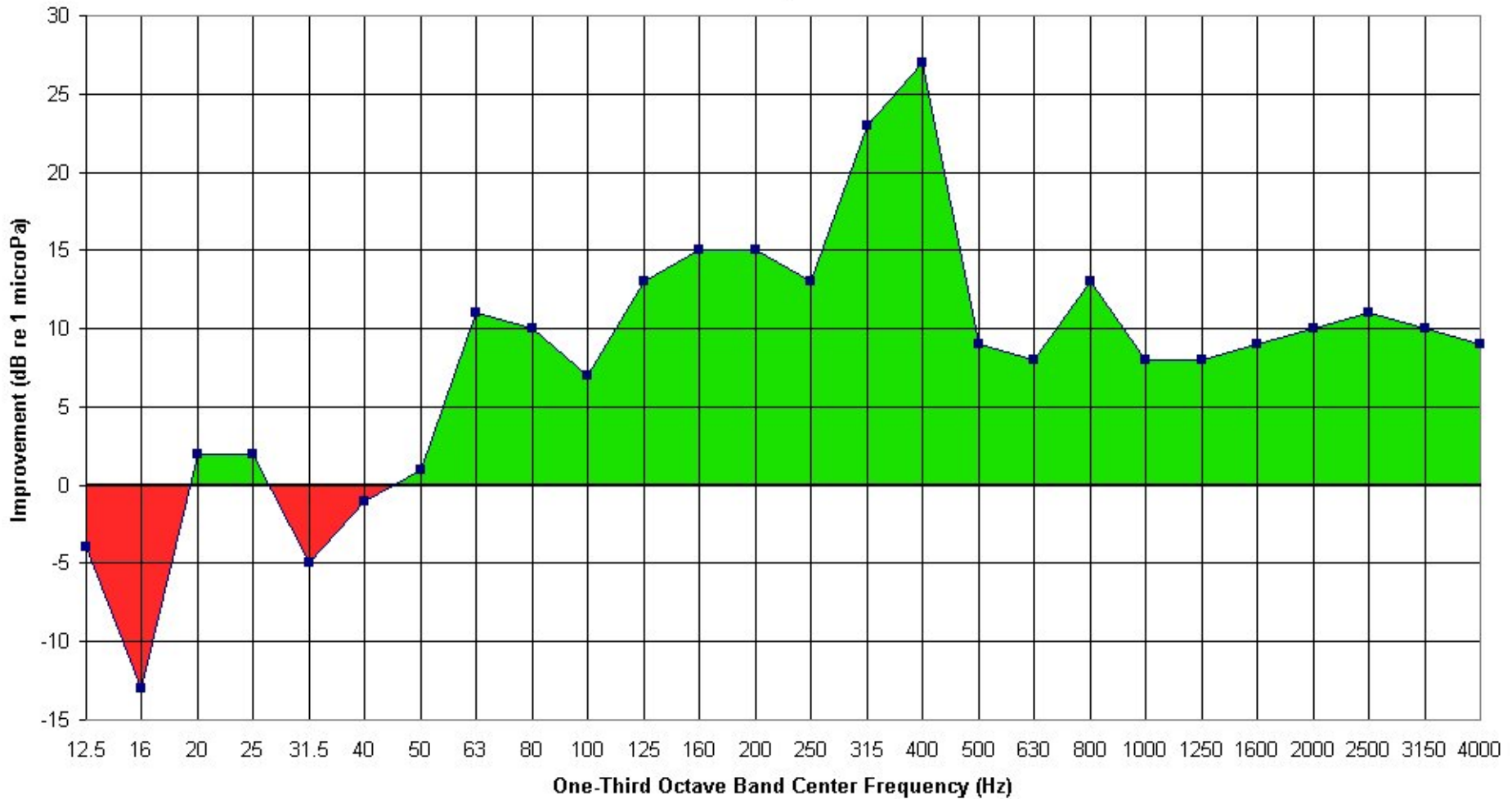
Relationship to Requirements Process





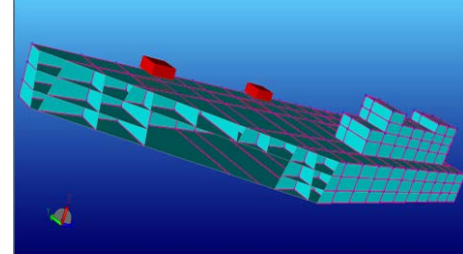
Integrated Ship Specification: T-AGOS 23

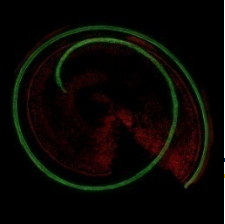
T-AGOS 23 vs. T-AGOS 19
Post Construction Comparison at 3 knots



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

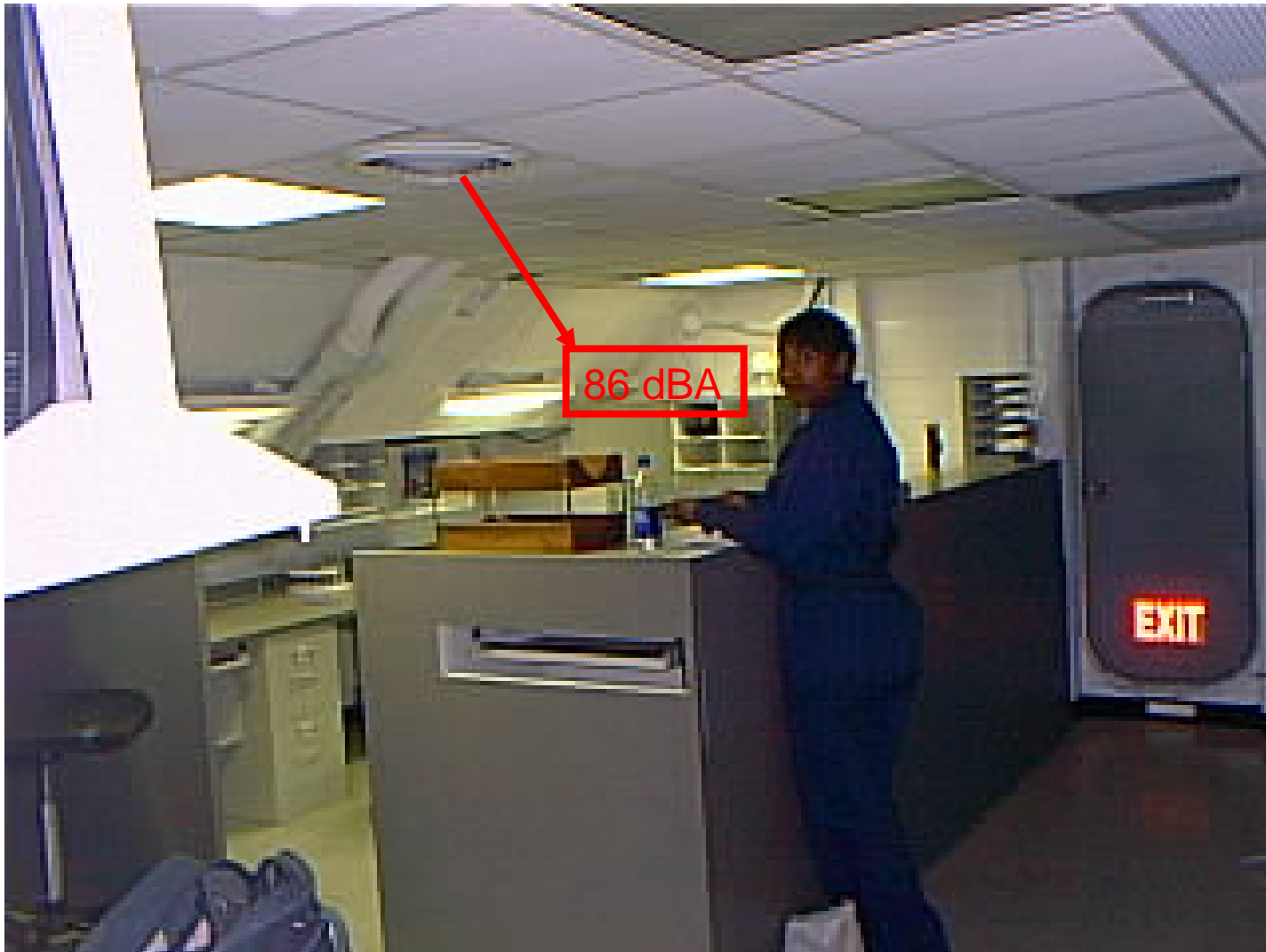




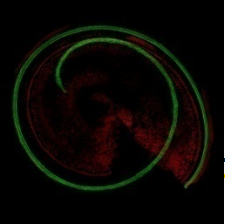
HVAC - Construction



HVAC – High Velocity



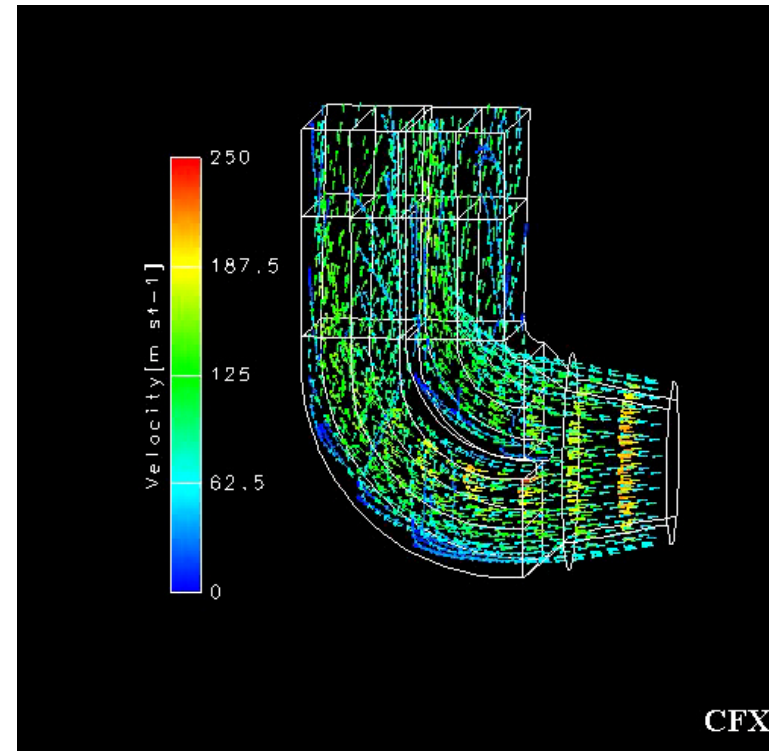
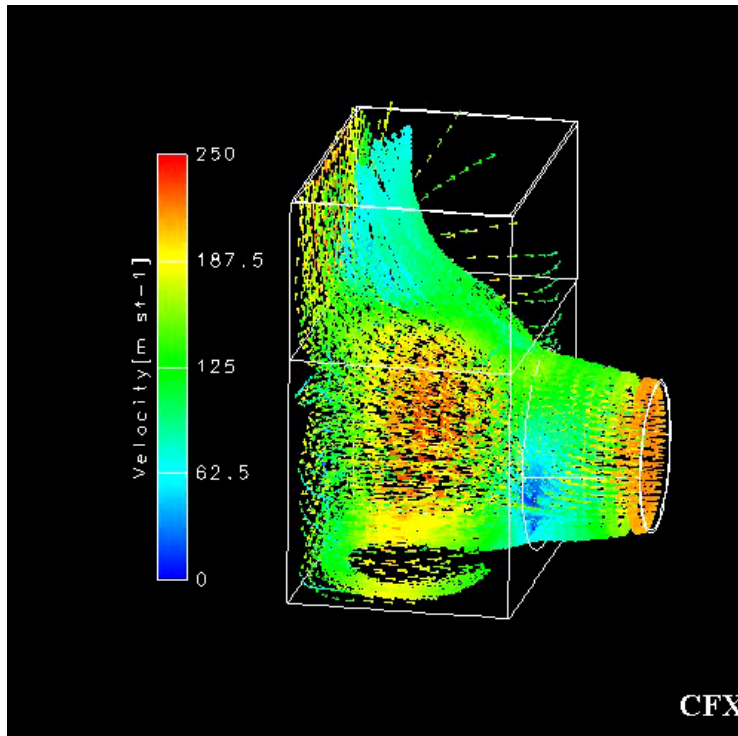
**Acoustic Insulation Compromised
by a Larger Fan**

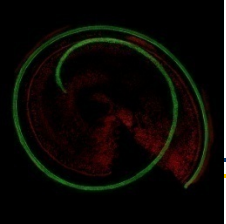


GT EXHAUST

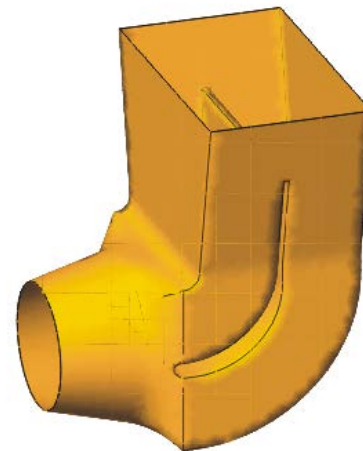
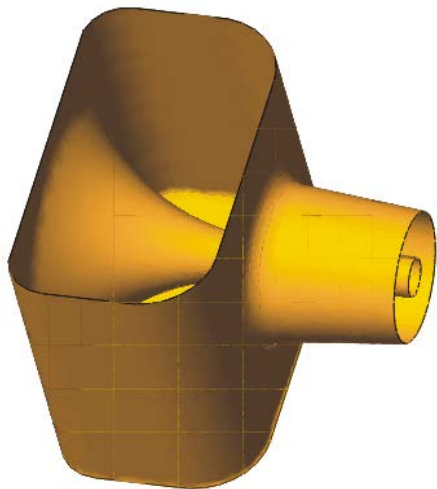
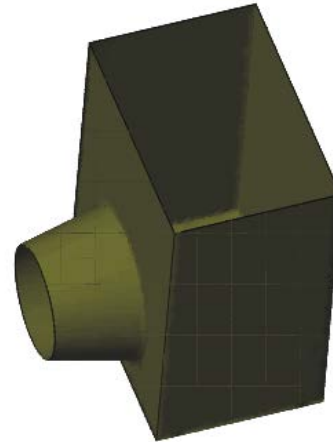
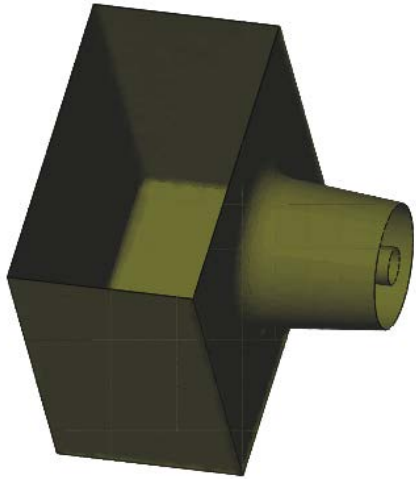
- PROBLEM
 - Recirculation evident

- SOLUTION
 - Smooth flow





Flow Control



GT Intake and Exhaust

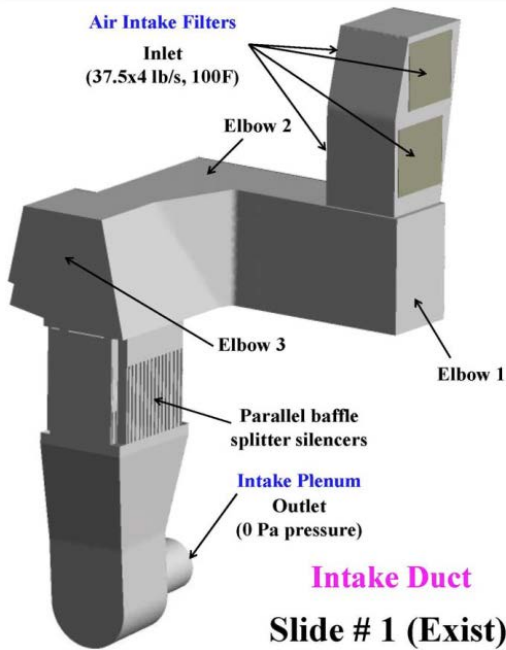
- Problem:

- Inefficient design with much turbulent flow

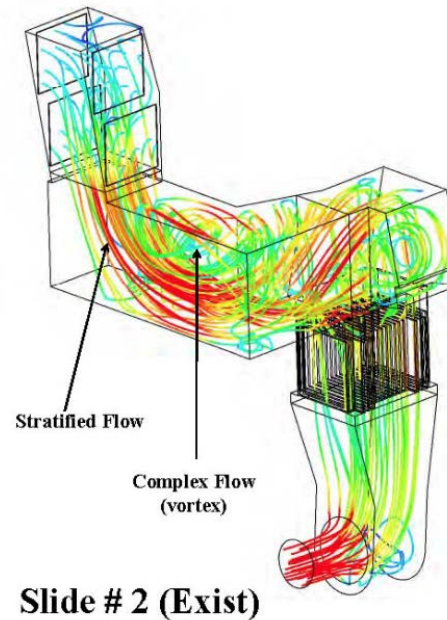
- Solution

- Use CFD to design smooth flow

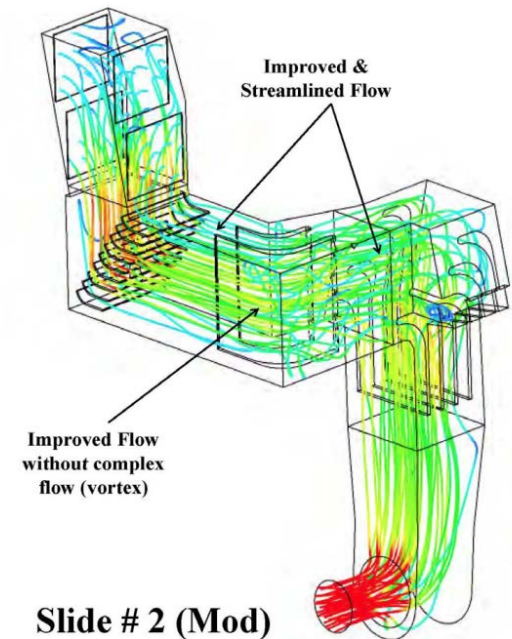
Intake Configuration and Boundary Condition



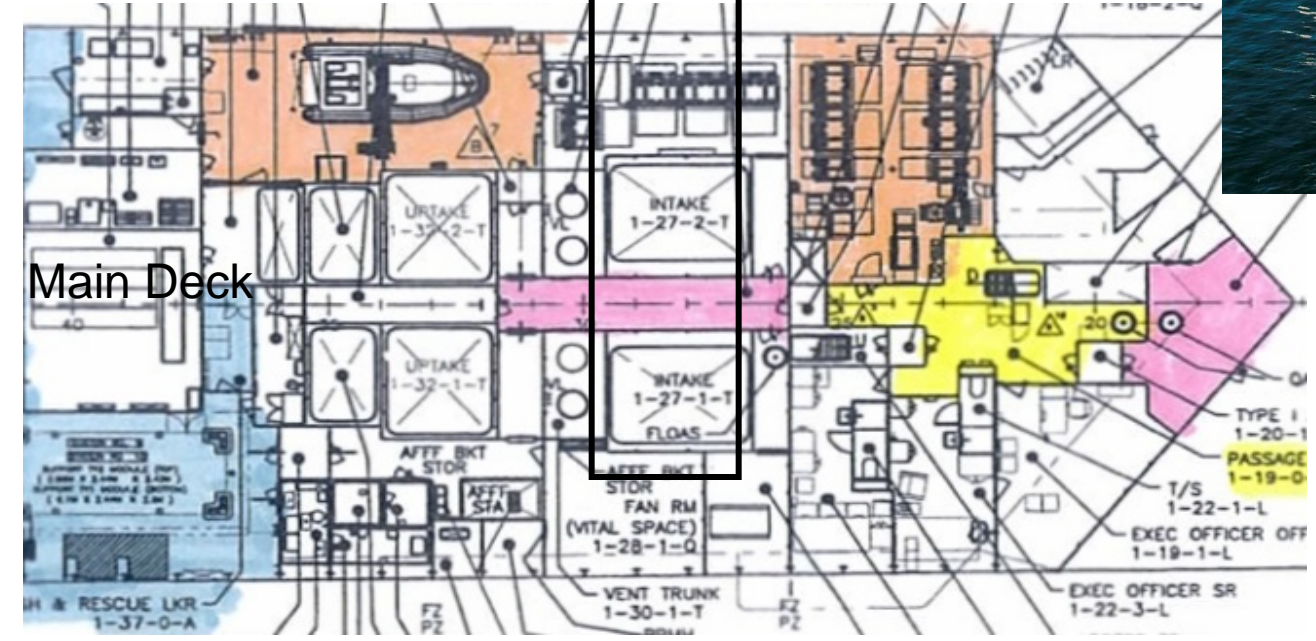
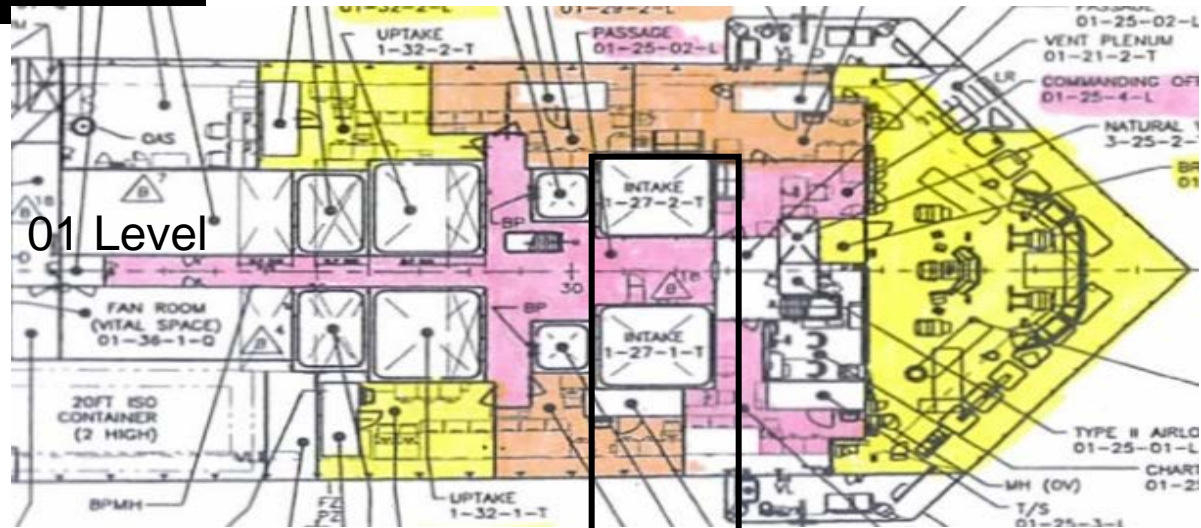
Streamline inside the Intake (Isometric View)



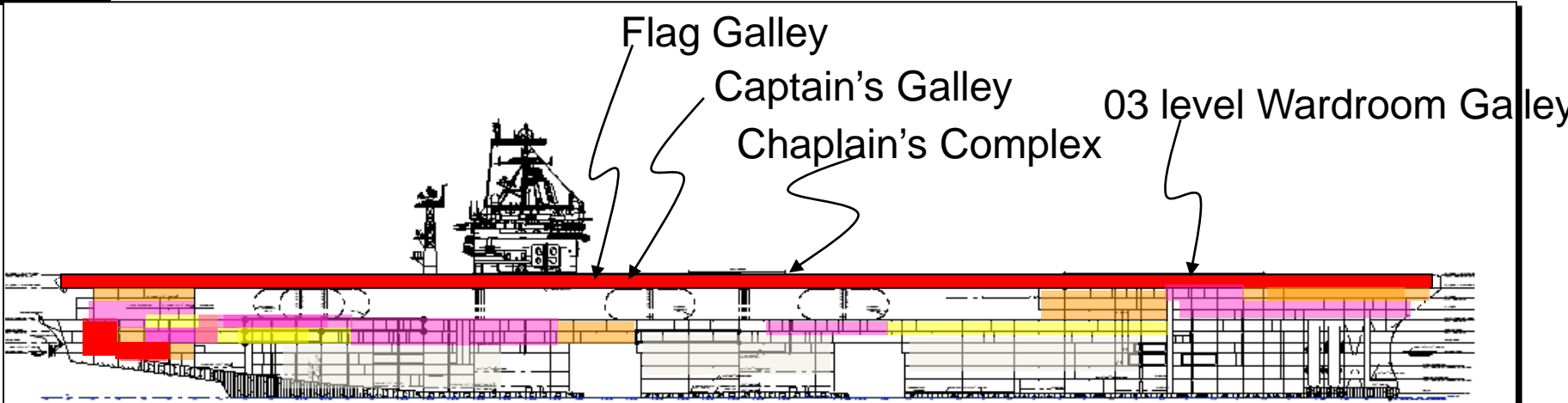
Streamline inside the Intake (Isometric View)





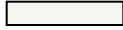



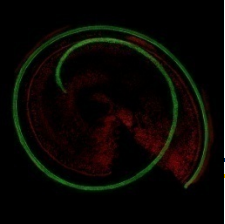
LCS 1 Noise Overages



Location Risk: Airborne Noise Levels



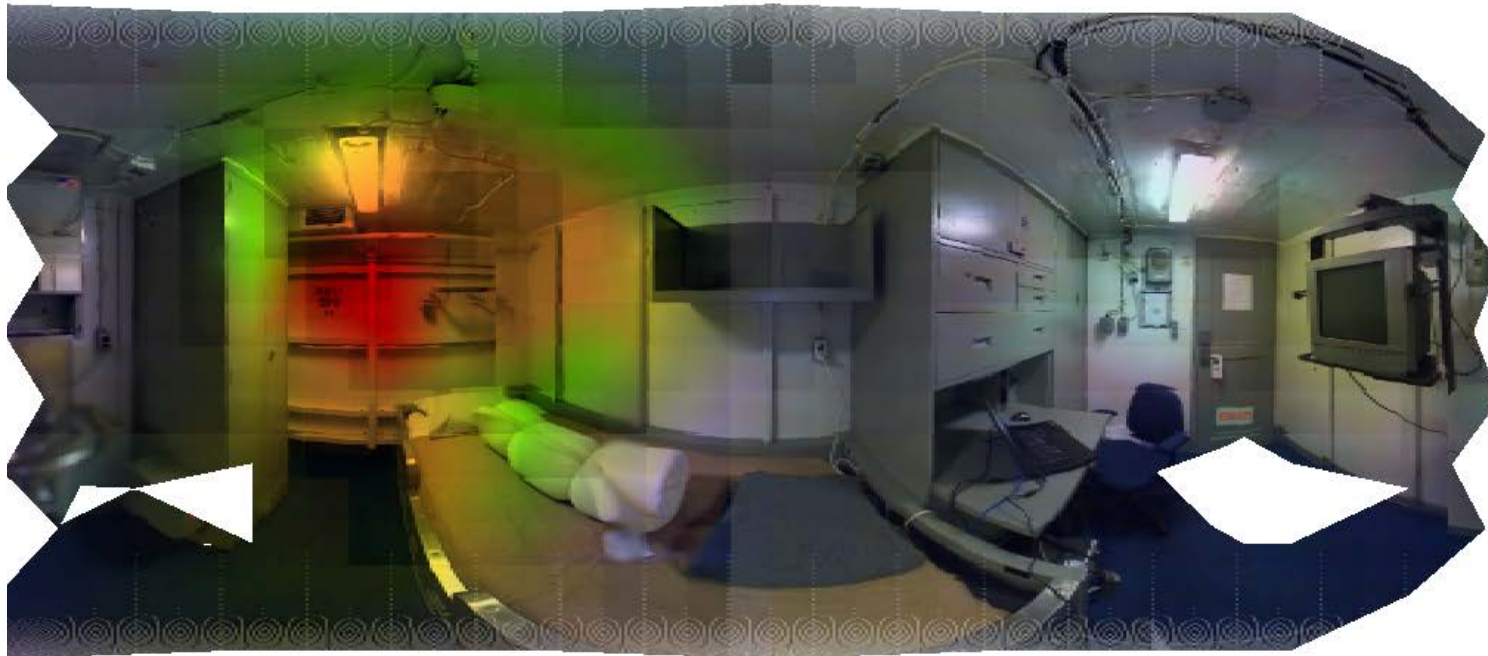
	Sound levels	> 84 dB
	Sound levels	$80 \leq 84$ dB
	Sound levels	$70 \leq 80$ dB
	Sound levels	$65 \leq 70$ dB
	Sound levels	≤ 65 dB
	Sound levels	not estimated



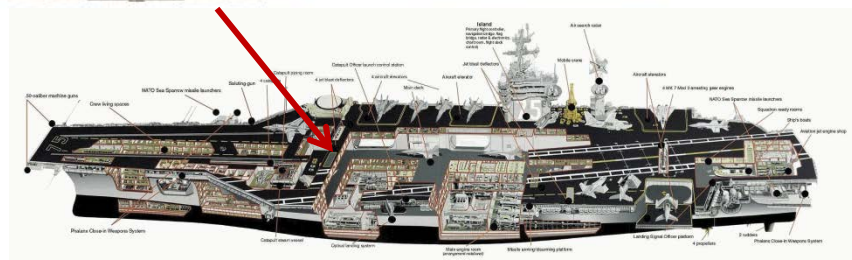
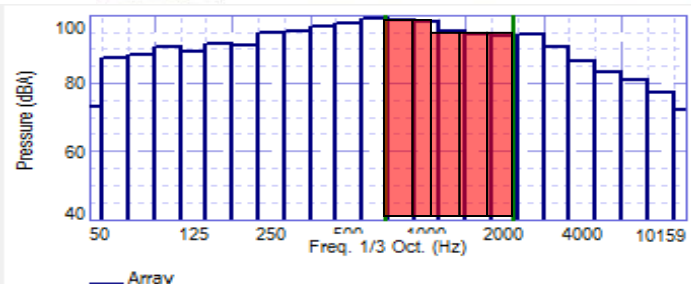
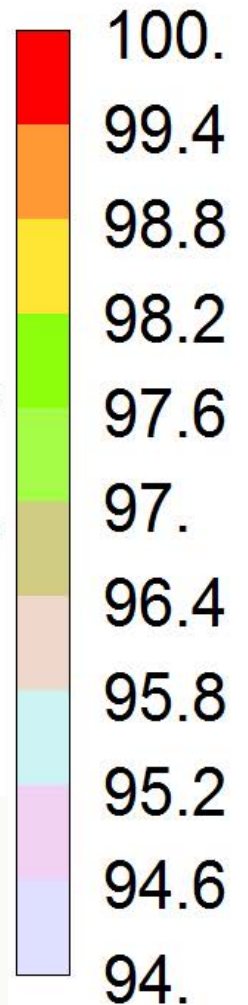
Acoustic Holography

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

800-2500 Octave Band



dBA (Pa)





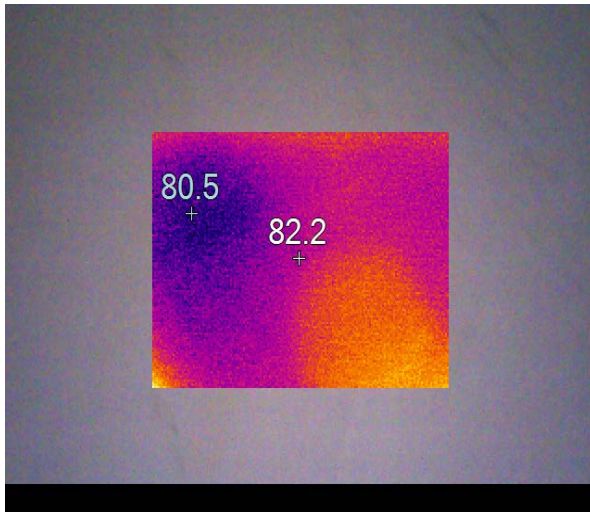
Innovative Treatments: Tech21 Temp-Coat

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

Condensation Mitigation

USS ANZIO (CG 68)

2-236-1
AEGIS COOLING RM NO. 1
2-236-0-Q

ELECTRICAL SAFETY PRECAUTIONS

ELECTRICAL EQUIPMENT SHALL BE
PERSONS ONLY.
CONSIDERED ACTIVE UNTIL TESTED WITH
KNOWN TO BE IN GOOD CONDITION.
PERSONS SHALL NOT APPROACH
VOLTAGE, EXCEPT TO ACCOMP
DURING WHETHER A CIRCUIT IS ENER
VOLTAGES AND IS STRICTLY FORBID
ION BOXES, LEVER TYPE BOXES AND
FULLY CLOSED.
CHANCE OF INJURY, SHALL BE PRO
OF SPLICES, THE PROPER LENGTH,
L AREA FOR CURRENT REQUIREMENTS,
ALL OBJECTS IN POCKETS OR OTHER
STATUS.
ARTICLES IN OR NEAR SWITCHBOARDS
IS STRICTLY FORBIDDEN.
ELECTRICAL MACHINERY ESPECIALLY
CERTAIN CASES SUFFICIENT TO CAUSE
WARRANT TO GROUND BEFORE WORKING
USER WHICH IS CONNECTED TO A DE
SCONNECTED ENTIRELY. SHORT CIRCUIT
SWITCHES
KEEP FREE HAND CLEAR AT ALL TIMES.
TO BE DONE OFF CIRCUIT.
SWITCHES
BEFORE THAT
BE READY
ARE NOTIFIED TO STAND CLEAR.
TION.
BEFORE PROTECTIVE DEVICES ARE SET
MAINTENANCE
PANELS, BOXES, ETC., SHALL BE
WITH PAINTER'S DUSTER HAVING NO ME
STICS ABOUT 4" LONG, OR A BELLOW'S
METALLIC PART OR NEAR THE NOZ
CLEANING.
DUSTS, OR ANY INFLAMMABLE VA
VENTILATION MUST BE PROVIDED TO

**Bare metal
1066**

DE-ENERG
1. OPEN A
CUT
2. TAG A
SEPAR
CIRCU
3. DISCHARGE EACH CIRCUIT TO GROUND BEFORE ATTEMPTING WORK. DISCH
SERIES SHOULD ALSO BE DISCHARGED BETWEEN TERMINALS.
4. USE PROTECTIVE SAFETY GROUNDS WHENEVER POSSIBLE.
ENERGIZED CIRCUITS
1. NO WORK SHALL BE PERFORMED ON ENERGIZED SWITCHBOARDS WITHOUT
PERMISSION FROM THE COMMANDING OFFICER.
2. WORK APPROVED BY THE COMMANDING OFFICER SHALL BE PERFORMED BY
AN ELECTRICIAN'S MATE UNDER THE SUPERVISION OF AN ELECTRICIAN OR
EXPERIENCED ENGINEER OFFICER.
THE FOLLOWING PRECAUTIONS SHOULD BE TAKEN
(A) PROVIDE AMPLE LIGHTING.
(B) REMOVE LOOSE CLOTHING.
(C) REMOVE HOPPER TO
(D) WOOD, OR SEVERAL LAYERS OF DRY CARBON
(E) COVER WORKING METAL TOOLS WITH INSULATING RUBBER OR VINYL
(F) TAPE (NOT FRICTION TAPE).
(G) WORKER SHOULD INSULATE LIVE, METAL PARTS NEAR WORK BEFORE
PROCEEDING WITH REPAIR.
(H) USE ONLY ONE HAND. WEAR RUBBER GLOVES ON BOTH HANDS WHEN
WORK PERMITS.
(I) HAVE MEN STATIONED BY CIRCUIT BREAKERS OR SWITCHES, AND TELE
PHONE MANNED IF NECESSARY, TO EXPEDITE SECURING OF CIRCUITS
IN THE EVENT OF CASUALTY.
(J) A MAN QUALIFIED IN FIRST AID FOR ELECTRIC SHOCK SHALL STAND BY
DURING THE ENTIRE PERIOD OF REPAIR.
ELECTRICAL FIRES
IN CASE OF ELECTRICAL FIRE:
(A) DE-ENERGIZE CIRCUIT.
(B) REPORT CONDITION TO THE OOD BY MESSENGER OR TELEPHONE.
(C) SECURE VENTILATION IN THE VICINITY.
(D) EXTINGUISH FIRE BY USE OF CO₂ FIRE EXTINGUISHER DIRECTED AT THE
BASE OF FLAME.
(E) BEFORE USING OTHER EXTINGUISHING MEDIA, CONSIDER LOCATION,
AMOUNT OF SPACE, GASES FORMED, ETC.
INGALLS NO. 4001

**TEMP-COAT®
64**

Shipboard Noise Control

Sources of Noise are well known !

The usual acoustic culprits:

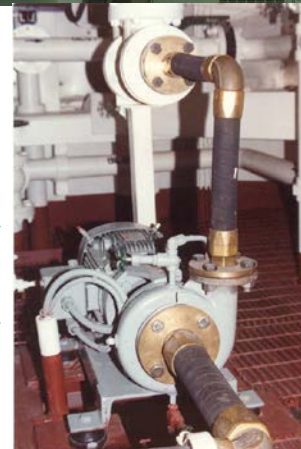
– Fans

– Ventilation

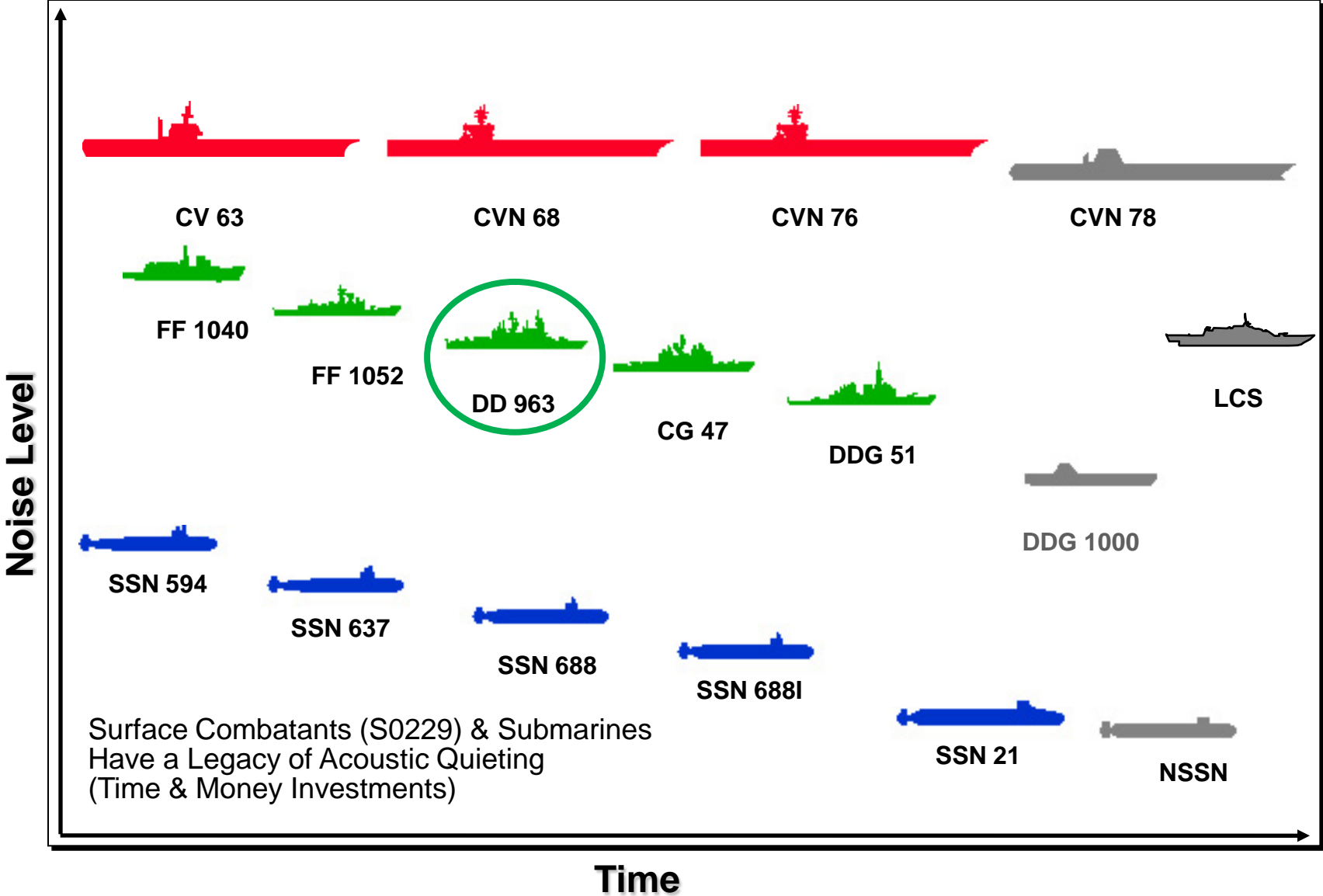
– Motors

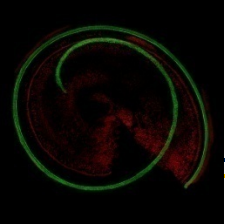
– Pumps

– Propellers



Hazardous Noise Control





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 ?

