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Comparing Blast Pressure Variations of Lead Primers

Roles of Major Types of Ships in the Navy's Fleet

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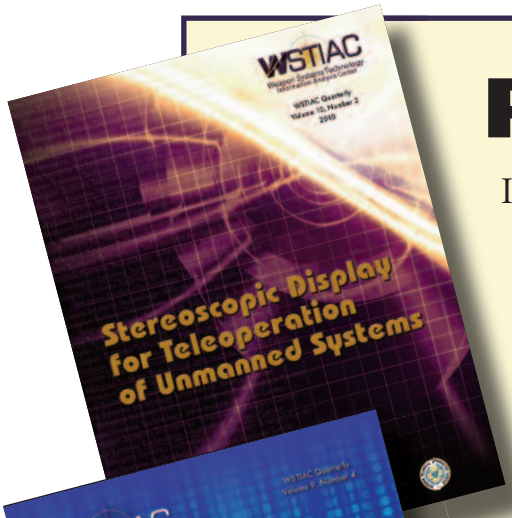

Past Issues

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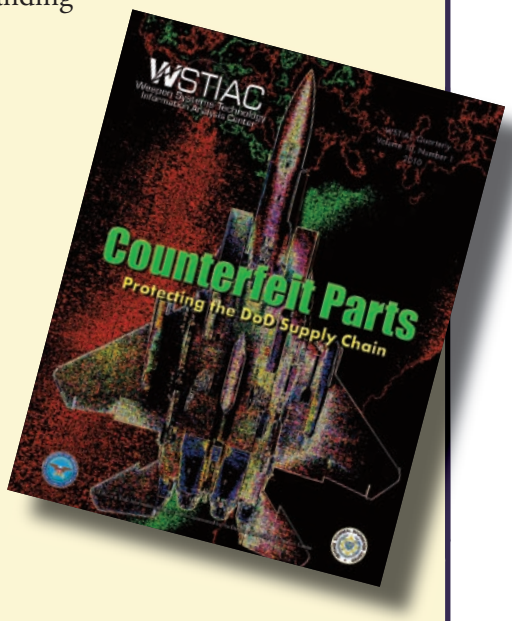

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Comparing Blast Pressure Variations of Lead Styphnate Based and Diazodinitrophenol Based Primers

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ABSTRACT

This article describes the blast pressure waves produced by detonation of both lead styphnate and diazodinitrophenol (DDNP) based firearms primers measured with a high-speed pressure transducer located at the muzzle of a rifle (without powder or bullet). These primer blast waves emerging from the muzzle have a pressure-time profile resembling free field blast pressure waves. The lead based primers in this study had peak blast pressure variations (standard deviations from the mean) of 5.0-11.3%. In contrast, lead-free DDNP-based primers had standard deviations of the peak blast pressure of 8.2-25.0%. Combined with smaller blast waves, these large variations in peak blast pressure led to delayed ignition and failure to fire in brief field tests.

INTRODUCTION

Over the past two decades, there has been a growing interest in removing lead from ammunition due to environmental and health concerns. For example, the US Army has issued the new M855A1 load with lead-free bullets to troops in Afghanistan. If lead-free bullets demonstrate field performance equal to their counterparts that include lead, the only lead needing to remain in duty ammunition would be lead based centerfire primers. Diazodinitrophenol (2-diazo 4,6 dinitrophenol, abbreviated as DDNP and also referred to as diazole and dinol) is regarded as a promising candidate to replace lead styphnate in centerfire priming compounds. An Air Force study showed that transitioning to training ammunition with lead-free bullets and primers can reduce instructor exposure to lead by 70% in indoor ranges and 41% in outdoor ranges.[1]

Testing of primer performance ultimately requires using ammunition fully loaded as it would be for a given application. However, it is also desirable to have a method to test and compare primer performance independently of a given cartridge and load to remove confounding effects of powders, bullets, neck tension, case capacity, bore friction, etc. so that performance of different primer designs can be compared more directly. The method employed here for directly comparing primer performance is to measure the blast pressure wave produced by impact detonation of a primer loaded in a cartridge case without any bullet or powder. In this study, measurements are presented for eight lead based primers (four large, 5.33 mm diameter, and four small, 4.45 mm diameter), and two DDNP-based primers (one large and one small).

Peter Griess is credited with discovering diazo compounds in 1858.[2] Over the next 50 years, the chemistry of diazo compounds and their applications were further investigated.[2] US patents for improved processes for manufacturing DDNP for explosive applications were awarded in 1922, 1935, and 1946.[3-5] In 1932, a patent for primer compounds including DDNP was awarded to agents of the Remington Arms Company.[6] In the 1980s, interest increased in using DDNP as a main component in non-toxic priming compounds, and since 1985 more than a dozen patents have been awarded for specific applications to small arms. Hoping to further reduce toxicity of gunshot residues, some of these formulations employ non-toxic oxidizers as well, such as zinc peroxide. Between 2000 and 2009, several American ammunition manufacturers offered at least one product line with lead-free primers, and DDNP-based primers were being manufactured on a commercial scale at Muron in Russia.[7]

METHOD

The measurement method was originally described in the Review of Scientific Instruments.[8] Blast pressures were measured using a high-speed pressure transducer (PCB 102B or PCB 102B15) placed coaxially with the 7.82mm diameter rifle barrel and directly facing the muzzle with no separation between the end of the barrel and pressure transducer. Only a primer is loaded in the brass cartridge case (no bullet or powder) and detonated by the impact of the firing pin.

A cable connects the pressure transducer to a signal conditioning unit (PCB 842C) that produces a calibrated voltage output, which is then digitized with a National Instruments PXI-5105 fast analog to digital converter operating at a rate of 1 million samples per second. The voltage waveform is converted to pressure using the calibration certificate provided by the manufacturer with each pressure sensor. Ten samples each of eight models of widely used lead based primers were tested along with two DDNP-based primers, a large rifle primer (model KVB-7E) and a small pistol primer (model KVB-9E) manufactured in Russia at Muron. Brief field tests were also conducted comparing two large rifle primers in loaded ammunition and noting muzzle velocities, accuracy, and ignition delays.

RESULTS

Figure 1 shows blast pressure waveforms of four primer types. The arrows in the figure denote the range of peak blast pressures for a sample size of 10. Compared with its average peak blast pressure, the DDNP-based KVB-7E has a much larger variation in peak blast pressure than other primers. (Waveforms for different models are offset in time to facilitate comparison.) Simple blast waves are usually characterized by peak overpressure, duration, and impulse (the area under the curve of pressure vs. time). Since the durations and basic shapes are similar, the impulse is nearly proportional to the peak pressure, and the peak pressure is the main distinguishing characteristic of these blast waves. Therefore, the results and discussion will focus on the average peak magnitude and the standard deviation of peak magnitudes for each primer type.

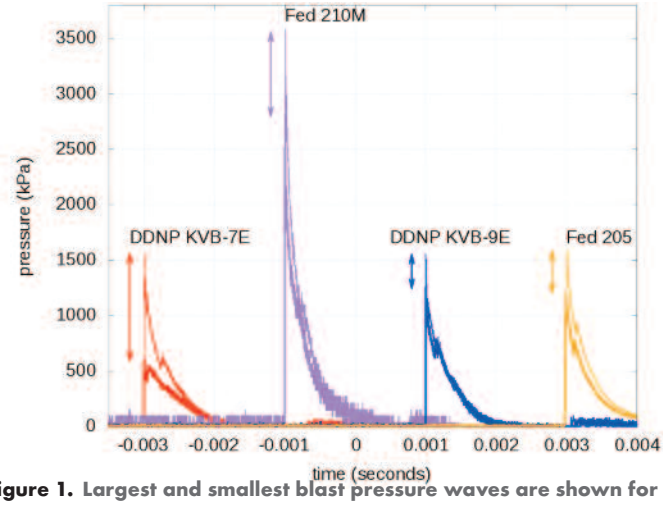

Figure 1. **Largest and smallest blast pressure waves are shown for two DDNP-based (KVB-7E and KVB 9E) and two lead based (Fed 210M and Fed 205) primers.**

Figure 2. **DDNP-based KVB-7E primer which produced a misfire in a 30-06 test load. The crater suggests the misfire was not due to a light primer strike. The other nine 30-06 test loads with this primer demonstrated a perceptible delay in ignition.**

Table 1. **Peak pressure averages and standard deviations from the mean (SD) with a sample size of 10.**

Primer	Diameter (mm)	Peak Pressure (kPa)	SD (kPa)	SD (%)
Fed 210M	5.33	2908	223	7.7%
Fed 215M	5.33	3811	192	5.0%
CCI 200	5.33	2561	270	10.7%
CCI 250	5.33	3587	404	11.3%
DDNP KVB-7E	5.33	1186	296	25.0%
Rem 7 ½	4.45	2303	186	8.1%
Fed 205	4.45	1469	103	7.1%
CCI 450	4.45	1602	104	6.5%
Fed 205M	4.45	1434	103	7.2%
DDNP KVB-9E	4.45	1331	109	8.2%

Table 1 shows average peak pressures along with standard deviations from the mean for the primers in this study. Primers of diameter 5.33 mm are labeled "large", and primers of diameter 4.45 mm are labeled "small" by manufacturers. Except for the DDNP-based large rifle primer, large rifle primers produce stronger blast waves than small primers, and "magnum" rifle primers (Fed 215M, CCI 250) produce stronger blast waves than non-magnum primers of the same size. There are significant differences in the standard deviations observed for different primer types, and it is notable that so-called "Match" primers are not always more consistent than non-match primers. Perhaps most notable is that in each group (large and small), the standard deviation of the DDNP-based primer is the largest percentage of its mean value. For the large rifle primers, the standard deviation of the DDNP-based primer (25%) is more than twice the standard deviation of any lead styphnate based primer that was tested.

Since it is of interest to know how much these blast pressure differences impact field performance, some brief field testing was conducted comparing 10 shots with the DDNP-based KVB-7E rifle primer with 10 shots of the lead styphnate based Fed 210M in each of two otherwise identical loads: 1) a 30-06 load using 51.0 grains of H414 (a ball powder) in Remington brass with a 220 grain Sierra MatchKing bullet and 2) a 7.62x51mm NATO load using 46.0 grains of Varget (an extruded powder) using Remington brass with a Berger 155.5 grain Fullbore boat tail bullet. Both tests were conducted with Remington 700 rifles in HS Precision stocks. The most obvious difference between the lead based and DDNP-based primers was a perceptible delay between firing pin strike and ignition in 15 of 19 shots with the DDNP-based primers (and one misfire); in contrast, there were no misfires or perceptible delays in ignition with the lead based primer. (In fact, in over one thousand rounds using lead based primers in these two rifles, the authors have never observed a perceptible delay in firing nor a misfire.) Figure 2 shows the primer which failed to ignite the powder charge and resulted in a misfire.

Excluding the misfire, the average velocity of the 30-06 load was lower (703 m/s) for the DDNP-based primer compared with the lead based primer (727 m/s). The standard deviation in muzzle velocities was comparable for the DDNP-based primers (4.8 m/s) and for the lead based primers (4.4 m/s) in the 30-06 load, and the average 5 shot group size (extreme spread measured at 200 m) was 2.5 minutes of angle (MOA) for the DDNP-based primers and 2.4 MOA for the lead based primers.

In the 7.62x51mm NATO load, both primers produced an average muzzle velocity of 823 m/s with the DDNP-based primer giving a smaller standard deviation (2.8 m/s) than the more powerful lead styphnate based primer (6.5 m/s). This agrees with the hypothesis that having a primer that is not more powerful than needed to reliably ignite the powder charge produces more consistent muzzle velocities than a more powerful primer.[9] The delay in ignition in 6 of the 10 shots with the DDNP-based primer suggests that this primer is at the low end of strength needed to reliably ignite 46 grains of an extruded powder. This ignition delay is the most likely cause of the larger average group size (2.5 MOA) of the DDNP-based primers in the 7.62x51mm NATO load compared with the lead styphnate based primers (1.8 MOA) at 200 m.

DISCUSSION

It is possible that DDNP-based primers from other suppliers might yield more consistent results. Unfortunately, Winchester, Remington, and ATK were all contacted but chose not to provide lead-free primers for testing. None of these companies offer lead-free primers as stand-alone components, and to our knowledge, DDNP-based primers are currently only available in training ammunition, with no major supplier offering service caliber or hunting ammunition for self-defense, law-enforcement, hunting, or military duty.

In the explosives literature, DDNP is reported to have a higher detonation velocity but a lower deflagration point and impact sensitivity than lead styphnate and lead azide.[10] The higher detonation velocity and pressures were reported to sometimes cause breech

damage. In response, manufacturers of training ammunition have attempted to compensate by making various changes such as enlarging the flash hole, crimping the primer more tightly, and moving to a smaller primer diameter.[11][12] It is possible that the lower pressures and larger pressure variations reported here may be due to instability in shipping and storage rather than an inherent quality of newly manufactured DDNP based primers. The development of DDNP as a priming compound continues. Recent work suggests that improved manufacturing methods for a spherical DDNP may improve purity and decrease the impact sensitivity.[13]

While a main impetus for developing DDNP-based priming compounds was to reduce toxicity due to heavy metal compounds, it has been reported that there may be different health risks associated with exposure to their residues. Specifically, DDNP may activate an inappropriate immune system (allergic) response. Also, in enclosed rifle ranges, there are health risks associated with the use of compositions such as Sintox, which are mixtures of DDNP, tetrazine, zinc peroxide, and titanium. In part because of these risks, work is ongoing to develop non-toxic primers based on other compounds.[14] The assumption that lead-free ammunition is non-toxic has also been called into question by an Air Force study reporting a rise in health related complaints following the transition to lead-free ammunition, even though measured contaminant levels were all below occupational exposure levels.[15] Transitioning to lead-free ammunition does not reduce the ventilation requirements for ranges, as was believed at one time.

The history of primer technology is somewhat cyclical with several notable instances of new primer chemistry being introduced to better meet an environmental or gun maintenance concern with several decades passing before the new chemistry became reliable. In 2010, the Office of the Product Manager for Maneuver Ammunition Systems projected that green primer formulations for use in the US military will be evaluated and candidates selected in FY 2011, and that ammunition with green primers will be at full production by the end of FY 2012.[16] At the turn of the 20th century, primer development was driven by the need for a non-corrosive formulation. In the following years, changes in primers used by the military were necessary due to lack of shelf-stability, which led to misfires. This was a reason the US military moved from mercury fulminate-based primers prior to WWI to a formulation based on potassium chlorate, antimony trisulphide and sulphur. However, this formulation was associated with misfires and corrosion, forcing another change.[7]

The lesson of primer history is that care is needed to prevent another large scale move to new primer technology that will compromise field performance and produce unintended consequences. Since difficulty obtaining consistent field performance from lead-free rifle primers was observed in this study and has been noted by others [17][18], the authors recommend independent testing demonstrate the following characteristics before any DDNP-based primer is adopted for duty:

1. Peak blast wave magnitude and consistency comparable with lead based primers.
2. Misfire rates at or below those with lead based primers.
3. Shelf-life and long term stability comparable with lead based primers.
4. Muzzle velocity consistency and peak chamber pressure comparable with lead based primers.
5. Ignition delay times comparable with lead based primers.
6. Comparable accuracy with lead based primers in both machine rests and hand-held testing.

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REFERENCES

1. Cameron, E.J., "Comparative Analysis of Airborne Chemical Exposure to Air Force Small Arms Range Instructors," Air Force Institute of Technology, AFIT/GES/ENV/06M-01, March 2006. DTIC Doc.: ADA450111 (http://handle.dtic.mil/100.2/ADA450111)
2. Cain, J.C., *The Chemistry of the Diazo-Compounds*, Edward Arnold, London, 1908. Reprinted in 2003 as *Diazo Chemistry – Synthesis and Reactions*, Watchmaker Publishing.
3. Dehn, W.M., "Process for Increasing the Sensitiveness and Power of Explosive Compositions and Product Thereof," US Patent 1,428,011, 1922.
4. Hancock, R.S., and L.C. Pritchett, "Method for Producing Diazodintrophenol and the Product Thereof," US Patent Re. 19,645, 1935.
5. Garfield, F.M., and H.W. Dreher, "Manufacture of Diazodintrophenol," US Patent 2,408,059, 1946.
6. Burns, J.E., "Ammunition," US Patent 1,862,295, 1932.
7. Warlow, T.A., *Firearms, the Law and Forensic Ballistics*, CRC Press, 2004, pp. 100-102.
8. Courtney, M., and A. Courtney, "A Table-Top Blast-Driven Shock Tube," *Review of Scientific Instruments*, Vol. 81, No. 12, 2010. p. 126103.
9. Salazar, G.A., "A Match Primer Study in the 6BR Cartridge," *Precision Shooting*, June 2008.
10. Meyer, R., J. Kohler, and A. Homburg, *Explosives*, Wiley-VCH Verlag GmbH & Co., 2002.
11. Petty, C., "Brass from Non Toxic Ammo," *American Handgunner*, Nov-Dec, 2003.
12. Petty, C., "Lead-free Ammo: When Solutions Beget Problems," *American Handgunner*, May, 2005.
13. Yang, Z., Y. Liu, D. Liu, L. Yan, and J. Chen, "Synthesis and Characterization of Spherical 2-Diazo-4,6-Dinitrophenol (DDNP)," *Journal of Hazardous Materials*, Vol. 177, No. 1-3, 2010. pp. 938-943.
14. Huynh, M.H.V., M.D. Coburn, T.J. Meyer, and M. Wetzler, "Green Primary Explosives: 5-Nitrotetrazolato-N2-Ferrate Hierarchies," *Proceedings of the National Academy of Sciences*, Vol. 103, No. 27, 2006. pp. 10322-10327.
15. Moran, M.P., and D.K. Ott, "Lead Free Frangible Ammunition Exposure at United States Air Force Small Arms Firing Ranges, 2005-2007," Air Force Institute for Operational Health, May2008. DTIC Doc.: ADA487506 (http://handle.dtic.mil/100.2/ADA487506)
16. Woods, J., "Small Caliber Ammunition Enhancing Capabilities," *NDIA Joint Armaments Conference*, May 2010. (www.dtic.mil/ndia/2010armament/ThursdayLandmarkBJeffreyWoods.pdf)
17. Ayoob, M., *Gun Digest Book of SIG-Sauer*, Krause Publications, 2004.
18. Sweeney, P., *Gun Digest Book of the AR-15, Volume 2*, Gun Digest Books, 2007, p. 43.

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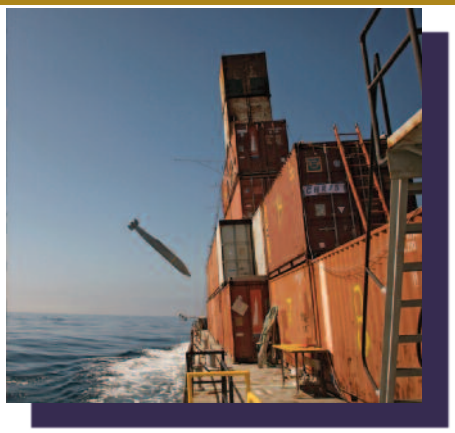


The Navy completes the first free-flight testing of the Joint Standoff Weapon C-1 variant at Point Mugu Sea Range California, July 26. (U.S. Navy photo)

NAVY CONDUCTS JSOW C-1 FREE-FLIGHT TESTING

The U.S. Navy completed the first free-flight testing of the Joint Standoff Weapon C-1 variant at Point Mugu Sea Range California, July 26. Free-flight tests are done to verify that the weapon's characteristics meet the performance requirements in the design. This event was the first end-to-end functionality test of an inert JSOW C-1, from pre-flight to target impact. "The successful outcome of free-flight testing marks another important milestone achieved by the dedicated men and women of PMA-201," said Capt. Carl Chebi, Precision Strike Weapons (PMA-201) program manager. "JSOW C-1 will provide a much needed Network Enabled Weapon capability to the fleet."

A team from Air Test and Evaluation Squadron (VX) 31 deployed the test weapon from an F/A-18F Super Hornet. On shore, an Integrated Battlespace Arena asset, an advanced simulation facility, maintained the Link 16 network – a secure military tactical data exchange – and managed the network messages. The target for the test was an unmanned 260-foot long Mobile Ship Target (MST). After the weapon achieved Link 16 net-entry, it was launched and began receiving in-flight target updates via the weapon data link on the moving target. It successfully acquired the MST autonomously and guided to the predetermined aim point on the ship.

"The accomplishment of this free-flight test has advanced the program closer to providing a standoff weapon that the aircrew can provide target updates after weapon separation," said Lt. Cmdr. Samuel Hanaki, JSOW Deputy Program Manager. "Precisely engaging moving maritime targets is a needed capability for the warfighter and we are working diligently to provide this weapon to the fleet."

The JSOW is an air-to-ground, medium-range precision guided, glide weapon that employs a GPS/inertial navigation system and an infrared seeker for terminal guidance. The JSOW C-1 variant adds a Link 16 weapon data link for in-flight target updates and upgraded seeker software to autonomously target and strike a specific aim point on a moving ship. The JSOW C-1 will be the first Network Enabled Weapon in the military's inventory and the first weapon with the capability to precisely strike moving maritime targets.

This test was the first of two planned developmental test free-flights. Following the developmental test phase, the program will enter an integrated test series of free-flights prior to operational testing. Initial operating capability of the JSOW C-1 is scheduled for 2013.

PMA-201 is responsible for the research, development and acquisition of the fleet's air-to-ground precision guided weapons, general purpose bombs, and aircraft armament-related equipment.

SOURCE:
http://www.navair.navy.mil/index.cfm?fuseaction=home.NAVAIRNewsStory&id=4717

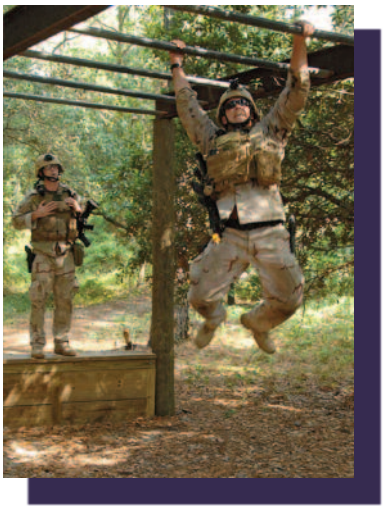
ONR LIGHTENS BURDEN FOR NAVY EOD TEAMS

From Office of Naval Research Public Affairs

A lightweight power system developed by the Office of Naval Research's (ONR) TechSolutions Program to cut the 50 pounds of battery devices hauled by the Navy's explosive ordnance disposal (EOD) teams was delivered July 22.

Responding to a request from the Explosive Ordnance Disposal Training and Evaluation Unit (EODTEU) 2, to create a lightweight power device to charge their specialized equipment, TechSolutions partnered with Naval Surface Warfare Center Crane, Ind., and Protonex Technology Corp. to develop the Power Management Kit (PMK). Five units were shipped to the team for a trial. "The PMK gives the warfighter a very significant weight reduction in batteries, chargers and adapters, while also increasing real-time awareness of power usage and availability," said Phil Robinson, Protonex's vice president and ONR's principal investigator for the PMK project.

The kit is a lightweight, portable system containing common military rechargeable batteries, a solar-powered blanket, a one-pound Soldier Power Manager (SPM) unit and "smart" cables to link the SPM with EOD equipment. The PMK is centered around the SPM, which can harness energy from a variety of sources to charge batteries and provide power to attached gear. Any new equipment added to the EOD team's arsenal can be supported by merely providing a new cable. Therefore, the SPM itself never requires an upgrade.



Explosive Ordnance Disposal technician 2nd Class Justin Eaton, from Explosive Ordnance Disposal Mobile Unit (EODMU) 6, speeds across the monkey bars while going through an obstacle course during a training exercise. (U.S. Navy photo by Mass Communication Specialist 2nd Class Kori Melvin/Released)

By enabling teams to use alternative energy sources, such as a solar cell-covered blankets and fuel cells, the PMK reduces the team's logistics footprint. Few of the Navy's EOD teams' primary tools and equipment use the same power sources, so Sailors and Marines must carry multiple single-purpose batteries to power their gear.

"Currently, if one were to collect all the battery chargers allocated to an EOD platoon, they would fill a 4-foot by 4-foot table," according to EODTEU 2 Combat Development staff. "The PMK, with all of its cables, and the SPM in a soft roll case weigh only nine pounds, replacing up to 50 pounds of specialized chargers and related equipment."

A graphical interface displays information about batteries and sources, power usage, state of charge and operational details. This data is stored and analyzed, providing EOD teams with unprece-

dented visibility, safety, situational awareness and readiness when planning future missions.

TechSolutions accepts recommendations and suggestions from Navy and Marine Corps personnel on ways to improve mission effectiveness through the application of new technology. The TechSolutions team provides Sailors and Marines with prototype technologies to rapidly address immediate needs. TechSolutions works closely with the fleet and force to meet specific requirements that cannot be readily satisfied with commercial off-the-shelf technologies. Typical turn-around time for a working prototype is 12-18 months.

ONR provides the science and technology necessary to maintain the Navy and Marine Corps' technological advantage. Through its affiliates, ONR is a leader in science and technology with engagement in 50 states, 70 countries, 1,035 institutions of higher learning and 914 industry partners. ONR employs approximately 1,400 people, comprising uniformed, civilian and contract personnel, with additional employees at the Naval Research Lab in Washington, D.C.

SOURCE: http://www.navy.mil/search/display.asp?story_id=61732

FLY-BY-WIRE TECHNOLOGY NOW USED IN ARMY UTILITY HELICOPTERS

Randy Siniard, RDECOM

In use in other Defense Department aircraft for years, fly-by-wire now replaces the conventional manual flight controls in some Black Hawk helicopters with an electronic interface. In older aircraft, cables run from the pilot's controls to various control systems such as rudders, ailerons and, in the case of helicopters, the pitch controls on the rotor blades. With fly-by-wire technology, the flight-control movements are converted to electronic signals and sent to flight control computers that use them to determine how to move the aircraft. This technology can automatically perform functions without input from the pilot, such as systems that automatically stabilize the aircraft. "The fly-by-wire variant of the UH-60M Black Hawk offers increased handling capability, lower maintenance burden, decreased pilot work load, and full-authority digital engine control," Maj. Jeffrey Stvan, assistant program manager UH-60 Modernization, said.

This technology greatly decreases the workload of the pilots, allowing them to focus on their surroundings and reduce fatigue, by permitting them to better control the loads. "Fly-by-wire offers increased handling capabilities and decreased pilot workload. This allows the pilot to focus on his current mission," Stvan said. "One aim of the fly-by-wire system is to allow the pilot to keep more of his concentration outside the cockpit and on his surrounding environment."

Maj. Carl Ott, an Army experimental test pilot for the Aviation and Missile Research Development and Engineering Center's Aeroflightdynamics Directorate at Moffett Field, Calif., has done testing for the Utility Project Office and Sikorsky, involving fly-by-wire technology. He said fly-by-wire technology is geared toward making the aircraft highly stable and more predictable.

This technology will also help troops on the ground, when a pilot can focus more on the surroundings and efficiently making

Maj. Carl Ott, of the Aeroflightdynamics Directorate, Moffett Field, Calif., stands with a Black Hawk helicopter which is integrated with the fly-by-wire technology prior to a flight test. Photo Credit: Paul Langston, RDECOM

deliveries and place payloads that will be a great advantage, officials said. "The fly-by-wire is an enabling technology that will allow for more advanced, adaptive, flight controls and sensors to be integrated into a helicopter making them easier and safer to fly," Ott said.

SOURCE: http://www.army.mil/article/63427/Fly_by_wire_technology_now_used_in_Army_utility_helicopters/

ESC AWARDS CONTRACT FOR LIGHTENED INSTRUMENT LANDING SYSTEM

Patty Welsh, 66th Air Base Group Public Affairs

Officials at the Electronic Systems Center issued an $8.8 million contract award to Northrop Grumman Systems Corp., Network Systems Division Aug. 12 to provide the Air Force a deployable precision approach landing capability to support contingency operations or humanitarian missions across the globe. The fixed-price contract is for the Deployable Instrument Landing System, which will provide guidance to aircraft on final approach during low visibility, or low ceiling weather conditions.

The D-ILS will have the ability to convert a bare forward-operating base into a precision-approach-capable operating airfield, can augment an existing airfield, or be used at damaged airfields for conducting humanitarian operations. "I think the D-ILS is going to become an important asset for the Air Force," said Matthew MacGregor, the D-ILS program manager, "There will always be a need to support contingency operations and, if weather situations continue to ravage the world, the ability to assist in humanitarian operations will become very important." While fixed-based instrument landing systems are a time-tested solution, they are large structures that need to be transported on multiple aircraft and require installation of concrete, electronics and cabling.

The new D-ILS will be able to be transported on one C-130 Hercules and set up in 120 man-hours, which equates to two personnel being able to complete the task in about a week. "It was critical to the user community that the system have the ability to be set up and maintained by a small number of people," MacGregor said.

The contract is for 34 systems with a five-year period of performance. If all the potential options on the contract are exercised, the value could increase to almost $58 million. Production is anticipated to happen around the middle of 2013 with initial operating capability slated for early fiscal year 2014. "We're glad

Members of the 36th Communications Squadron and civilian contractors use a crane to erect an instrument landing system at Andersen Air Force Base, Guam, in 2009. Officials at the Electronic Systems Center issued a contract award Aug. 12, 2011, for a deployable instrument landing system to provide a leaner system that will be more easily transportable and require less personnel to set up. (Courtesy photo)

to get this effort started," said Col. Jimmie Schuman, Aerospace Management Systems Division director. "My team is looking forward to getting the system developed, tested and fielded as quickly as possible."

SOURCE: http://www.af.mil/news/story.asp?id=123268992

OFFICIALS CONDUCT STUDY OF AIRCRAFT OXYGEN GENERATION SYSTEMS

Master Sgt. Amaani Lyle, Air Force Public Affairs Agency

Air Force officials continue to conduct an Aircraft Oxygen Generation study, with members of the Air Force Scientific Advisory Board taking the leading role. Secretary of the Air Force Michael Donley directed the quick look study in the wake of recent F-22 Raptor incidents. Officials seek to identify a common thread among the incidents and will report their findings to senior Air Force leaders to help prevent such incidents from occurring in the future.

In a July 13 memorandum to the secretary of defense, Secretary Donley noted that pilots flying the F-22 have reported in-flight, physiological events at a rate three times higher than crews from other similar aircraft. The symptoms are similar to those resulting from an inadequate oxygen supply which affected the performance of the pilots experiencing them in varied ways. "The Air Force takes flying-related incidents seriously. We met with leaders, operators and maintainers in the F-22 community to talk about the Scientific Advisory Board's oxygen generation study," said Lt. Gen. "Hawk" Carlisle, the deputy chief of staff for Operations, Plans and Requirements, Headquarters U.S. Air Force. "As part of the meeting we were able to provide the latest information on the status of the study and address their concerns regarding a timely return to fly."

"This board is the secretary's brain trust," said Lt. Col. Matthew Zuber, the Air Force SAB executive director. "It utilizes the nation's best scientists and engineers to advise Air Force senior leadership on science and technology issues." The SAB, composed of special government employees, works with Air Force officials to conduct three to five studies per year and advises the secretary and the chief of staff on the findings, Zuber said. Zuber added the Air Force has expanded the scope of the scientific investigation beyond the F-22 to include such platforms as the F-35 Lightning II, T-6A Texan II, F-16 Fighting Falcon and the A-10 Thunderbolt II. The study has incorporated extensive ground testing and limited flight testing as well.

The SAB study panel investigation is supported by the F-22 System Program Office, the Air Force Safety Center, industry partners, Naval Air Systems Command and Air Force Research Labs. "We're all in the same room and not holding back any effort to determine whether these events are related to hypoxia, air contaminants or other factors," Zuber said, adding that no possibilities have been eliminated. This particular investigation, Zuber explained, involves a strong fact-finding analysis with deliberation among a cross-section of experts.

The study will benefit from technical data generated by flight test activities conducted at Edwards Air Force Base, Calif., laboratory tests conducted by Air Force Research Labs, and contractor personnel, he said. "The zero-risk solution is not to fly, and that's not a long-term option; it's an inherently dangerous business to fly and fight wars," Zuber said. "We want to make sure we mitigate risks to a level that's appropriate for the urgency of the mission."

The SAB AOG study plans to provide the Air Force secretary and Air Force chief of staff interim reports prior to the final report projected for later this fall. Once complete, the product will be releasable to the general public. Until the report is submitted, it would be inappropriate to speculate on potential outcomes of the study, Zuber said.

SOURCE: http://www.af.mil/news/story.asp?id=123268093

ARMY ANNOUNCES GROUND COMBAT VEHICLE CONTRACTS

Office of the Assistant Secretary of Defense Public Affairs

The Army announced today the award of contracts to BAE Systems Land and Armaments, L.P., of Troy, Mich., for $449.9 million, and General Dynamics Land Systems, Inc., of Sterling Heights, Mich., for $439.7 million, for the Ground Combat Vehicle program technology development phase. These contractors have been selected to develop competitive, affordable and executable designs for a new Army Infantry Fighting Vehicle, or IFV, over the next 24 months.

The contract awards follow the Department of Defense's formal approval of the Ground Combat Vehicle, or GCV, program to enter the technology development phase. Approval of this first major milestone builds on months of ongoing collaboration between the Army and the Office of the Undersecretary of Defense for Acquisition, Technology and Logistics, to successfully develop, build and field an affordable, effective and suitable IFV. "The Army enthusiastically welcomes the formal launch of the Ground Combat Vehicle program, which will provide much needed protection and mobility to soldiers in combat," said Secretary of the Army John McHugh. "Given the economic environment the nation currently

U.S. Army graphic. NOTE -- Generic representation of a combat vehicle only. The final Army Ground Combat Vehicle may bear little to no resemblance to this representation. There is no requirement for the vehicle to be either tracked, or wheeled.

faces, the Army recognizes that it is imperative to continually address requirements as we build a versatile, yet affordable, next-generation infantry fighting vehicle."

The department's GCV acquisition strategy, which emphasizes affordability and a seven-year schedule, calls for aggressive exploration of GCV IFV capabilities trade-space via continued requirements and affordability analysis during the 24-month technology development phase. As the Army finalizes GCV requirements during this phase of the formal acquisition process, these efforts will enable the Army to realize program schedule and affordability objectives. The Army remains committed to a seven-year schedule as the appropriate amount of time necessary to design, develop, build and test the next-generation infantry fighting vehicle.

To develop a successful program with well-informed decision points at each major milestone, the Army will undertake a three-pronged approach during the first phase of this effort. First, contractors will work collaboratively with the Army to develop competitive, best-value engineering designs to meet critical Army needs. Concurrently, the Army will initiate an update to its GCV IFV analysis of alternatives and conduct separate technical and operational assessment of existing non-developmental vehicles. Results from this assessment, along with contractors design efforts, will inform GCV requirements to support the next program milestone and facilitate a full and open competition for the next phase of the GCV program. "This is an important milestone in our Army's modernization program. GCV is the first combat vehicle designed from inception for an IED (improvised explosive device) environment. It will provide armor protection and the capability to maneuver cross-country with the nine-man infantry squad," said Army Chief of Staff Gen. Martin E. Dempsey. The Army's overall strategy for developing GCV is consistent with efforts to implement acquisition reform and best acquisition practices.

SOURCE:
http://www.army.mil/article/63891/Army_announces_Ground_Combat_Vehicle_contracts/

ONR'S TECHSOLUTIONS PROVIDING SEALS WITH NEW GLASSES THAT CHANGE LENS COLOR ON THE FLY

Geoff S. Fein, Office of Naval Research, Corporate Strategic Communications

The Office of Naval Research's (ONR) TechSolutions department is set to deliver to Navy Special Warfare Command personnel later this year new protective eyewear that will eliminate the need for warfighters to stop to change out colored lenses to accommodate differences in light levels. The Fast-Tint Protective Eyewear (FTPE) changes color quicker than transitional lenses commonly found at an optometrist's office. "Transition time is less than 0.5 seconds," said Stephanie Everett, ONR's TechSolutions program manager.

"Currently, warfighters are using a set of interchangeable lenses that require them to stop and manually switch lenses to adjust the goggles to a particular light environment," Everett said. "But they can't take the time to stop and remove and replace the lenses." Instead, they often simply remove their sunglasses when moving inside, leaving their eyes unprotected. The FTPE was designed to enable them to maintain ballistic protection under all lighting conditions, without interrupting their operational tempo.

Liquid crystal solutions within the lenses contain customized dyes that transition to amber, blue, dark gray or clear when an electric charge is applied. Lenses can change color automatically as wearers move in and out of varying environments, or lens colors can be altered manually by pushing a small button on the side of the glasses. Additionally, the lenses meet the American National Standards Institute's ballistic impact safety requirements.

The request for new eyewear came to TechSolutions from warfighters in July 2009, and the project is almost complete. The initial delivery was for 30 pairs of the new eyewear, which have already gone out for evaluation with warfighters who will use them in training. "They will provide structured feedback on the glasses," said ONR's Command Master Chief Petty Officer Charles Ziervogel, who oversees the TechSolutions department. After this evaluation, Special Operations Command (SOCOM) is expected to take delivery of the FTPE glasses. "SOCOM is buying 100 units based on the initial assessment and seeing the results from the current evaluation," Ziervogel said.

Last August, an earlier prototype was assessed, which led to design changes, which are incorporated in the current eyewear. "The user feedback made this prototype even better," Everett said. Results from this round of assessments were expected in April. The company, along with Naval Surface Warfare Center Crane, Indiana, was selected to develop FTPE. "We expect additional minor design changes based on the results of the current assessment," Everett said. AlphaMicron will incorporate any changes into what will be close to a final product.

TechSolutions accepts recommendations and suggestions from Navy and Marine Corps personnel working at the ground level on ways to improve mission effectiveness through the application of technology. It is solely focused on delivering needed technology and moving the sea services toward more effective and efficient use of personnel. TechSolutions uses rapid prototyping of technologies to meet specific requirements.

WSTIAC contributed to this effort. Matt Luna, Technology Transition (T2) Team Leader, is the point of contact. mluna@alionscience.com

The Roles of Major Types of Ships in the Navy's Fleet

(Text is excerpted from "An Analysis of the Navy's Fiscal Year 2012 Shipbuilding Plan," Congressional Budget Office, June 2011, DTIC Document ADA545315)

Nimitz Class Aircraft Carrier

The Navy's 11 **aircraft carriers** are the heart of the battle force fleet. Each carries an air wing of about 60 aircraft, which can attack hundreds of targets per day for up to a month before needing to be rested. Carriers are by far the largest ships in the fleet, with a weight (displacement) of about 100,000 tons. Ten of the 11 current carriers belong to the Nimitz class.

Ohio Class Ballistic Missile Submarine

Strategic **ballistic missile submarines** carry the major part of the U.S. nuclear deterrent, up to 24 Trident missiles with four to eight nuclear warheads apiece. The Navy has 14 Ohio class ballistic missile submarines in the strategic role and has converted 4 more to a conventional guided missile (SSGN) configuration, each of which displaces about 19,000 tons submerged. Those SSGNs carry up to 154 Tomahawk missiles as well as special-operations forces.

Los Angeles Class Attack Submarine

Attack submarines are the Navy's premier undersea warfare and antisubmarine weapon. Since the end of the Cold War, however, they have mainly performed covert intelligence gathering missions. They have also been used to launch Tomahawk missiles at inland targets in the early stages of conflicts. The Navy has 53 attack submarines, 44 of which belong to the Los Angeles class. At 7,000 tons, they are less than half the size of ballistic missile submarines.

Freedom Class Littoral Combat Ship

Large surface combatants – which include cruisers and destroyers – are the workhorses of the fleet. They defend the Navy's aircraft carriers and amphibious warfare ships against other surface ships, aircraft, and submarines. They also perform many day-to-day missions, such as patrolling sea lanes, providing an overseas presence, and conducting exercises with allies. In addition, they are capable of striking land targets with Tomahawk missiles. Different types of surface combatants have displacements ranging from 9,000 to 15,000 tons.

Wasp Class Amphibious Assault Ship

Small surface combatants are frigates and, in the future, littoral combat ships. Frigates today are used to perform many of the same day-to-day missions as large surface combatants. Littoral combat ships are intended to counter mines, small boats, and diesel electric submarines in the world's coastal regions. More routinely, they will also participate in patrolling sea lanes, providing an overseas presence, and conducting exercises with allies. These ships range in size from 3,000 to 4,000 tons.

Austin Class Amphibious Transport Dock

The Navy's two classes of **amphibious assault ships** (also known as large-deck amphibious ships or helicopter carriers) are the second largest ships in the fleet at 40,000 tons. They form the centerpiece of amphibious ready groups, and each can carry about half the troops and equipment of a Marine expeditionary unit. They also carry as many as 30 helicopters and 6 fixed-wing Harrier jump jets, or up to 20 Harriers.

Wasp Class Amphibious Assault Ship

The Navy has four other classes of amphibious warfare ships, and such ships are divided into two types: **amphibious transport docks** and **dock landing ships**. Two of those ships together provide the remaining transport capacity for a Marine expeditionary unit in an amphibious ready group. They range in size from 16,000 to 25,000 tons.

Supply Class Fast Combat Support Ship

The many **logistics and support ships** in the Navy's fleet provide the means to resupply, repair, salvage, or tow combat ships. The most prominent of those vessels are fast combat support ships, which operate with carrier strike groups to resupply them with fuel, dry cargo (such as food), and ammunition. These ships can be as small as 2,000 tons for an ocean-going tug or as large as 50,000 tons for a fully loaded fast combat support ship.

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