Industrial Hygiene Afloat:

Issues and Responsibilities onboard a Nuclear Aircraft Carrier

41st YUMA PACIFIC-SOUTHWEST AIHA SECTION ANNUAL MEETING
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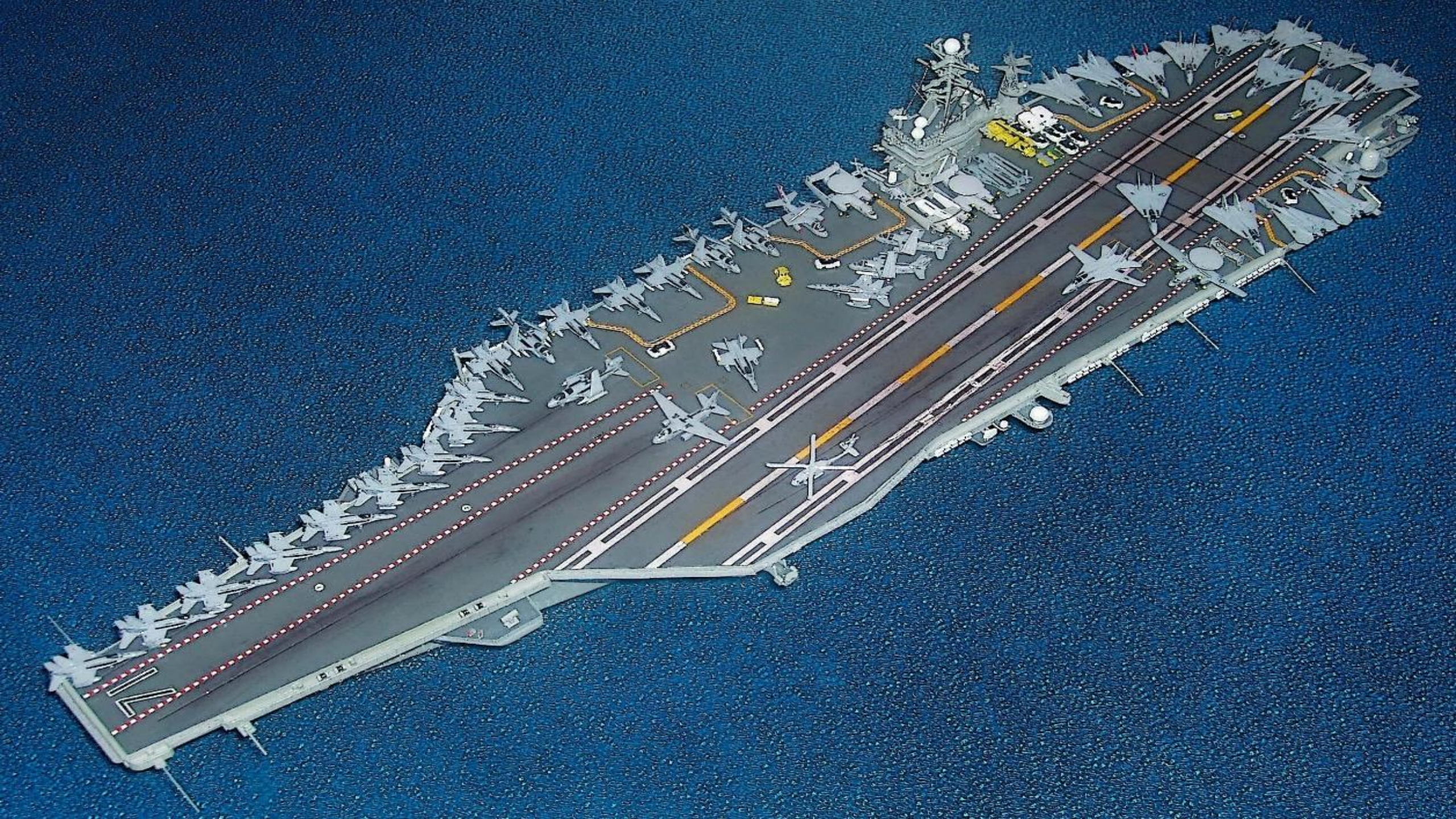
Carrier Based Industrial Hygiene

Safety Department

- Safety Officer (CDR): Aviator; predominantly concerned with flight deck safety
- Industrial Hygiene Officer (LT/LCDR):
  1. Manages OSH programs
  2. Conducts exposure assessments (limited sample analysis) and OSH training
  3. Determines medical surveillance requirements (31 surveillance programs)
- 9 Enlisted (experienced tradesman representing each major shipboard industry)
  - Serve as: Industrial Hygiene Technicians; Industrial Trade Safety SMEs; Workplace Monitors
- 60-70 collateral duty (part time) Safety Petty Officers attached to the industrial work centers, but tasked by Safety to provide oversight, training, and feedback

Profile of an Aircraft Carrier

- Dimensions (Length: 1040 feet; Width: 252 feet; 18 decks; 100K tons)
- 4500 officers and sailors (when air wing is embarked)
  - Males and Females (mostly male)
  - 18 – 50 years of age (75% below 25)
- 185 industrial work centers; 3 aircraft hanger bays; 4 acre flight deck
- 80 aircraft (72 fixed wing and 8 rotary)
- Accompanied by 5-7 addition ships and submarines in Carrier Strike Group that provide support (i.e. refueling) and a perimeter defense
- 3-phase deployment cycle (6-8 months per phase): sea trials and pre-deployment training; deployment; maintenance availability period



Aircraft Carrier Industrial Operations

- Flight Operations
  - steam catapults (launch) and arresting gear (recovery)
  - Aircraft arming, fire fighting, fueling, and handling
- Power Generation
  - Two nuclear reactors powering four turbines (194 MW/each) and four shafts
  - Four 8-MW emergency diesel generators
- Aircraft Maintenance
  - Airframes, Avionics, Composite, Fuel Testing, Jet Engine Repair, and NDI Shops
- Ship Maintenance
  - Carpentry, Machine, Sheet Metal, and Welding Shops
  - Corrosion and damage control (painting, paint removal, hot work, etc.)
  - Machinery: arresting gear; fuel and water pumps; electrical generators; water evaporators; hydraulic elevators; steam catapults; propulsion and steerage; ventilation systems; and, windlasses (anchors, underway replenishment, etc.)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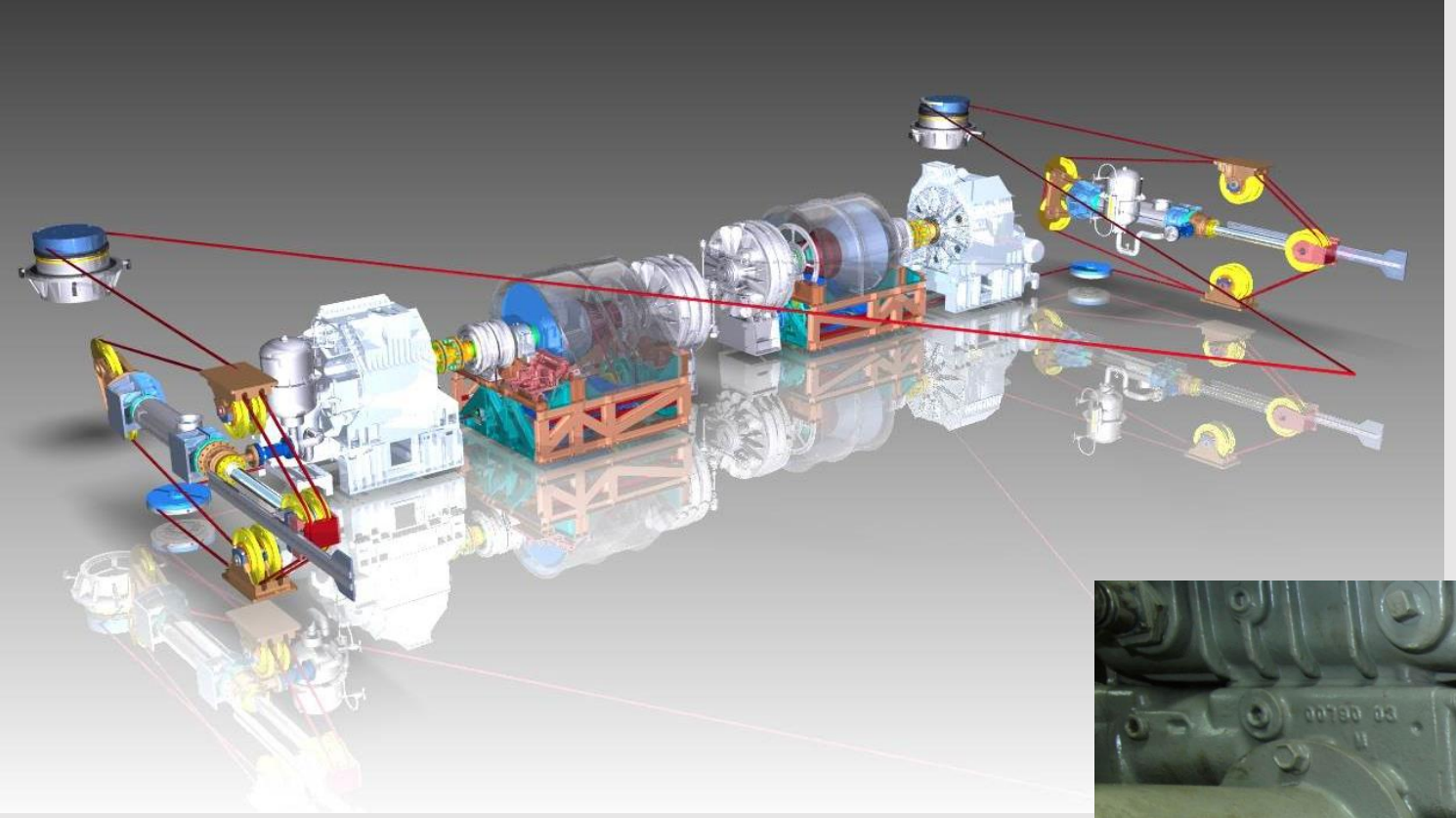
AC


NG

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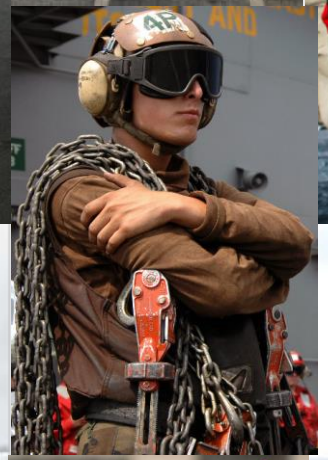
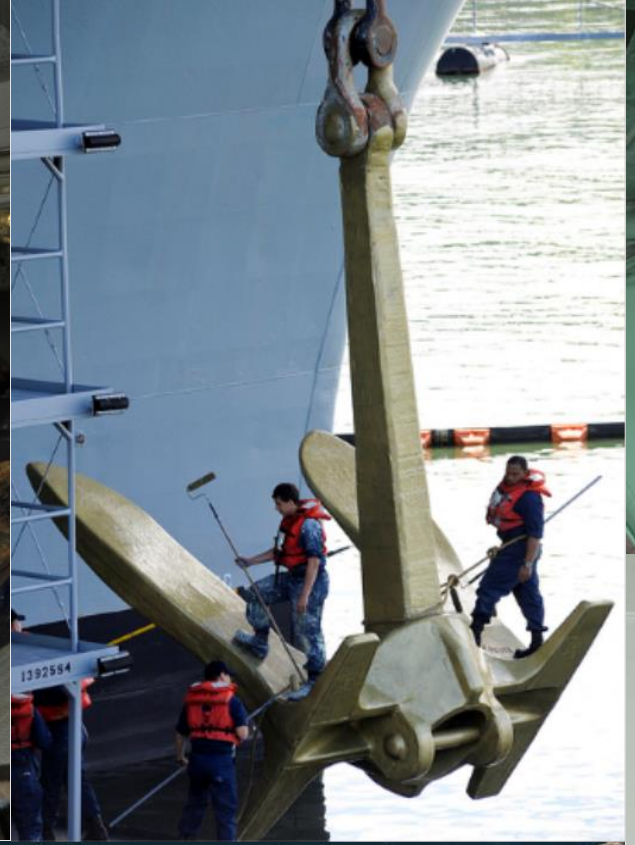



GNB
RAYMOND
US NAVY
GROSS VEH
WT W/O LOAD
7200 LBS


GPCX
SGM12B




U.S. NAVY


GLENN DEFENSE MARINE
ASIA PTE LTD

HOT WORK EVERYWHERE!


U.S. NAVY


U.S. NAVY

Patch work permitted afloat →

← Production work done ashore

Small paint booth onboard

↓

Hazardous Materials Management

- Hazardous Materials
  - Storerooms: Segregated by chemical compatibility and ventilation, fire suppression, and spill containment requirements
  - Issue Points: Central issue (1st deck); 2 deep stock (5th/7th deck); 2 paint issue rooms (FWD/AFT); and, approximately fifty (7-day) storage lockers
- Hazardous Waste
  - Single collection point called “The Mountain” between Hanger Bay 3 and the fantail
  - Waste consolidated for offload at next suitable port visit
- Pollution Prevention
  - 2 sewage (CHT) treatment systems (FWD/AFT)
  - Recycling systems
    - OPA/OWS
    - Trash Incinerator
    - Plastic Processor

Ventilation Performance Assessments

- Hazardous Material Storerooms
- Cryogenic Plant (O_2/N_2)
- Laundry Facility
- Mechanical Shops
- Battery Charging Rooms
- Abrasive Blasting Booths
- Jet Engine Repair Shop
- Diesel Generators
- Welding and Plating Shops
- Jet Fuel Pump Rooms
- Sewage Treatment Plants
- Medical and Dental Labs
- Chemistry and Radiography Labs
- Gas Cylinder Storerooms
- Paint Booths
- Galley Hoods
- Propulsion Spaces
- Electronics Repair Shops

Exposure Monitoring

Chemical Stressors

- Heavy Metals: Beryllium; Cadmium; Hexavalent Chromium; Nickel; Lead
- Strippers: Methylene Chloride; Phenol
- Jet Engine Exhaust: Aldehydes; [Poly-cyclic] Aromatic Hydrocarbons; VOCs
- Minerals: Asbestos; Crystalline Silica
- Coatings: Isocyanates; Heavy Metals
- Sewage: Hydrogen Sulfide; Sulfur Dioxide
- Miscellaneous: CO; Composite Fibers; Jet and Diesel Fuels; Halogenated Gases and Solvents; Organophosphates; Phosgene; Synthetic Resins; Welding Fumes; etc.

Physical Stressors

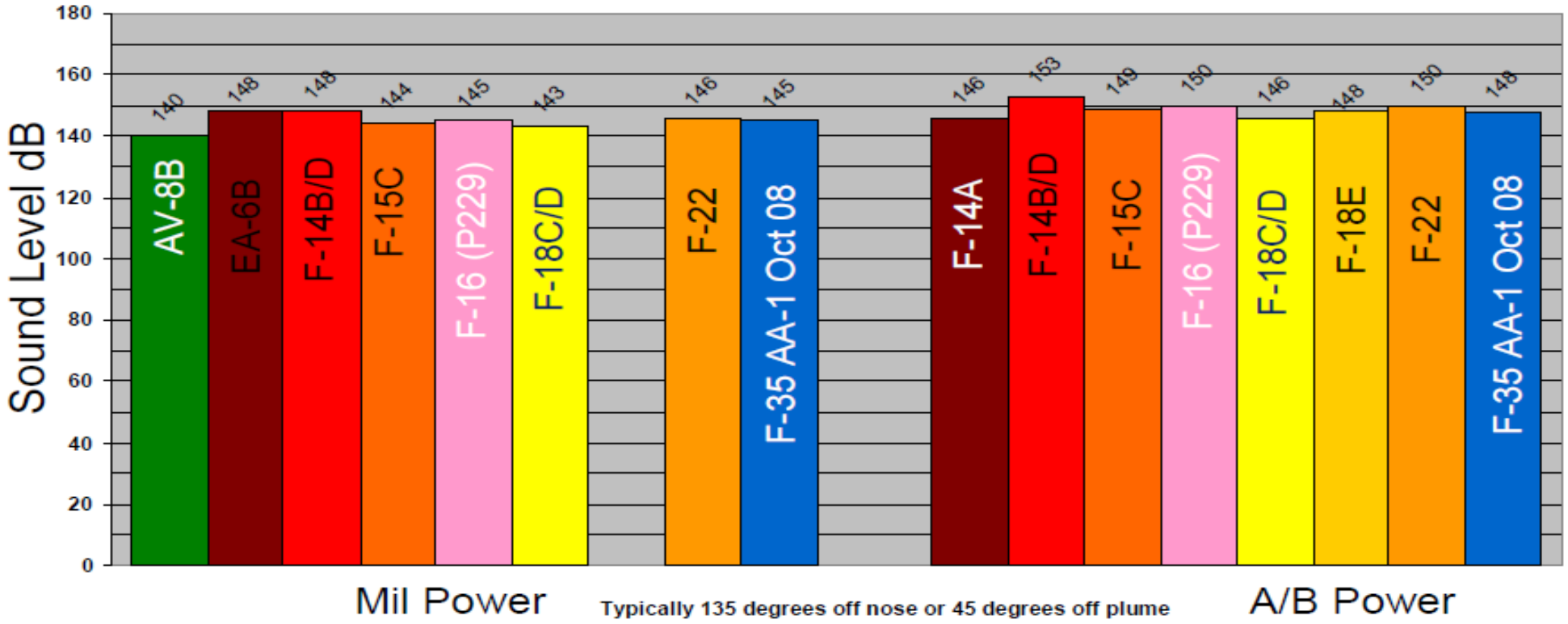
- Hazardous Noise (SPLs up to 150 dB)
- Human Factors and Ergonomics:
  - Heat Stress (and sometimes Cold Stress)
    - Flight Deck, Catapult and Engineering Spaces; Galleys
  - Hand Vibration from using pneumatic tools
  - Heavy Lifting (equipment; ordnance; parts)
  - Repetitive Motions (Controllers; Food Prep)
  - Illumination
- Radiation
  - Non-Ionizing: ELF/radar transmitters; lasers
  - Ionizing: monitoring outside reactor spaces; radiography equipment; NDT radionuclides
- Slips, Trips, Falls, Cuts, Compressions, Pinches, Projectiles, Confined Spaces

Noise

- Hearing loss is the #1 VA disability claim by Navy veterans by orders of magnitude
- 70% of crew is exposed to hazardous noise on a daily basis (≥ 85 dBA; 8-Hr TWA)
- Technology does not exist to attenuate flight deck noise below hazardous levels
- Inhalation of jet fuel vapors (ototoxicity) may increase hearing loss vulnerability
- Noise from an aircraft catapult launch can be heard six decks below the flight and is often at hazardous exposure levels deck within two decks (>50% of berthing)
- All hands enrolled in the Hearing Conservation Program
  - Annual audiograms and surveillance
  - Training and hazard communication
  - Provision of adequate PPE or to technological limits
- New R&D to mitigate exposures

Jet Noise Levels

Best Data Available
(Source JSF Vibroacoustics IPT)



Peak Jet Noise Levels of Modern High Performance Aircraft are Fairly Consistent

Ototoxins in Jet Fuel: Ethylbenzene (0.37%); n-hexane (2.21%); n-Propylbenzene (0.71%); p-Xylene (0.35%); Toluene (1.33%)

Campo P, Lataye R, Cossec B, Placidi V (1997) **Toluene-induced hearing loss**: a mid-frequency location of the **cochlear lesions**. Neurotoxicol Teratol 19:129–140

Campo P, Loquet G, Blache`re V, Roure M (1999) **Toluene intoxication route in the rat cochlea**. Neurotoxicol Teratol 21:427–434

Cappaert NLM, Klis SF, Muijser H, de Groot JCJ, Kulig BM, Smoorenburg GF (1999) The **ototoxic effects of ethyl benzene** in rats. Hear Res 137:91–102

Cappaert NL, Klis SF, Baretta AB, Muijser H, Smoorenburg GF (2000) **Ethyl benzene-induced ototoxicity** in rats: a dose dependent mid-frequency hearing loss. J Assoc Res Otolaryngol 1:292–299

Cappaert NL, Klis SFL, Muijser H, Kulig BM, Smoorenburg GF (2001) Simultaneous exposure to **ethyl benzene and noise: synergistic effects** on outer cells. Hear Res 162:67–79

Gagnaire F, Marignac B, Langlais C, Bonnet P (2001) **Ototoxicity in rats exposed to ortho-, meta- and para-xylene vapors**. Pharmacol Toxicol 89:6–14

Lataye R, Campo P (1997) Combined effects of a simultaneous exposure to **noise and toluene on hearing function**. Neurotoxicol Teratol 19:373–382

Lataye R, Campo P, Loquet G (1999) **Toluene ototoxicity** in rats: assessment of the frequency of hearing deficit by electrocochleography. Neurotoxicol Teratol 21:267–276

Pryor GT, Dickinson J, Howd RA, Rebert CS (1983) **Neurobehavioral effects of subchronic exposure of weanling rats to toluene or hexane**. Neurobehav Toxicol Teratol5:47–52

J Toxicol Environ Health A. 2014;77(5):261-80. doi: 10.1080/15287394.2013.862892.

Exposure to low levels of jet-propulsion fuel impairs brainstem encoding of stimulus intensity.

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Abstract

Jet propulsion fuel-8 (JP-8) is a kerosene-based fuel that is used in military jets. The U.S. Armed Services and North Atlantic Treaty Organization countries adopted JP-8 as a standard fuel source and the U.S. military alone consumes more than 2.5 billion gallons annually. Preliminary epidemiologic data suggested that JP-8 may interact with noise to induce hearing loss, and animal studies revealed damage to presynaptic sensory cells in the cochlea. In the current study, Long-Evans rats were divided into four experimental groups: control, noise only, JP-8 only, and JP-8 + noise. A subototoxic level of JP-8 was used alone or in combination with a nondamaging level of noise. Functional and structural assays of the presynaptic sensory cells combined with neurophysiologic studies of the cochlear nerve revealed that peripheral auditory function was not affected by individual exposures and there was no effect when the exposures were combined. However, the **central auditory nervous system exhibited impaired brainstem encoding of stimulus intensity**. These findings may represent important and major shifts in the theoretical framework that governs current understanding of jet fuel and/or jet fuel + noise-induced ototoxicity. From an epidemiologic perspective, results indicate that jet fuel exposure may exert consequences on auditory function that may be more widespread and insidious than what was previously shown. It is possible that a large population of military personnel who are suffering from the effects of jet fuel exposure may be misidentified because they would exhibit normal hearing thresholds but harbor a "hidden" brainstem dysfunction.

PMID: 24588226

Flight Deck Hearing Protection

Old Cranial

- **Foam-lined circumaural muff**
- **Worn with foam earplugs**
- **Combined Noise Reduction Rating = 30 dB**

New Cranial

- **Digital Active Noise Reduction Muff**
- **Custom molded earplugs**
- **Combined Noise Reduction Rating = 41 dB**

Engineering Out Hazardous Noise Exposures

- Ford Class Carrier replaced steam piston catapults and water braking systems with new electromagnetic induction carriage that acts as a rail gun to shoot the aircraft off the deck.
- Newest aviation platform (JSF) coordinates landing with arresting gear and only accelerates to afterburner if an equipment failure occurs.
- Both innovations will potentially reduce the need for aircraft to power up to afterburner during launch and recovery.
  - Afterburners increase the jet noise by 10 dB above full turbine power.
  - Afterburners decrease fuel burn efficiencies to approximately 98%, resulting in increased inhalation exposures to ototoxic aromatic hydrocarbons.

Pharmaceutical Hearing Protection

- 3 protective chemicals in trials
  - D-methionine
  - Ebselen
  - N-acetylcysteine (NAC)
- Mechanism of Action
  - Boost levels of glutathione, a natural antioxidant found in the cochlea that reduces chemical stress in the hair cells
  - Initial results indicate that the dose groups experienced a 20-25% reduction in hair cell loss compared to the placebo (control) groups.

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Questions?