



Naval Medical Research Unit - Dayton
Wright-Patterson AFB, Ohio



Science Update

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NAMRU-D MISSION:

To maximize warfighter performance and survivability through premier aeromedical and environmental health research-delivering solutions to the field, the Fleet, and for the future.

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Key visit from Office of the Assistant Secretary of Defense

*Dr. Henry Williams
& Dr. Michael Gargas*



Dr. Mason being greeted by Dr. Henry Williams, Deputy Director, Aeromedical Directorate, and Dr. Michael Gargas, Director, Environmental Health Effects Directorate.

On August 30th, Dr. Patrick Mason, a member of the SES from the Office of the Assistant Secretary of Defense for Research and Engineering (ASD (R&E)), toured NAMRU-Dayton. As Director of the Human Performance, Training, and BioSystems Directorate at ASD(R&E), Dr. Mason coordinates over \$3 billion in research and engineering programs in the DoD. He has purview over a broad range of research areas that directly relate to NAMRU-D research efforts including human performance, human-systems integration, training, and environmental sciences.

During his tours through the Aeromedical and Environmental Health Effects Directorates, Dr. Mason was briefed by a number of scientists who explained their current projects and recent findings. In the Aeromedical Directorate Dr. Jeffrey Phillips



Dr. Joseph Chandler describes fatigue research during Dr. Mason's visit to NAMRU-D

briefed Dr. Mason on our current hypoxia research, including new findings on the time course of recovery from hypoxic events. Dr. Phillips also discussed novel ways to detect hypoxia in its early stages, allowing aircrew to take corrective action before serious cognitive impairment develops.

LT Stephen Eggan also presented some of NAMRU-D's latest spatial disorientation work including his latest project using basic research to locate and better understand the brain structures and mechanisms that are responsible for how humans maintain, and in some cases lose, spatial orientation. His approach includes leading edge techniques such as dense array electroencephalography and functional magnetic resonance imaging. As a neuroscientist himself, Dr. Mason was particularly interested in this effort.

(story continued on page 4)

Effects of Submarine Atmospheres

LCDR William Howard & Dr. Kimberly Bynum

To protect the health of submariners, the U.S. Navy sets 90-day continuous exposure limits for more than 200 components of submarine atmospheres. Since these standards were developed before the November 2011 addition of female crewmembers aboard submarines, these standards have been re-evaluated with an eye towards health effects that are specific to females, including reproductive hazards and effects on a developing fetus.

While the effects of many atmospheric components can be assessed by reviewing the existing literature, there are some gaps where the effects on reproductive and developmental health are either unknown or unclear. One of the atmospheric components, carbon dioxide, has been shown to have potential reproductive and developmental effects, but the levels of concern have not been clearly defined.

In order to determine whether the current exposure limits for carbon dioxide are protective of the reproductive health of female submariners, as well as any unborn children potentially being carried, researchers at NAMRU-Dayton undertook a technically demanding study in which timed pregnant rats were exposed for nearly the entire duration of pregnancy to either purified air or carbon dioxide at levels of up to 3% in air. In addition to the logistical difficulties of assembling 120 rats known to be at specific days of pregnancy,



Ohio Class Ballistic Missile Submarine, vessel on which women may serve.

the rats were exposed to specific levels of carbon dioxide 24 hours a day for 16 days, weighed at regular intervals, had food intake measured and were then subjected to thorough examinations to observe any abnormalities in the mothers or developmental effects on the developing fetuses. The results of the study are currently being evaluated to help determine safe levels of carbon dioxide exposure during pregnancy and will be used to help ensure that the health of all submariners is protected.

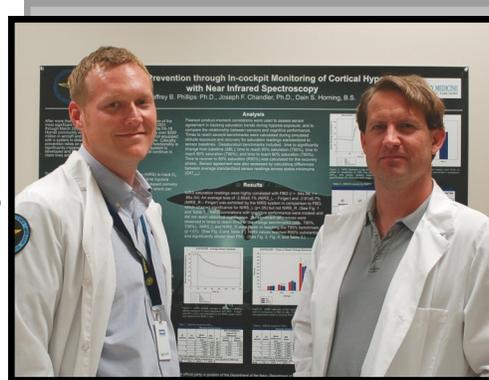
Scientists Receive SAFE Award

Dr. Richard Arnold

The Wright Brothers Chapter of the SAFE Association, an international professional organization “dedicated to ensuring personal safety and protection in land, sea, air, and space environments” recently hosted their 2012 awards ceremony in Dayton, Ohio. John C. Hill, President of SAFE, Wright Brothers Chapter, presented NAMRU-Dayton’s Dr. Jeff Phillips and Mr. Dain Horning with the chapter’s award for “2012 Outstanding Program Team, in recognition of outstanding contributions as part of the F-22 Physiological Support Team”. This award recognized the outstanding work of the joint Air Force – Navy team addressing emergent problems surrounding pilot life support systems in the F-22 Raptor. Since the

summer of 2011 NAMRU-Dayton’s hypoxia research team has been supporting USAF efforts to address oxygen problems in the F-22, while leveraging these efforts to address similar problems in the F/A-18. The SAFE award is the latest of several recent awards and recognition Phillips,

Horning, and their USAF teammates have received for their pioneering work to understand and address this challenging problem. NAMRU-Dayton leadership has strongly supported these efforts through recent initiatives to expand hypoxia research facilities and staff, further positioning the lab as a leader among DoD laboratories in addressing this dangerous threat to aviators.



Dr. Jeffrey Phillips (left) and Mr. Dain Horning (right) of NAMRU-D.

Senior Research Psychologist Speaks at Multiple Colombian Conferences

Dr. Richard Arnold

NAMRU-Dayton fatigue researcher, Dr. Lynn Caldwell, attended the 2012 ARP-SURA Aviation and International Congress, held 15-17 August in Bogotá, Colombia. This meeting was sponsored by ARP-SURA, a private company which educates both military and civilian organizations in the reduction of risks, leading to improvement in the safety and occupational health of employees. This conference was attended by a variety of organizations, including members of the Colombian Air Force, pilots from various airlines, safety officers and management personnel who oversee work hours and shift schedules. More than 300 people from both military and civilian institutions attended the aviation portion of the meeting on 15 August, with over 200 attendees per day from various organizations attending the general portion of the meeting on 16-17 August.

ARP-SURA invited Dr. Caldwell to present three lectures during the conference, including a 4-hour review of fatigue countermeasures for aviation operations, and two, 2-hour reviews of fatigue countermeasures for general operations. The presentations were well received and elicited numerous questions from the audiences. Overall, the meeting served as an excellent venue for demonstrating the

expertise and capabilities of NAMRU-D scientists, presenting new avenues for potential international research collaborations with military aviation researchers in Colombia.

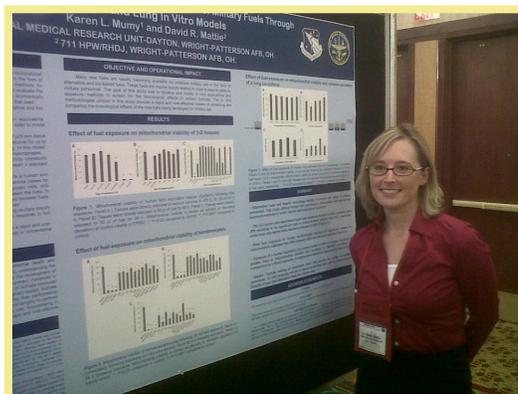


Attendees of the 2012 ARP-SURA Aviation and International Congress including NAMRU-D's Dr. Lynn Caldwell (pictured to the left of the banner).

NAMRU-D Highlights Research at MHSRS

CDR Daniel Hardt

The first annual Military Health System Research Symposium (MHSRS) was held in Fort Lauderdale, FL on 13-16 August 2012. This inaugural event, which serves as the principal forum to address joint health research approaches, challenges, discoveries, methods, policies and technologies, was attended by four key NAMRU-D personnel, including: CAPT Doug Forcino (Commanding Officer); Dr. Richard Arnold (Director, Aeromedical Research); CDR Dan Hardt (Department Head, Inhalation Toxicology); and, Dr. Karen Mummy (Microbiologist). CDR Hardt provided a platform presentation on NAMRU-D's recently completed "Reproductive Toxicity Evaluation of Major Submarine Atmosphere Components in Rats", which validated the safety of atmospheric breathing air standards for male and newly integrated female submariners. Dr. Mummy provided both



Dr. Karen Mummy presenting her research findings.

platform and poster presentations entitled: "Evaluating the Potential Occupational Effects of Military Fuel through Dermal and Lung *In-Vitro* Models", which summarized NAMRU-D's technical advances using *in-vitro* systems to identify the relative toxicities of new fuels. These cell culture techniques greatly reduce the monetary expense and time required to screen out fuels that pose an unacceptable occupational health risk to personnel, and thus focus more costly (*in-vivo*) toxicological risk assessments on fuels with less potential to cause harm to

our sailors, airmen, soldiers and marines. Both of the presentations were well received and demonstrate NAMRU-Dayton's relevance to the warfighter and ongoing commitment to force health protection through health risk assessment and finding practical scientific solutions to military operational problems.

Occupational Exposure Standards for Specialized Navy Applications

Dr. Lisa Sweeney

Equipment used by the U.S. Navy for deep submergence training, e.g., submersibles and diving suits, must meet specified standards, including standards pertaining to the potential internal accumulation of hazardous compounds. The sources of these compounds include metabolism, decomposition, solvents, paints, plasticizers, and refrigerants. While atmospheric exposure



Naval Reserve Deep Submergence Unit Detachment officers describe capabilities of atmospheric diving system. (U.S. Navy photo By Mass Communication Specialist 2nd Class Ron Kuzlik/Released).

standards for deep submergence systems have previously been developed, primarily based on 90-day submarine exposure standards, the Naval Sea Systems Command requested that NAMRU-D develop and document proposed exposure standards specifically applicable to training scenarios for pressurized rescue modules (PRM).

Proposed exposure standards were developed for 18 chemicals and proposed screening values were developed for two categories of chemicals (total hydrocarbons and total halogens). The proposed exposure standards capture some of the unique aspects of the diving training scenarios. For example, a maximum daily exposure duration of 12 hrs (rather than the typical assumption of 8-10 hrs) was assumed, to accommodate the possibility of two 6-hr training sorties in one day. Because

Navy divers are a fit, healthy group, uncertainty ("safety") factors for population variability may sometimes be reduced from those applied to a broader population; asthmatics are specifically excluded from serving as Navy divers and submariners, so exposure standards need not be reduced to account for exceptionally sensitive individuals. In general, the chemical-specific proposed exposure standards are equivalent to or higher than the existing values. Of the five recommendations to make the standards more stringent, two serve as "screening" values, rather than chemical-specific recommenda-

tions. In the event that compounds that are identified in the PRM environment are not among those for which exposure standards are available, NAMRU-D has suggested criteria for the evaluation and application of exposure standards from other organizations. Additionally, NAMRU-D has provided guidance on the consideration of risks from simultaneous exposure to multiple compounds (i.e., mixtures). NAVSEA will have NAMRU-D's proposed standards and guidance externally reviewed in FY13.



The U.S. Navy's Deep Submergence Unit releases the U.S. Navy Submarine Rescue Diving and Recompression System's (SRDRS) Pressurized Rescue Module (PRM) (U.S. Navy photo by Chief Mass Communication Specialist Kathryn Whittenberger/Released).

ASD visit (cont.)

While touring the Environmental Health Effects Directorate, CDR Dan Hardt, Dr. Brian Wong, and Mr. Arden James described current research investigating submariner health and the development of the exposure systems used to evaluate submarine atmospheres. In addition, Dr. Mason was briefed by Mr. Jim Reboulet who described NAMRU-D's

unique exposures systems for exposing laboratory animals to jet fuel gases, vapors, and aerosols in combination with controlled sound exposure—this work is being conducted collaboratively with scientists from the Air Force. The tour ended in the *in vitro* laboratory where Dr. Karen Mumy discussed the lab's expanding capabilities in cell culture ap-

proaches that are intended to someday replace *in vivo* animal testing.

Dr. Mason was pleased to see that we are working with USAF colleagues on many of our projects. He emphasized the importance of such teaming, and he encouraged the command to increase this constructive collaboration.

Defense Research and Development Canada

Dr. Richard Arnold

On 19 July 2012 NAMRU-Dayton hosted a visit by scientific leaders representing Defense Research and Development Canada. Distinguished visitors included Joseph Templin, the Director for Science and Technology (Air), Dale Redding, the Director General of DRDC-Toronto, LCol Paul Burke, Commanding Officer CFEME, LCol Rob Poisson, S&T Manager, Dr. Bob Cheung, DRDC-Toronto Senior Scientist, Dr. Joe Baranski, Chief Scientist DRDC-Toronto, and Dr. Keith Niall, First Secretary Defense TTCP. Overview briefings were provided to describe capabilities of the Canadian and US laboratories, during which numerous topics of mutual interest and expertise were highlighted. NAMRU-D Commanding Officer, CAPT Doug Forcino



Mr. Roy Dory explains the capabilities of the Disorientation Research Device.

then led the visitors on a tour of the command's laboratory facilities, including stops in both the Toxicology and Aeromedical laboratories.

The Toxicology Directorate's inhalation toxicology facilities were toured, with highlights including recent research on the effects of combined jet fuel and noise exposure on hearing loss, and a demonstration of NAMRU-D's unique nose-only inhalation towers. In vitro toxicology facilities were also toured, showcasing the laboratory's robust capability to conduct human cell line based toxicology research. Tours of the Aeromedical Directorate followed, which highlighted ongoing research in the areas of hypoxia monitoring and mitigation, fatigue countermeasures, basic neural mechanisms of spatial orientation, and motion sickness mitigation. Device demonstrations included the Vertical Linear Accelerator, which supports vestibular and whole-body vibration research, and the new Disorientation Research Device, which is expected to play a defining role in the next generation of spatial disorientation research by DoD and our allies. Numerous topics with potential for research collaboration were identified during the course of the visit, and discussions with NAMRU-Dayton's Canadian colleagues continue.

NAMRU-D Products & Presentations

- Arnold, R. (2012, August). *Cross-platform UAS task analysis*. Oral presentation given at ONR Unmanned Aircraft Systems Interface, Selection, and Training Technologies Industry Day, Arlington, VA.
- Caldwell, J. L. & Caldwell, J. (2012, August). *Operational Management of Fatigue*. Oral presentation given at the International Events Mining Sector and Aviation and the International Congress in Colombia 2012 ARP SURA, Barranquilla City, Colombia.
- Caldwell, J. L. & Caldwell, J. (2012, August). *Understanding and Managing Fatigue in Aviation*. Oral presentation given at Fatigue in Aviation for Pilots, Management Personnel, Maintenance, Human Resource, Aviation Officers, and Supervisors, Bogotá, Colombia.
- Hardt, D. & Gargas, M. (2012, August). *Reproductive toxicity evaluation of major submarine atmosphere components in rats*. Oral presentation given at the Military Health System Research Symposium/Advanced Technology Applications for Combat Casualty Care, Fort Lauderdale, FL.
- Mumy, K., Doyle, T., & Mattie, D. (2012, August). *The use of dermal and lung in vitro models to evaluate potential occupational effects of military fuels*. Poster presented at the Military Health System Research Symposium/Advanced Technology Applications for Combat Casualty Care, Fort Lauderdale, FL.
- Patterson, F. (2012, September). *Air frame design*. Oral presentation given at Aviation Human Factors and SMS Wings Seminar, Pensacola, FL.
- Patterson, F. (2012, September). *Cockpit spatial strategies*. Oral presentation given at Aviation Human Factors and SMS Wings Seminar, Pensacola, FL.
- Sweeney, S., Okolica, M., Gut Jr., C., & Gargas, M. (2012). Cancer mode of action, weight of evidence, and potential cancer reference value for hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). *Regulatory Toxicology and Pharmacology*, 64, 205-224.
- Sweeney, L., Prues, S., Wilfong, E., Reboulet, J., & Hess, K. (2012). *Subacute Effects of Inhaled Jet Fuel-A (JET A) On Airway and Immune Function in Rats* (Technical Report No. NAMRU-D-12-39).
- Williams, H., Hartzler, B., Egan, S., Wells, W., Varino, F., Arnold, R. (2012). *Proceedings of the Unmanned Aircraft System / Remotely Piloted Aircraft (UAS/RPA) Human Factors and Human Systems Integration Workshop* (Report No. NAMRU-D-12-41).

Commanding Officer's Corner

CAPT C. Douglas Forcino

I have been aboard NAMRU-Dayton for almost four months and I am continuously impressed by the people, the place, and our growing reputation. Interest in our capabilities has been expressed by DoD leadership as well as by the national and international research communities. In August, Dr. Patrick Mason from the OASD visited and encouraged us to further expand our collaborations with the USAF 711th Human Performance Wing. In July, a delegation from Defense Research and Development Canada in Toronto was here and spoke of initiating collaborations with us using the Disorientation Research Device when its installation is complete. Dr. Lynn Caldwell, an internationally known expert in fatigue, spoke at national and international conferences over the course of the summer and LCDR Hong Gao represented NAMRU-D on a trip to Taiwan where she discussed our capabilities in aeromedical research and environmental health effects research. Recently, Dr. Jeffrey Phillips and Mr. Dain Horning received an award for the work they performed during their involvement with the F-22 Oxygen Sensor Response Team. All of these events point to the emergence of NAMRU-D as a recognized leader within DoD in our mission areas of aeromedical research and environmental health effects research.

Many of our scientists have enhanced NAMRU-D's reputation by presenting research findings at several professional scientific conferences. Notable recent presentations include CDR Daniel Hart's submarine atmosphere research and Dr. Karen Mumy's research using dermal and lung in-vitro models to examine the potential occupational effects of military fuels. Both presentations were made at the first Military Health System Research Symposium in Ft. Lauderdale, FL.

As we approach the second anniversary of NAMRU-D's establishment as a command in October of this year, the future looks bright. The promise of the BRAC mandated colocation with the Air Force 711th Human Performance Wing and the School of Aerospace Medicine is being realized in the sharing of intellectual capital and equipment. We are not only collaborating more and more with our Air Force colleagues, but we are also being asked to perform work for the aviation and submarine communities within the Navy, as well as for the Air Force and Army. We encourage and invite visits by our sponsors and others who are interested in our capabilities and in possible collaborations.

Happy second birthday, NAMRU-D and happy 237th birthday, Navy.



Captain C. Douglas Forcino, USN
Commanding Officer

Taking the Helm of Navy Medicine's Aeromedical & Environmental Health Research

NAMRU - Dayton

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