



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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Deputy Surgeon General Visits NAMRU-Dayton

Dr. Richard Arnold

Rear Admiral Michael H. Mittelman, U.S. Navy Deputy Surgeon General, visited NAMRU-Dayton on 23 February 2012. NAMRU-D Commanding Officer, CAPT Keith Syring and his leadership team provided RADM Mittelman an overview of command capabilities and facilities, showcasing the laboratory's multifaceted mission to support the fleet through toxicological and aeromedical research. Inhalation and environmental toxicology labs in building 837 were toured, followed by aeromedical laboratories in building 851. Research on submarine atmospheres, biofuel toxicity, jet fuel and noise-induced hearing loss, hypoxia detection and mitigation, motion-sickness countermeasures, and individualized fatigue assessment and modeling were among the projects highlighted.

RADM Mittelman's visit to the aeromedical laboratories represented a homecoming of sorts.

He served a tour of duty at NAMRL early in his career during which time he became the Navy's first designated aerospace optometrist, ultimately serving as NAMRL deputy director of research. With the relocation of the NAMRL facilities from NAS Pensacola to Wright-Patterson AFB occurring so recently, RADM Mittelman's visit provided him the opportunity to see both the continuity of



Dr. Michael Gargas, Director of Environmental Health Effects Research, and CDR Daniel Hardt, Inhalation Toxicology Department Head, providing RADM Mittelman with an overview of the NAMRU-D research facilities.

mission from Pensacola, and the outstanding new opportunities afforded through NAMRU-D's association with the USAF 711th Human Performance Wing and Harry G. Armstrong Center of Excellence for Aeromedical Research, Training, and Education at Wright-Patt.

One other important Air Force association was made the day of the DSG visit. Major General Thomas W. Travis, U.S. Air Force Deputy Surgeon General, was aboard Wright-Patt to tour USAF 711th HPW laboratories, and briefly visited NAMRU-D's aeromedical facilities. Of particular interest to Maj Gen Travis was the Disorientation Research Device (DRD-Hercules), which is the Navy's contribution to a new state of the art complex of large man-rated research devices being installed at the Armstrong Center. DRD-



Life Scientist, Michelle Okolica describing results from the Gas chromatograph-mass spectrometer.

Hercules will be joined by a new Air Force high-G human centrifuge and two new hypobaric research cham-

bers. Together these new devices represent a nearly \$90 million investment in the future of aeromedical research. Through the support and leadership of both DSGs, aeromedical research at Wright-Patterson AFB holds unprecedented promise to reduce the greatest health, safety, and performance threats to our nation's military pilots and aircrew.

DoD's Largest Toxicology Inhalation Research Facility

CDR Daniel Hardt

Since the 1950s, NAMRU-Dayton, and its antecedents, has specialized in evaluating the health risks from military relevant inhalation hazards. Inhalation is by far the most dangerous exposure route for anyone working with toxic materials that can be carried in air. If all the airways and air sacs of a person's lungs were laid flat

on the ground, they would cover the size of a tennis court. The walls of these air sacs are 1/50th the thickness of tissue paper to permit the efficient exchange of gases between the body and the environment. The large surface area and extremely thin membranes of the lung make it an ideal portal to introduce harmful materials into the body. Inhalation exposure systems are traditionally designed to examine the health effects from occupational (≤ 8 -hour) exposures, since personnel are not



Figure 2. A mass flow monitor and other equipment used to control atmospheric and environmental conditions inside of an H-1000 chamber, which can be operated manually or remotely.



Figure 1. A bank of four H-1000 whole body inhalation exposure chambers.

expected to continue similar exposure during their off hours. However, Sailors onboard submarines do not have the option of leaving the submarine to breathe fresh air at the end of their shift, neither can deployed troops avoid breathing airborne particle matter when they are caught in a weeklong Middle Eastern sandstorm.

NAMRU-Dayton's new Environmental Inhalation Exposure Laboratory, which is now classified as DoD's largest toxicology inhalation research facility, contains eight H-1000 (1 m³) and four H-2000 (2 m³) whole body chambers that use automated technology to perform continuous animal exposures (24 hours/day; 7 days/week), and require minimal staff. Food and water are available to the animals upon demand, while husbandry (i.e., medical check-ups; emptying litter trays; etc.) is provided once each day. The automated system: (1) measures and records all atmospheric and environmental data within each chamber every second; (2) telephones the on-call duty personnel when any monitored parameter falls out of its target range; and, (3) provides a comfortable and healthy living environment for the test animals, which includes turning on and off laboratory lights to simulate the normal diurnal cycle. This unique system can be configured to expose animals to any combination of gases, liquid aerosols and vapors, and/or solid particle aerosols, allowing NAMRU-Dayton scientists to simulate any environmental exposure conditions that service members may encounter. The associated analytical components in the system provide a high degree of accuracy and precision. The system is currently being used to validate the health and safety of submarine atmospheric standards for mixed-gender crews, and plans are in the works to run a 90-day sand (PM_{2.5}) inhalation animal study in late 2012 or early 2013.

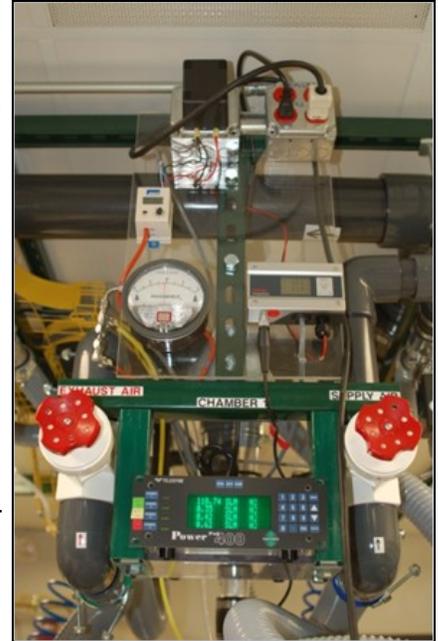


Figure 3. A tower of four multiple gas analyzers used to measure gas exposure concentrations inside each of the four H-1000s displayed in Figure 1.

Aeromedical Directorate Hosts Spatial Disorientation Conference

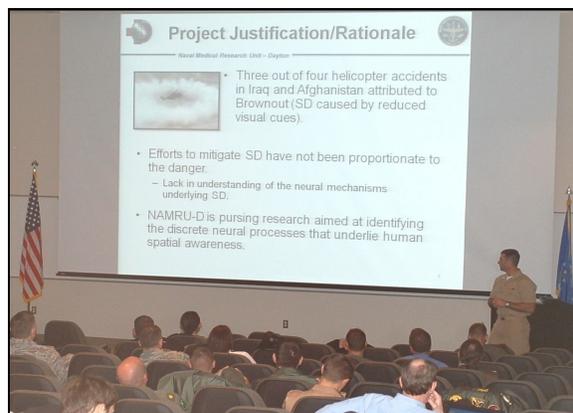
Dr. Henry Williams

On 25 and 26 January 2012, NAMRU-D and the Air Force Institute of Technology (AFIT) co-hosted a Spatial Disorientation (SD) Countermeasures Workshop aboard Wright-Patterson Air Force Base. SD is currently the DoD's leading cause of Class A mishaps; yet, it has been over eight years since a meeting such as this one has convened. Therefore, it was not surprising that the workshop was very well attended with 81 participants from 43 organizations. Personnel from the US Navy, Air Force, Army, Air National Guard, Coast Guard, and the FAA were in attendance. Academia, private industry, and government organizations, including Defence Research and Development-Canada, were also represented.

There were 21 presentations across the two day workshop. The first day began with a history and overview of SD, followed by presentations on the scope of the problem. Concepts that might help pilots avoid or recover from SD were also discussed. It was clear from these briefs that SD remains an important concern for all of the services.

The second day included briefs that addressed training solutions and novel sensory approaches to combat SD. Several attendees described their current SD research efforts, including NAMRU-D's LT Eggan who spoke about his upcoming project that will utilize dense-array EEG to identify specific parts of the brain that are responsible for human spatial awareness, and Dr. Fred Patterson, who gave several presentations on various SD topics.

The conference concluded with breakout sessions which allowed participants to individually discuss Training Solutions, Design Solutions, and Future Research on SD. A NAMRU-D proceedings report is being prepared for publication in the near future, which will describe discussion results, summaries of the briefings, and recommendations to combat this significant problem that continues to degrade aviation safety.



LT Stephen Eggan briefing 2012 SD Countermeasures attendees about his upcoming project on human spatial processing.

NAMRU-D Scientists Attend Society of Toxicology Conference

Dr. Lisa Sweeney

The Society of Toxicology (SOT) 51st Annual Meeting was held 11-15 March 2012 in San Francisco, CA. The yearly meeting provides an opportunity for attendees to expand and deepen their knowledge in the field of toxicology and share their discoveries with the broader community of scientists from industry, academia, and government. The following themes were reflected in this year's scientific sessions, plenary lectures, and continuing education offerings: Aberrant Gene Expression in Toxicity and Disease—Epigenetics and microRNAs, Characterizing Toxic Modes of Action and Pathways to Toxicity, Clinical Toxicology from Bedside to the Bench and Back, Influence of Global Climate Change on Environmental Health Issues, and Regulatory Science: Bridging the Gap between Discovery and Product Availability.

NAMRU-D's Environmental Health Effects Directorate staff participated in a range of activities at the meeting. NAMRU-D scientists presented the results of inhalation toxicity studies of Middle Eastern sand (particulate matter) and tungsten alloy



NAMRU-D SOT attendees (left to right): Dr. Gunasekar, Dr. Wong, Dr. Mummy, LT Ortiz, Dr. Gargas, Dr. Sweeney.

powder, a reproductive toxicology evaluation of major submarine atmosphere components, and *in vitro* screening studies for potential occupational effects of new military fuels on skin or the lung. Dr. Michael Gargas chaired a meeting of the Tri-Service Toxicology Consortium, which brings together toxicologists from the Navy, Air Force, and Army to share information, coordinate activities, and encourage collaboration. NAMRU-D scientists also took advantage of continuing education opportunities for emerging areas such as MicroRNAs in Biology and

Toxicology, Alternative In Vitro Toxicology Testing for the 21st Century, and Immunotoxicity Risk Assessment for Chemicals. The NAMRU-D exhibit booth at the ToxExpo highlighted the Directorate's capabilities and recent research and served as a venue for interactions with sponsors, collaborators, and other interest parties. Attendance at the SOT annual meeting provided an opportunity for the NAMRU-D staff to share their research and identify future directions for efforts that will enhance the health of military personnel.

NAMRU-D Scientists Travel to Germany

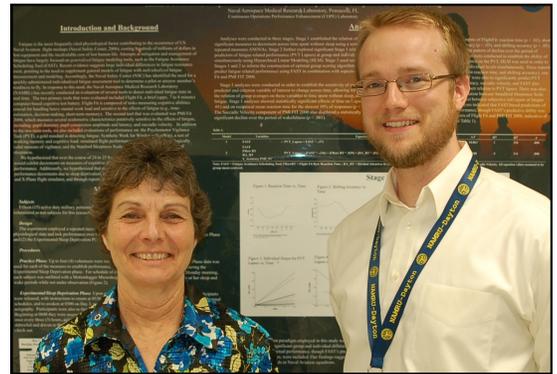
Dr. Lynn Caldwell & Dr. Joseph Chandler

The 2012 European Flight Surgeons' Conference and NATO RTO Technical Course was held 12-16 March at Ramstein Air Base, Germany, at the NATO HQ Air Command Ramstein. This international meeting brings together aerospace medicine professionals to share knowledge and form partnerships. This year's conference and course focused on "Aircrew Performance Enhancement & Sustainment." Attendance from 21 countries included physicians, mental health professionals, physiologists, researchers, and medical enlisted personnel. Drs. Lynn Caldwell and Joseph Chandler (pictured to the right) attended as representatives of NAMRU-Dayton.

Leaders from US Department of Defense aeromedical organizations highlighted the broad range of experts who spoke. Col Jay Neubauer, U.S. Air Forces in Europe (USAFE) Command Flight Surgeon, opened the meeting followed by Col Mark Coakwell, Conference Director and USAFE Chief of Aerospace Medicine. Key addresses on the future and direction

of aeromedical research and practice were given by MGen Thomas Travis, USAF Deputy Surgeon General and MGen Douglas Robb, USAF Joint Staff Surgeon. Flight surgeons, scientists, and physiologists from various countries, including the U.S., Germany, Iraq, England, and Russia, presented universal aeromedical challenges in the unique context of their countries' defense organizations. Topics included medical standards, fatigue, health issues, operational resiliency, and nutrition.

Dr. Caldwell, NAMRU-D Senior Research Psychologist, presented an overview of fatigue countermeasures, concluding with the dilemma of whether to use prescription stimulants during operations. Dr. Chandler, NAMRU-D Research Psychologist, presented an overview of individual differences in fatigue susceptibility, including how measurement of these differences can add to the ability of models



to predict performance, leading to effective fatigue management.

The meeting served as an excellent venue for NAMRU-D scientists to share current US Naval research and form relationships with flight surgeons and other scientists from around the globe. These key collaborations, and the exchange of ideas they drive, uniquely inform discussions of operational needs, allowing for comprehensive solutions to the common aeromedical challenges experienced wherever military aviators fly.

Preparing for Disorientation Research Device Christening

Ms. Ashley Turnmire



DRD in its final testing phases.

With NAMRU-Dayton's Disorientation Research Device (DRD) scheduled to be complete this summer, preparation for the device's christening is already underway. The BRAC director for the Bureau of Medicine and Surgery (BUMED), along with public affairs staff from BUMED and Naval Medical Research Center (NMRC) visited NAMRU-Dayton in February to obtain general information about the research device and begin media

preparations for the christening ceremony. The over 100 ton, state-of-the-art DRD will allow researchers to study a range of aviation mishap causal factors, including, spatial disorientation, motion sickness, fatigue, and hypoxia. The completion of the DRD's construction will close the final chapter of the BRAC relocation.



NAMRU-D XO, CAPT Rita Simmons describing the DRD's capabilities to NMRC PAO, Doris Ryan, and BUMED Deputy PAO, Shoshona Pilip-Florea.

F-22 Oxygen Sensor Response Team Receives Director's Award

Ms. Ashley Turnmire

On January 27th the F-22 Oxygen Systems Response Team, which includes two NAMRU-D researchers, Dr. Jeffrey Phillips and Mr. Dain Horning, received the USAF 711th Human Performance Wing Director's Award for their outstanding support. The response team was assembled after recent concerns with F-22 oxygen sensors.

F-22 Oxygen Sensor Response Team receiving award from 711th HPW Director, Mr. Thomas S. Wells (third from right). Mr. Dain Horning and Dr. Jeffrey Phillips, pictured second and third from the left on back row.



NAMRU-D Products & Presentations

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- Chandler, J. F. (2012, March). *Individual differences in fatigue susceptibility profiles*. Presentation given at the 2012 European Flight Surgeons Conference, Ramstein Air Base, Germany.
- Eggan, S. M. (2012, January). *Localization of human spatial processing using dense-array EEG*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Fechter, L. D., Fisher, J. W., Chapman, G. D., Mokashi, V. P., Ortiz, P. A., Reboulet, J. E. ... Mattie, D. R. (2012). Subchronic Jp-8 jet fuel exposure enhances vulnerability to noise-induced hearing loss in rats. *Journal of Toxicology and Environmental Health, Part A: Current Issues*, 75, 299-317.
- Hardt, D. J., James, R. A., Gut, C. P., & Gargas, M. L. (2012, March). *Reproductive and developmental safety evaluation of major submarine atmosphere components in rats*. Poster presented at the 2012 50th Annual Meeting of the Society of Toxicology, San Francisco, CA.
- Hardt, D. J., James, R. A., Gut, C. P., McInturf, S. M., & Gargas, M. L. (2012). *Health risk assessment of women in submarines: Reproductive and developmental toxicity evaluation of major submarine atmosphere components (CO, CO₂, and O₂) in rats (Rattus norvegicus) – Phase II (Neurological and reproductive performance study) (Report No. ADA553409)*. Retrieved from <http://handle.dtic.mil/100.2/ADA553409>.
- Mumy, K. L., Doyle, T. L., & Mattie, D. R. (2012, March). *The use of dermal and lung in vitro models to evaluate potential occupational effects of military fuels*. Poster presented at the 2012 50th Annual Meeting of the Society of Toxicology, San Francisco, CA.
- Ortiz, P. A., Roberts, K. C., Parkinson, C. U., Mokashi, V. P., & Wong, B. (2012, March). *Inhalation toxicity of particulate matter from Middle Eastern bases in rats exposed for two weeks*. Poster presented at the 2012 50th Annual Meeting of the Society of Toxicology, San Francisco, CA.
- Patterson, F. R. (2012, January). *Air frame design*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Patterson, F. R. (2012, January). *Cockpit spatial strategies*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Patterson, F. R. (2012, January). *Training for spatial disorientation: Avoidance, recognition, and recovery*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Patterson, F. R. (2012, January). *US Navy and Marine Corps spatial disorientation mishaps, incidents, and surveys*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Phillips, J. B., Chernyshenko, O. S., Stark, S., Drasgow, F., & Phillips, H. L. (2012). *Development of scoring procedures for the performance based measurement (PBM) test: Psychometric and criterion validity investigation (Report No. 553288)*. Retrieved from <http://handle.dtic.mil/100.2/ADA553288>.
- Sweeney, L. M., Gut, C. P., Gargas, M. L., Reddy, G., Williams, L. R., & Johnson, M. S. (2012). Assessing the non-cancer risk for RDK (hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine) using physiologically based pharmacokinetic (PBPK) modeling. *Regulatory Toxicology and Applied Pharmacology*, 62, 107-117.
- Williams, H. P. (2012, January). *Spatial disorientation: Control and display issues*. Presentation given at the 2012 Spatial Disorientation Countermeasures Conference, Wright-Patterson AFB, OH.
- Wong, B., Parkinson, C. U., Mokashi, V. P., Stockelman, M. G., & Ortiz, P. A. (2012, March). *Tungsten, nickel and cobalt measurements in tissue and histopathology following inhalation of tungsten alloy powder by sprague dawley rats*. Poster presented at the 2012 50th Annual Meeting of the Society of Toxicology, San Francisco, CA.

Commanding Officer's Corner

CAPT Keith Syring

As I write my final CO's Corner, before handing over command to CAPT Doug Forcino, I cannot help but be amazed at all that has been accomplished during my brief assignment here at NAMRU-Dayton. Since October 2010, our staff has increased by over 115%, an expansion which has been reflected in our increased research productivity. This growth becomes even more impressive considering it occurred during the establishment of a new command. During a time of transition and fiscal challenge, NAMRU-Dayton surged forward to set the pace for efficient, effective DoD research.

In addition to strengthening our numbers, our overall command capabilities have greatly expanded. The Toxicology Directorate at NAMRU-D now houses the largest toxicology inhalation research facility in all of DoD, which allows a variety of new capabilities including improved control over chamber conditions. The Toxicology Directorate has also established a state-of-the-science approach to studying environmental exposures, which utilizes *in vitro* cell systems as an alternative to animals models. Continued use of this technique will enable the DoD to reduce the number of animals used in research studies, thus answering the call for innovative, cost-effective research strategies.

The Aeromedical Directorate has also taken center stage by hosting tri-service conferences on spatial disorientation (SD) and unmanned aircraft systems (UAS). Conferences such as these encourage inter-service collaborations and strengthen unity within the DoD. Interoperability of this kind was a driving factor in the decision to establish a Navy command on an Air Force base, and the realization of this goal in such a short time is no small feat. As evidence of the importance in making these connections, several of our hypoxia researchers are supporting the Air Force on a rapid response team investigating the effectiveness of using on-board oxygen sensors for the F-22. Results from these studies will aid in the prevention of future flight mishaps for both military and commercial aviation.

As I reflect on these accomplishments I would like to express my sincere gratitude to the NAMRU-D team for their level of energy and mission accomplishment; this staff has surpassed expectations and their integrity will position the command for a successful future. I wish the best of luck to those who are departing as well as those who will continue the legacy of ground-breaking scientific research. As noted by the late Admiral George Anderson, "The Navy has both a tradition and a future—and we look with pride and confidence in both directions."



Captain Keith Syring, USN
Commanding Officer

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

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