**Desert Sand (PM2.5) & Burn Pit Emissions**

Animal studies underway to determine potential biomarkers and assess the toxicities of inhaled sand alone, burn pit emissions alone, and in combination. NAMRU-D is investigating the role of matrix metalloproteinase-3 in deployment-related pulmonary fibrosis. Also looking into mechanisms and treatment of deployment-related lung injury; repair of the injured epithelium.

**Nanomaterials**

Research looking into inhaled nanomaterials via proof of principle using aluminum and silver nanomaterials completed. Nanomaterial persistence in an inhalation atmosphere study underway. PBPK modeling of nanomaterials, joint project with NIOSH.

**Fire Extinguishing Powders**

NAMRU-D is evaluating if high concentrations of extinguisher powder cause incapacitation and prevent ability to escape. Sponsor is USAPHC.

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**Investigators**

- Dr. Brian Wong
- Dr. Karen Mumy
**Aviation Environment Program**

**Mission:**
To maximize warfighter performance and survivability through premier aerospace medical and environmental health effects research by delivering solutions to the Field, the Fleet and for the Future.

**Vision:**
By working with military, government, academic and industry partners, we will develop innovative solutions for the aeromedical and environmental health threats faced by our Navy and Marine Corps.

**Toxicity of Jet Fuels**
90-day subchronic inhalation studies in animals with respiratory depression (RD50) determinations for various alternative fuels to assess potential toxicity associated with exposure and help guide occupational exposure limits. Identification of cytokine & miRNA biomarkers indicative of neurological effects due to jet fuel exposure.

**Jet Fuel and Noise**
Animal studies to determine dose-dependent deficit in hearing related to combined jet fuel aerosol and noise exposure compared to noise-induced hearing loss alone.

**In Vitro Lung and Dermal Screening Tests for Fuel Toxicity**
Develop a battery of in vitro assays and exposure methods for general toxicity assessments in a rapid and cost effective manner. Effect of jet fuel vapor exposure assessed in co-cultures of human lung, immune cells and dermal cells.

**Polyalphaolefin (PAO) Fluid**
PAO fluid is used for cooling electronics in aircraft. NAMRU-D researchers are looking into acute and subchronic inhalation exposures of PAO aerosols. Collaborative study with 711 HPW.

**Investigators**
- Dr. Brian Wong

Polyalphaolefin (PAO) fluid aerosolization system, showing the reservoir (A) containing the PAO fluid, metering pump used to pump the fluid to the spray nozzle (B), the glass spray chamber (C) used to contain the PAO spray inside the vented enclosure (D).
In Vitro Toxicology Program

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**Investigators**
- LT Dan Xu, PhD
- Dr. Karen Mumy

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**In vitro Core**

In vivo toxicity testing is animal, time and cost intensive. In vitro approaches are needed for more rapid screening of compounds and the eventual replacement of whole animal testing.

Core capabilities include assessments of:
- Genotoxicity: Ames, comet, micronucleus assays
- Cytotoxicity with various relevant animal and human cell lines
- Mechanism of action determinations
- Unique exposures for cell lines and tissue models
Neurotoxicity Program

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Investigators:
- Dr. Joyce Rohan
- Mr. Shawn McInturf
- Dr. Karen Mumy

Electrophysiology
- Activities in distinct brain regions (e.g., hippocampus, prefrontal cortex, cerebellum)
- Characterize neuronal function
  - Synaptic transmission
  - Synaptic plasticity
  - Spontaneous spiking
- Can be performed in vitro/ex vivo and in vivo

Behavioral Testing
- Motor function
- Anxiety
- Habituation
- Startle reflex
- Sensorimotor gating
- Spatial learning
- Memory
- Recognition memory

Jet Fuel
Effects on synaptic transmission can be evaluated using our microelectrode dish system (MED64).
Effects on learning and memory in rodents can be assessed using our Morris water maze and Cincinnati water maze. Startle reflex and sensorimotor gating can be assessed using our acoustic startle reflex chambers.

Collaborative study with USAF 711th HPW/RHDJ, WPAFB.

Hypobaria/Hyperoxemia
We use swine models to assess neuronal effects of hypobaria and/or hyperoxemia. Recording of spontaneous spiking activity in swine hippocampus is shown.

Collaborative study with USAF 59th Clinical Research Division, Lackland AFB.

Transcranial direct current stimulation (tDCS)
Using rats, we found significant enhancement of synaptic plasticity following tDCS. We are interested in tDCS as a possible countermeasure of adverse neurological effects.

Collaborative study with USAF 711th HPW/RHCPA, WPAFB.

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Approved for Public Release
February 2018
**Naval Medical Research Unit Dayton**

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**Investigators**
- CDR Carlis Brown

**Advanced Applications Using Inhalation**

- **Toxic Load Modeling**
- **Inhalation at Altitude**

**Toxic Load Modeling (in collaboration with US Army)**
Basic research in toxicology: Haber’s Law. Researchers are conducting short duration “pulse” inhalation exposures in rats using Hydrogen Cyanide (HCN) or Carbon Monoxide (CO). Collaborative study with US Army (ECBC).

**Inhalation at Altitude**
Air Force cockpit atmosphere study aims to evaluate how altitude and oxygen contribute to hypoxia-like events. Study simulates high altitude in a closed nose-only exposure system. Generate test atmosphere with potential contaminant(s).

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</table>

Inhalation and simulated altitude system
Submariner Health Program

Mission:
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Health Effects of Submarine Atmospheres
Current exposure limits for submarine atmospheric compounds were developed for all male crews and need to be re-evaluated to ensure health protection of all crew members now that women are serving on submarines. NAMRU-D researchers conducted animal experiments to assess current exposure standards for key atmospheric components of concern (O2, CO2, CO). Studies to date indicate that existing exposure standards are protective of both male and female crewmember health. Additional chemicals are proposed for further testing.

Reproductive & Developmental Health
Women serving on submarines means that air standards must protect the reproductive health of both men & women as well as the developmental health involved with a potential pregnancy. NAMRU-D researchers studied timed pregnant female rats exposed to increased CO2 concentrations. Conducted evaluation of maternal health effects as well as growth & development of fetuses & allowed recommended alterations to health protective exposure limits.

Submarine Environment Advisory Board (SEAB)
Key member of SEAB charged with reviewing “issues on behalf of the Submarine Force relevant to submariner health regarding identification, monitoring, and risk mitigation of hazardous environmental exposures.

NAMRU-D’s Environmental Health Effects Research Laboratory has ten H1000 Whole-Body Inhalation Chambers.