Noise Reduction for Dive Helmets

Steven Africk Ph.D., Acentech Incorporated

Goal: Reduce the noise in dive helmets due to respiration and external sources

Acentech
Acoustics | Audiovisual | Vibration

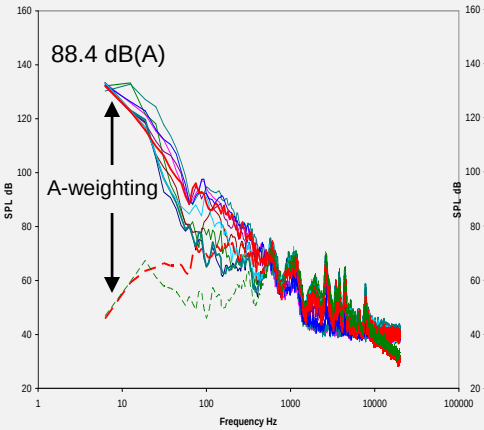
NAVSEA
NAVAL SEA SYSTEMS COMMAND

Motivation

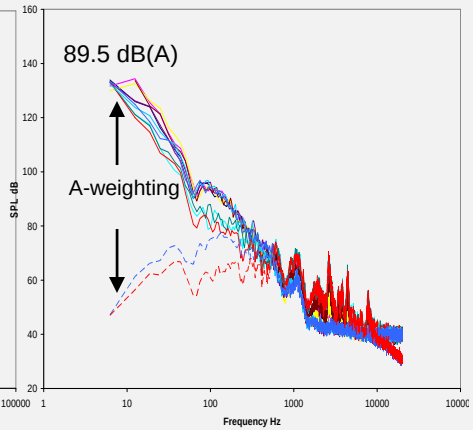
Divers are exposed to hazardous levels of noise due to both:
- Respiration (helmet ‘self’ noise)
- External noise (e.g. tools, sonar, ship machinery).

Levels can exceed 100 dBA, increasing with depth.
Communication sound levels must exceed all others.
Bottom times are limited by NOEL protective guidelines but stress, fatigue, and the risk of hearing loss may not be eliminated.
Helmets have not been subjected to methodical noise control.

KM-37 Respiration noise, 6 Hz band, simulation 40 RMV, Dive Lab , September 2009



Inhale



Exhale

Simulated Depth	Inhale dBA	Exhale dBA	Power Average, dBA
5’ (1.2 atm)	90.4	93.9	93.0
84’ (3.5 atm)	100.4	94.2	97.3
165’ (6.0 atm)	104.4	91.6	99.6

Approach

Respiration Noise
Perform ‘noise audit’ to identify noise sources and paths to diver’s ears in KM-37 helmet

Drawing on past experience, identify and test design modifications to quiet these processes

This could include, for example, widening of restrictions to slow airflow, vibration isolation, etc.

Coordinate with Navy and industry to assure that proposed modifications are practical, economical, and acceptable to divers

External Noise
Develop acoustical treatments to be applied to the outside of helmets based on submarine coating and baffle technology

Coordinate with Navy and industry to assure that proposed treatments are practical, economical and acceptable to divers

External Helmet Treatment

High transmission loss (TL) by acoustic compliance

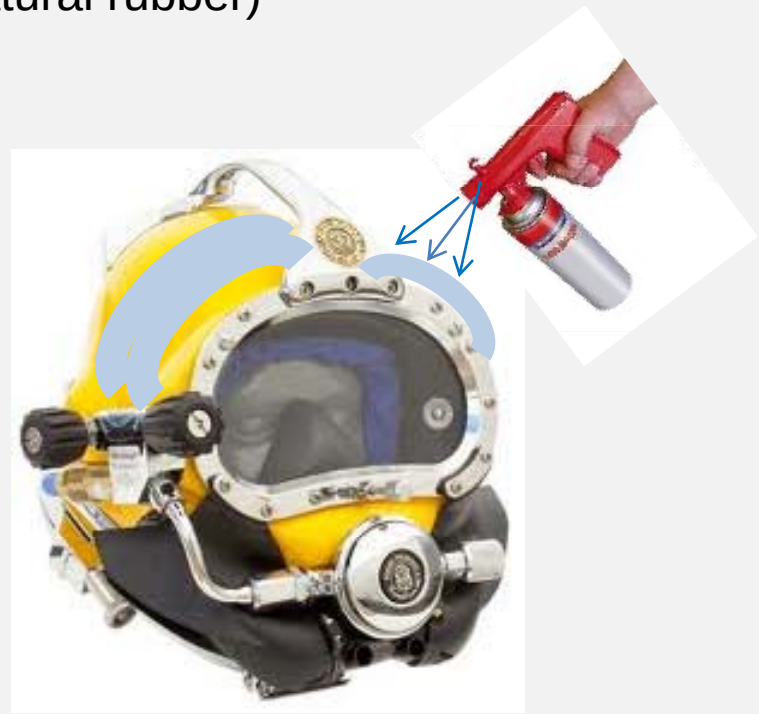
Elastomeric foams (e.g. polyurethanes, natural rubber)

Spray-on option

Air bladder design

Issues:

- Buoyancy effects
- Depth dependence
- Durability
- Thermal isolation



What is a Noise Audit?

A measurements-based means to identify and rank order various noise producing components and/or mechanisms in a device

Individual sources or components are run separately or otherwise isolated and their noise measured to determine their contributions to the total noise.

Paths through which noise and vibration travel within the system are identified

This methodology leads to the most effective strategy for reducing overall noise in complex structures or devices

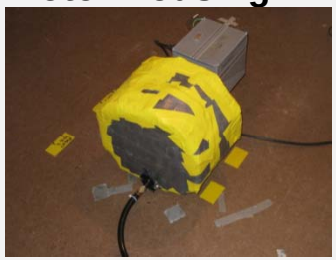
Vacuum Pump Example

Sources isolated by:

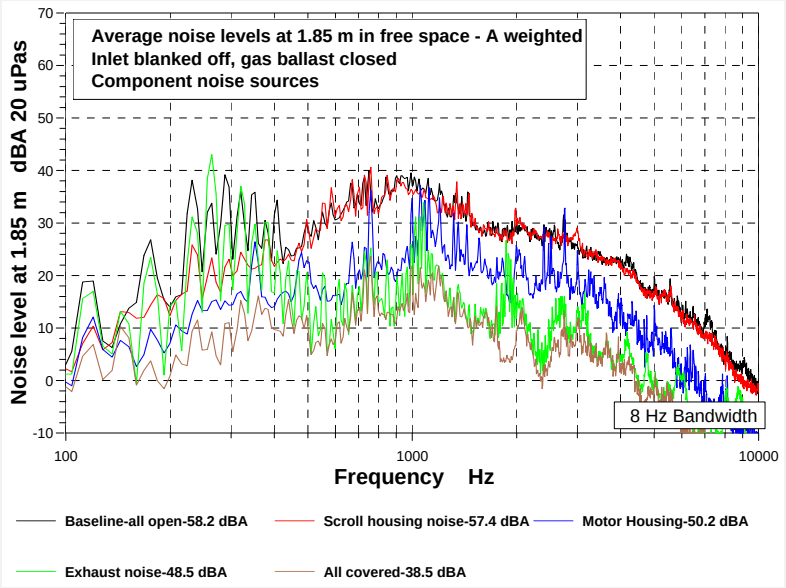
lead sheet (grey)
foam (inside)
duct tape (yellow)

Scroll Housing

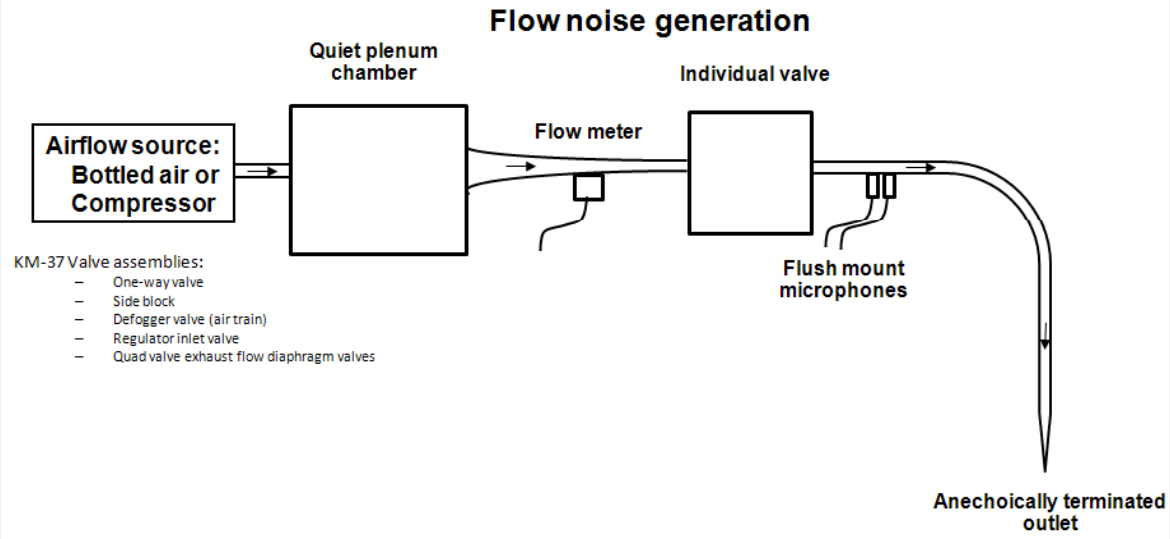
Motor Housing



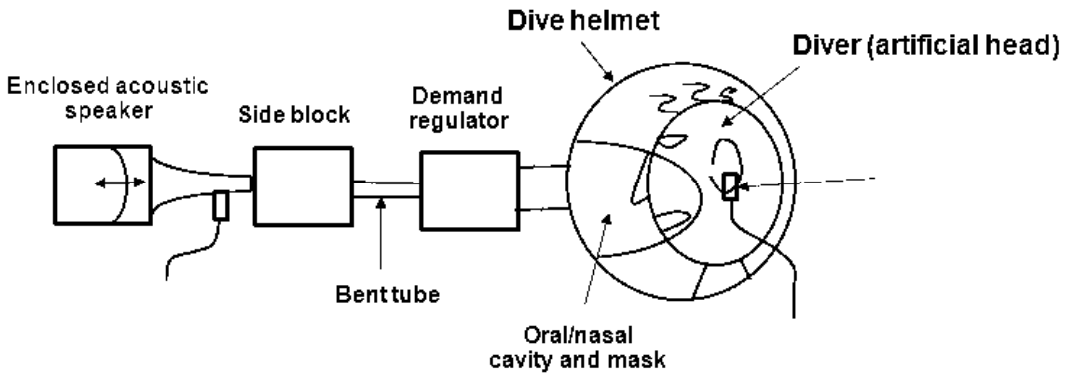
Exhaust pulsation



Helmet Noise Audit Measurement Examples



Transfer function for the inlet one way valve



$$\text{Transfer Function} = \frac{\text{Diver ear mic level}}{\text{Input mic level}}$$

Programmatics

Status: New Start, June 2011

MILESTONES

1. Very low frequency noise evaluation
2. External acoustic treatment specification
3. Breathing system noise audit
4. Design & demonstrate quieted helmet components
5. Relevant environment demo test plan and final report

SCHEDULE