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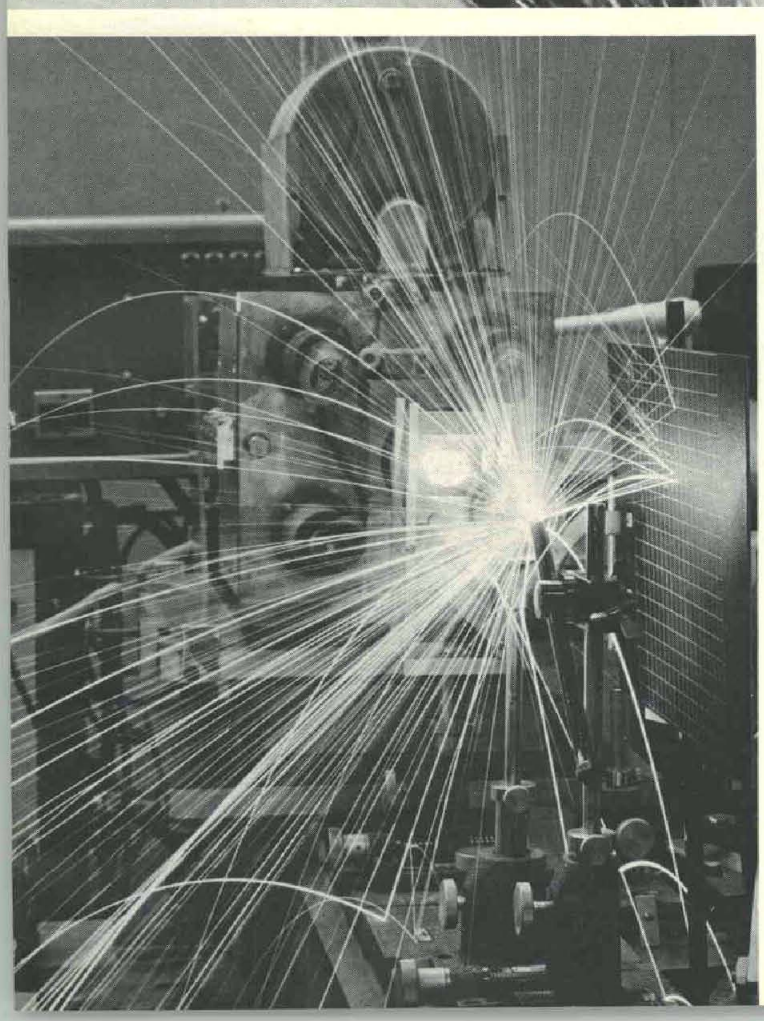
SEPTEMBER - OCTOBER 1979

Forty years of scientific achievement in ...



Ballistic Research

(See Page 1)

R,D&A ARMY

Vol. 20 No 5 **September-October 1979**

ABOUT THE COVER:

Detonation of an explosive device at one of BRL's test ranges, and molten particles being ejected from a steel bar, under the focus of a 200-Joule ruby laser beam, are shown on front cover of this issue. The back cover shows BRL's Soft Recovery System, located on Spesutie Island, one of BRL's test sites at APG, used to recover electronically instrumented projectiles fired from large-caliber weapons. Full muzzle velocity is achieved after firing and the system's water trough slows the projectile as it transverses to zero velocity so that BRL scientists can monitor the projectile and recover the highly instrumented package unharmed for examination.

FEATURES

DEPARTMENTS

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Purpose: To improve informal communication among all segments of the Army scientific community and other Government R,D&A agencies; to further understanding of Army R,D&A progress, problem areas and program planning, to stimulate more closely integrated and coordinated effort among Army R,D&A activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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BRL Programs Respond to Critical Army Requirements

For more than 40 years the Ballistic Research Laboratory (BRL) has been the Army's foremost center for research in ballistics and related sciences supporting ballistics. The laboratory has used the fundamental knowledge gained through the years by its scientists and engineers to solve problems of immense military significance covering the entire range of weaponry—from small arms and their ammunition through large missiles to nuclear weapons and their effects.

Now a major research element of the Army Armament R&D Command (ARRADCOM), BRL remains unique. Its activities span the spectrum of weapons systems, including armaments already fielded, to those in engineering development, as well as those that are only concepts.

The laboratory traces its origin to World War I, when important work in exterior ballistics was carried out by a branch of the Office of the Chief of Army Ordnance, in Washington, DC. However, it was not until 1935 that all phases of ballistic research were brought together at Aberdeen Proving Ground, MD.

At that time the Research Division, a group of 33 civilian scientists, was organized to investigate interior, exterior, and terminal ballistics and ballistic measurement computations and ammunition surveillance. In 1938, to give greater emphasis to its special field, the division was renamed the Ballistic Research Laboratory but its mission and organization remained the same.

Today the laboratory has five major divisions carrying out a broad, comprehensive program. The current program consists of more than 400 work units funded from mission and Army customer projects and from other Department of Defense and U.S. agencies, such as NASA, the Civil Defense Preparedness Agency, and the Department of Transportation. The annual budget averages $50 million.

BRL received the Army Laboratory of the Year Award in 1976, the DARCOM Award for Laboratory Excellence in each of the past four consecutive years, and Presidential recognition in 1977 for exceptional contributions to Army R&D.

Dr. Robert J. Eichelberger is BRL director, and Dr. Lawrence J. Puckett is assistant director.

A survey of ongoing activities at BRL reflects the vast scope of capability and the extent of involvement of BRL in the Army's materiel acquisition and readiness operations.

Looking first at the Launch and Flight Division, headed by Dr. Charles H. Murphy Jr., one finds that it conducts studies in aerodynamics of shells and other missiles and develops information for improved weapon design techniques.

Roots of BRL's Launch and Flight Division (LFD) go back to the Ballistic Branch of the Chief of Ordnance, installed at Aberdeen Proving Ground in 1918. Technological methodology has become much more sophisticated but the present LFD mission resembles its earliest predecessor: perform basic and applied research to produce data and models for improving the performance of Army projectiles.

Research teams conduct experimental and theoretical investigations in high-energy fluid dynamics, aerodynamics, missile dynamics and continuum mechanics to study new weapon systems as well as the prediction of the flight environment of future weapons. Emphasis is on theoretical modeling with the aim of integrating the flight model with interior and transitional ballistics.

There were many formidable barriers to meeting this objective in prior years. Experimental and theoretical tools for analyzing flight mechanics were ludicrously rudimentary by today's standards. Shock waves and supersonic flows were then considered scientific curiosities.

By contrast, the wealth of progress in the intervening years now offers the researcher precise new tools. These include lasers, cinematography, radar and telemetry, along with theory and computers capable of enormously detailed descriptions of the nonlinear, chemically-reacting flows encountered by current and projected weaponry.

The division and its forerunners contributed much to this progress. This includes acquiring and exploiting the first supersonic wind tunnels in this country, and constructing the supersonic and transonic ballistic ranges which are still used with modernized instrumentation.

This progress also included developing the sunsonde and telemetry from instrumented projectiles over realistic, full-range flight trajectories, and the continual improvement in the stability criteria for projectile delivery systems of ever-increasing complexity.

Although the resources for addressing these flight problems have greatly improved, the relative difficulties have proliferated even more. This is due to the rigorous demands for increased capability in Army weapons systems.

Currently, LFD has research teams working in transitional ballistics, transient muzzle flows, sabot discard, computational aerodynamics, boundary layer effects, flow separtation and interactive dynamics of non-rigid payloads. All are incorporated to produce accurate firing tables and fire control data for the Army's land combat weapons.

Turning to BRL's Vulnerability/Lethality Division (VLD), one finds here the responsibility of generating data relative to the susceptibility of a target, structure or material. This encompasses research and testing to determine the lethality of existing and developmental munitions as well as the nuclear and nonnuclear weapons vulnerability of military targets, weapon systems and other equipment.

The division, headed by Mr. Alvan J. Hoffman, serves as the Army's lead laboratory for vulnerability technology. It leads the Army's effort in developing methods and data for assessing the vulnerability of many classes of targets.

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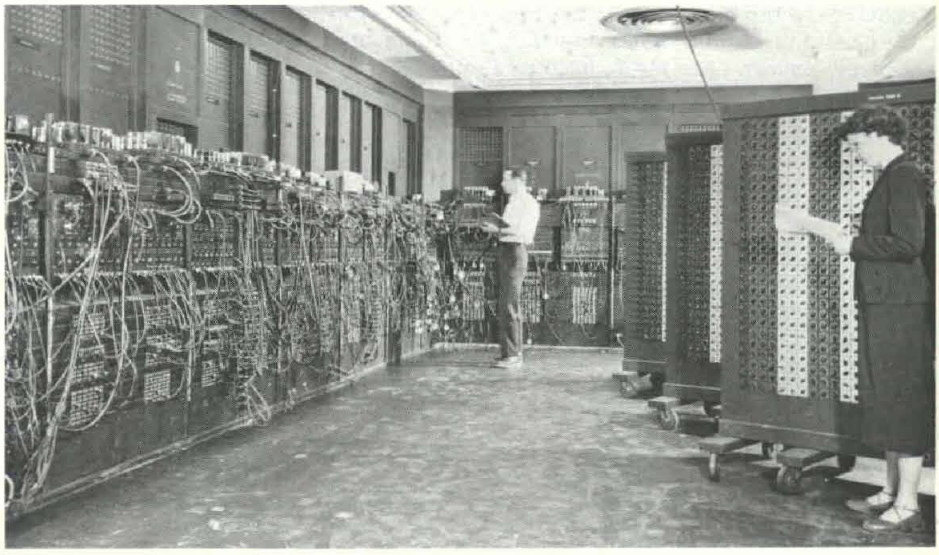


Electronic Numerical Integrator and Computer, world's first electronic computer, 1948.

40 Years of Progress in Ballistics Technology

By Dr. Robert J. Eichelberger

As we reflect on the 40 years in the life of the Ballistic Research Laboratory, we are proud of the role we have played in national defense and of our contributions to the civilian sectors of basic and applied sciences. Much of the credit for the tremendous progress in ballistics work during World War II, and for the continuing role that the laboratory plays today in advancing the science of ballistics and defense technology, is attributable to the founders of BRL, COL H. H. Zornig, Mr. R. H. Kent, and MG Leslie E. Simon (USA, Ret.), names sprinkled liberally throughout the annals of 20th Century ballistics.

Today we are the beneficiaries of a tremendous accumulation of knowledge and experience in weapons technology and its associated sciences. That accumulation, our corporate memory, and current capabilities place us in a unique position to examine the Army's capability requirements, to sift them, and to identify where missing technology precludes provision of material to meet these requirements. We can discern the need for a research task to answer specific questions or for an exploratory development project to exploit research results or to extend capabilities.

For several years our approach in research has been to couple our corporate knowledge of ballistics with the improvements in computer technology and scientific instrumentation. Experiments complement the use of mathematical models to describe physical phenomena and computer codes to predict the performance of weapons systems and their components. These critical experiments verify predictions, establish the accuracy of models, and provide insight into the construction of models.

With this approach, the BRL program is a continuing integrated effort to provide the scientific and engineering base necessary to advance the group of technologies comprising weapons technology. Explicit in this effort are identification of problems or unknowns that inhibit major progress in weapons technology and the construction of tasks to solve these problems.

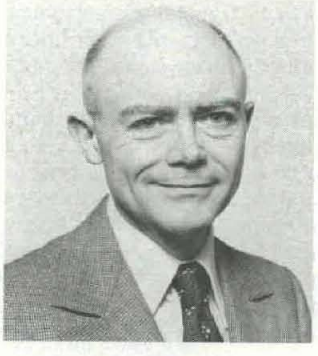
BRL efforts find immediate application to the solutions of problems occurring early or late in the materiel development cycle or during field use of weapons systems; and potential application to the exploratory or advanced development of materiel currently identified as necessary to meet scientific and technological objectives or on a longer time-scale to the unknown or visionary systems of the future.

Some of our recent contributions to provide the American soldier with superior weapon systems were:

- XM1 armor. Bearing the hallmarks of BRL research, this armor provides an unprecedented level of protection. Moreover, we are now on our third iteration for this type of armor—responding in the level of protection as our estimate of the threat escalates.
- Kinetic energy penetrator. Results of BRL investigations into sabot technology, penetrator materials and shapes, and aeroballistics of tank gun rounds provided the basic information needed for the design of an antitank round capable of defeating the approximated Russion T-72 tank.
- Antitank warheads. The fundamentals of shaped charge warhead and armor penetration mechanisms have been exploited to provide antitank warheads for the TOW and Hellfire systems.
- Instrumented tank gun/sabot technology. Results from intensively instrumented 105mm tank gun provide detailed information on gun tube/projectile interactions and the effects of tube vibrations on first round hit probabilities or improvements.
- Port firing weapons and squad automatic weapon system (SAWS). The BRL-designed port firing weapon for use with the infantry fighting vehicle is the only candidate for such application. The squad automatic weapon system, another BRL system, remains a viable candidate for SAWS.
- Vulnerability/survivability analyses. Some recent analyses include the Advanced Attack Helicopter (AAH), the Patriot System—both launcher and radar, the XM1 tank, and the Roland System. As an example of the importance of BRL contributions to the survivability of Army systems, the AAH incorporates no less than 16 significant vulnerability reduction features recommended by BRL.
- Systems analyses. Results of BRL analyses have been applied to SADARM, STAFF, DIVADS, armament for the LACV, and the 155mm self-propelled howitzer.

Our contributions and continuing dedication to providing our soldiers with the finest military equipment can be measured by the number of fielded systems that in one way or another bear the stamp of BRL, and in terms of the thousands of technical reports published by BRL, and the nearly-equal number of articles written by our personnel for scientific or technical journals.

Our staff and capabilities permit us to face the future with confidence and to affirm our resolve to make useful, significant contributions to U.S. Army weapon system technology.



DR. ROBERT J. EICHELBERGER is director of the Ballistic Research Laboratory and ARRADCOM associate technical director for Research and Technology. He is internationally recognized as an authority in ballistics research, and is a member of nine professional and three honorary societies and serves on more than 30 technical panels and committees. His academic credentials include a bachelor's degree from Washington and Jefferson College and a master's degree and doctorate from Carnegie Institute of Technology.

BRL PEOPLE

The BRL workforce of 496 employes includes 367 scientists and engineers, 44 technicians and 85 administrative personnel. More than 100 scientists hold doctoral degrees, 82 have master's degrees and 178 have bachelor's degrees in arts and sciences. The civilian staff is augmented with 8 military officers and 12 enlisted personnel. Two of the military personnel have been awarded doctoral degrees, four have received master degrees and six have bachelor degrees. There are 123 physicists, 49 physical scientists, 69 mathematicians, 93 engineers, 31 chemists, and 9 other academic disciplines in the civilian, military work force.

BRL Programs Respond to Critical Army Requirements

(continued from page 1)

Working concepts range from simple "quick-look" approaches to complex and sophisticated computer models.

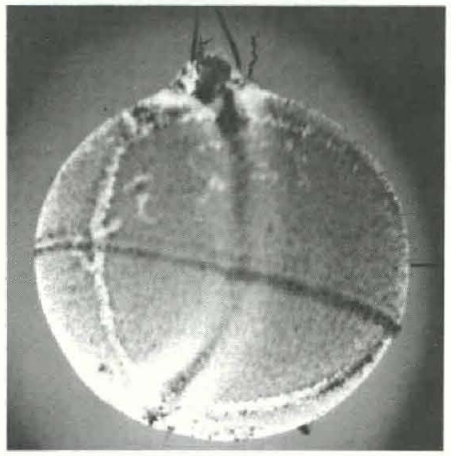
In addition to building the "tools" and obtaining experimental data bases, researchers at VLD are heavily involved in generating more specific vulnerability and lethality information for many other government agencies. The division has also assumed leadership for several working groups and supports others associated with the Joint Technical Coordinating Groups for Munitions Effectiveness and Aircraft Survivability.

Among U.S. allies it has influenced data exchange agreements, participated in NATO efforts to standardize models for armor protection and vulnerability assessment, and significantly affected NATO weapons developments.

VLD's principal programs include: surface targets such as armored vehicles, tube artillery command, communications and control equipment, air defense systems, building, bunkers and ammunition; aerial targets, like helicopters, remotely piloted vehicles, fixed wing aircraft and missiles; crew members in aircraft and vehicles; nuclear and laser effects on all appropriate targets; and methodology leading to new and improved models for all types of analyses and speedier, automated target description processes.

Research programs are responsive to urgent and critical Army requirements. Large quantities of data are provided to TRADOC for Cost and Operational Effectiveness Analyses (COEA) and other special studies. Data were recently provided for the XM1, IFV/CFV, Advanced Scout Helicopter (ASH) and Copperhead COEAs.

Array of instrumentation used in tracking Sputnik 1.



Kerr Cell photograph of a center-initiated spherical charge detonating (.1 microsecond exposure time).

Results of the VLD's technical program have aided significantly in establishing the lethality of nearly all of the anti-materiel and many of the anti-personnel systems in the Army. Indirectly, they effect all the armed service weapon systems.

Since the studies include both vulnerability and vulnerability reduction, they play a key role in the increased survivability of most major Army systems. This includes improved survivability of Black Hawk, Advanced Attack Helicopter and the XM1 tank, as well as increased survivability of fielded tanks, aircraft, howitzers and other combat materiel.

Another key unit is the Terminal Ballistics Division. This division, headed by Mr. Richard Vitali, is primarily concerned with the few milliseconds of time between the arrival of a projectile at a target and the completion of its interaction with the target. The attacker wants the projectile to effect a kill whereas the defender wants to survive without damage. By understanding the projectile-target interaction, the Terminal Ballistics Division permits the Army to improve its effectiveness in both attack and defense roles.

For the attack role, there are two principal techniques. The first is a long rod flying at high speed, called a kinetic energy penetrator. It must be designed for maximum penetration and peripheral damage.

The second is a relatively slow warhead. It uses high explosives at target impact to shape metal into a very fast penetrator or to produce fragments of the right size, shape and speed.

Concurrently, knowledge gained from this aspect is utilized in strong R&D efforts for improved protective techniques such as new armor approaches.

The Terminal Ballistics Division has been assisting the Department of Transportation and the Army Military Traffic Management Command in their efforts to reduce hazards of transporting fuels, chemicals, and explosives and to provide for greater safety of railroad operating personnel.

The Defense Nuclear Agency, the Army at large, and the Department of Defense Explosive Safety Board also call on the division for assistance in dealing with structures and their response to blast, shock and thermal loading.

Scientists and engineers in BRL's Interior Ballistics Division, headed by Mr. Leland A. Watermeier, study the interior ballistic cycles of Army gun systems—based on full understanding of behavior of

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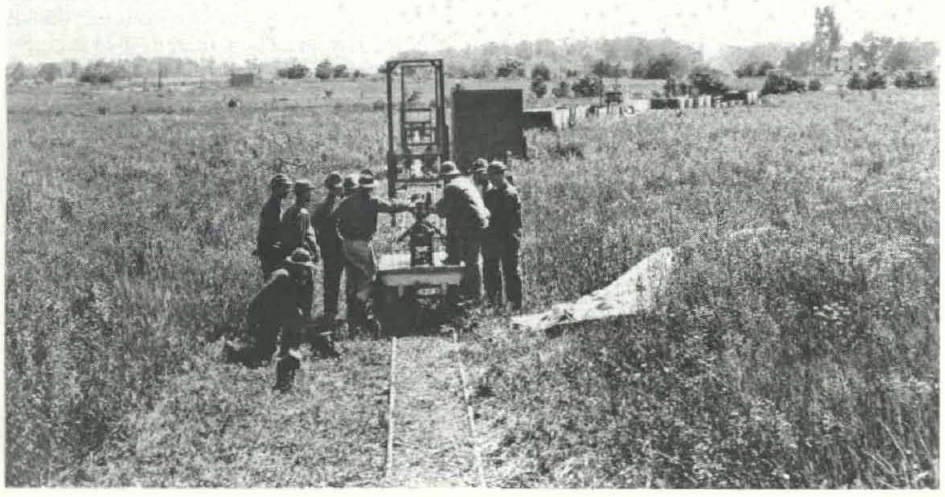


ROTC students observe measurement of the velocity of a rifle bullet at APG, MD, 1922.

MULTIPLE PHOTOGRAPHIC FLASHES, accurately timed, expose the motion of man and weapon during automatic fire tests at the Ballistic Research Laboratory.

(continued from page 3)

materials (propellants, ammunition, and weapons)—effects on the interior cycle due to ignition and combustion processes—chemical kinetics associated with interior balistics—projectile-launcher interactions and projectile launch conditions.

The current program is dedicated to research in methodology for the development of propelling charges. This includes investigations of high risk feasibility and application of novel propelling charges for air defense and tank weapon systems as well as techniques to increase performance of other Army devices.

Hypervelocity interior ballistics is in the forefront of the division's R&D program in support of systems that will include a traveling charge concept. This concept is being reexamined because of new superburning rate propellants and improved interior ballistic modeling and measuring techniques.

Novel developments are also being stressed in other areas of chemical propulsion, such as propellants with very low molecular weight combustions products. Alternate interior ballistic concepts, such as liquid propulsion technology and consolidated charge technology, are also being considered.

Considerable attention is being given to the design of minimum launch-weight projectiles without sacrificing structural integrity or accuracy, particularly as applied to the Army's XM1 tank cannon weapon system. Related areas include inbore behavior of projectiles along with heat transfer to gun tubes and its role to the erosion of these gun tubes.

Technology to provide low vulnerability ammunition for the Army's tank weapon systems is being emphasized in the DOD/DOE Insensitive High Explosives and Propellants (IHEP) Program. BRL scientists are also studying the geometrically, progressive, 19- and 37-perforation propellant for improved interior ballistic performance at existing maximum pressures.

The Ballistic Modeling Division is the BRL focal point for the mathematical modeling and analysis of weapon systems for ARRADCOM. It is headed by Mr. Harry L. Reed Jr. It incorporates two previous BRL research activities: concepts analyses and applied mathematics and science. These past designations describe the division's current primary functions.

Part of the division is dedicated to the analysis of weapon systems and weapon systems engineering. These efforts funnel input to various BRL research projects, permit a communication link between projects, establish a communication link between researchers and users of weapon systems, and provide support to ARRADCOM projects.

The division is also involved in direct development of mathematical models. These models describe analytically the total performance of complete weapon systems. Ballistic modeling involves system analysis and control theory as well as theoretical and experimental studies related to electromagnetic wave propagation, target signatures and target acquisition.

Major contributions are being made to millimeter wave technology. This played an important role in development of a 140-GHz and a 217-GHz IMPATT diode source. These devices have made 140- and 217-GHz radar systems practical for the tactical Army—providing the small size, simplicity and ruggedness of solid-state systems.

The division has six teams, each specializing in a different area, but primarily responsible for weapon system analysis and system engineering.

- The air defense team is heavily involved in the evaluation of two competing systems for the Army's new DIVAD (Division Air Defense) gun system.
- An artillery team is addressing the characterization of an artillery system that allows enough detail to permit the evaluation of engineering changes in weapon subsystems and enough tactical meaning to provide truly useful measures of effectiveness.
- The aircraft systems team is concerned with survivability of helicopter structure and concepts for heliborne gun systems that have high accuracy. The team is developing a precision aiming technique for heliborne antitank guns which shows a substantial improvement in accuracy over previous methods.
- The armor team has made significant contributions to the Army's medium-caliber antiarmor automatic cannon. Its tradeoff studies of mobility, armor and armament have provided a valuable data base for vehicle designers.
- The infantry weapons team has contributed to the development of improved infantry antitank weapons. This was achieved through its system engineering analyses of the STAFF (Smart Target-Activated Fire-and-Forget) and SADARM (Sense and Destroy Armor) munitions.
- The smoke and obscurants team has been planning and coordinating an Army program on multispectral screening agents, especially related to the millimeter wave realm. The team is often called on to make unusual, or unique transmission measurements (broad spectrum) related to systems performance in battlefield-like environments or when subject to countermeasures.

$43 Million Contract Awarded For Production of 99 PADS

Production of 99 Position and Azimuth Determining Systems (PADS), during a 3-year period, is called for in recent $43 million contract announced by the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA.

Litton Guidance and Control Systems, recipient of the contract, will produce nine systems the first year, 30 systems the second year, and 60 systems during the third year. The contract also includes engineering design of hardware and software, development of test equipment, and revision of the user handbook.

PADS is designed to provide the Army with a mobile, accurate field artillery survey system that can be used at battery, battalion and division levels. It will be primarily jeep-mounted, but can be transferred to a helicopter with no loss of survey.

The system can reportedly function at all vehicle speeds, whether on wheels or airborne, and during all types of weather conditions. It will improve field artillery mobility by permitting survey operations to keep up with faster moving weapons systems.

BRL Breakthrough Improves Antitank Capabilities

A team of ballistic experts at the U.S. Army Armament R&D Command's Ballistic Research Laboratory (BRL), Aberdeen (MD) Proving Ground, has been credited with a system analysis breakthrough that will reportedly provide infantrymen with highly effective antitank capabilities and an improved probability of kill.

Mr. Robert F. Gschwind and Mr. Harry R. Rogers, both engineers, Dr. Paul H. Deitz, a research physicist, and Mr. James F. O'Bryon, a mathematician, combined their talents and resources to conduct a comprehensive systems analysis of the Smart-Target-Activated Fire-and-Forget (STAFF) infantry antitank system.

Top officials and administrators recognize this accomplishment as a feat of exemplary engineering and mathematical judgment and expertise as well as an invaluable ballistic contribution developed in a very short time.

Gschwind, who has an extensive background in infantry weapons research, fire control, human factors engineering, computer modeling and mathematics, provided the overall integration of the simulation of the STAFF candidate system performance. He addressed the critical issue of fire control requirements, logic alternatives and effectiveness against targets.

Deitz, with proficiency in optics and physics, developed computer simulations to characterize the performance and response to the radiometric sensors on board the projectile. He assessed environmental conditions, including weather and target sizes and netted an efficient firing procedure for producing a high probability of target detection and kill. The system is believed to be highly effective in any kind of weather at ranges up to four kilometers.

O'Bryon, who is highly knowledgeable in aeroballistics, computer programing and statistics, provided the key to effectively simulate the anticipated flight and its dispersion characteristics.

Rogers combined the skills of computer modeling, vulnerability analysis and weapons engineering, to perform the final phase. He used terminal ballistics and vulnerability assessment simulations to evaluate the probability of killing targets. He developed a method to combine this data with delivery of error and target detection for the overall systems analysis.

Smoke PM Announces Completion of H^3S Tests

Successful completion of the High Humidity Hygroscopic Smoke (H^3S) Test at the Edgewood area of Aberdeen Proving Ground, MD, has been announced by U.S. Army Project Manager for Smoke/Obscurants COL Samuel L. Eure.

Recent tests involving the attenuation effects of smoke and other obscurants on the electro-optical spectrum had been conducted under conditions involving low to moderate humidities (20%-70%). Limited experimentation indicated high humidity (85% or greater) would increase the obscuring effects of various hygroscopic smoke materials such as Red Phosphorus (RP), White Phosphorus (WP) and Hexachloraethane (HC).

The objectives of the H^3S test were to:

- Validate a theoretically postulated effect of humidity on the attenuation characteristics of hygroscopic smoke in the visual, near infrared (IR) mid IR and far IR spectral areas of the electro-optical spectrum.
- Determine the effect of humidity on particle size distribution of hygroscopic smokes.
- Gain comparative information Climet, Knollenberg and University of Tennessee Space Institute particle size analyzers.

A total of 27 trials conducted with humidity ranging from 60% to 97%, using the three smoke sources. The U.S. Army Chemical Systems Laboratory provided the site for the test and materiel support. Dugway Proving Ground's Safari Team provided the analytical characterization of the smoke environments.

Included in the data were transmission measurements for various wavelengths, luminance, aerosol characterization (particle size distribution and density), and detailed meteorological data. Other participants included the U.S. Army Electronic Warfare Laboratory (EWL), University of Tennessee Space Institute, Project Manager for Training Devices (PM TRADE), and the University of Wisconsin.

EWL measured the transmission of solar-blind ultraviolet radiation through smoke and also measured scattered ultraviolet radiation from the smoke cloud. PM TRADE obtained data on the effects of H^3S obscurants on the centerline hit probability of the Multiple Integrated Laser Engagement System performance.

Dr. Davies, from the University of Wisconsin, in collaboration with scientists from NASA, measured the angular distribution of the radiation field inside and outside the smoke. They used two scanning photometers mounted on a vertical hoist.

Data will be compared with the prediction of newly developed theory for the transfer of radiation in three dimensional clouds. It is hoped that the relative scattering to absorption of the smoke will be determined. The final product will be the value of the singel albedo at a number of wavelengths in the visible and near IR.

Army Awards $15 Million Contract For MICNS Research and Development

A contract for almost $15 million has been awarded by the U.S. Army Electronics Research and Development Command (ERADCOM) for research and development of a Modular Integrated Communications and Navigation System (MICNS).

Harris Corp., Melborne, FL, received the contract for a 4-year period. They will initially receive $8,960,000. Mr. G. Harlan Carothers Harris, vice president and general manager, Government Information System Division, and COL Sammy Cannon, ERADCOM deputy commander, witnessed the contract signing.

MICNS is envisioned as a data link common to the Army's Standoff Target Acquisition System and Army Remotely Piloted Vehicles. MICNS will also be used by the U.S. Air Force in the video portion of an antijam Joint Services Weapon Data Link.

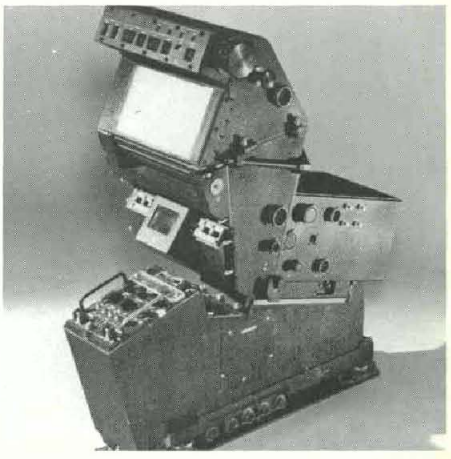
Side Looking Airborne Radar Slated for Mohawk Installation

An improved Side Looking Airborne Radar (SLAR), the AN/APS-94E, has been delivered to Europe by the U.S. Army Electronics Research and Development Command (ERADCOM). Plans call for installation of the new units on the twin engine Mohawk fixed wing aircraft over the next four months.

As the primary surveillance sensors on the Mohawk, the SLAR provides near real time detection of moving targets at ranges of up to 100 kilometers. Deployed with Mohawk units in Germany and Korea, it is used in border surveillance.

The APS-94E used dry film processing techniques to produce hard copy photographic imagery and replaces the APS-94D which employs wet chemical processing.

ERADCOM's Combat Surveillance and Target Acquisition Laboratory (CSTAL) at Fort Monmouth, NJ, provided technical direction for the development of the APS-94E to the contractor, Motorola, Inc. Senior CSTAL engineers Messrs. Jack Harary and Victor Jiranek directed the project.



SLAR AN/APS-94E

GSRS—Massive Firepower for U.S. and NATO

BY LTC Frederick P. Halbritter

Smoke and dust in the impact area of White Sands (NM) Missile Range (WSMR) are nothing new, but the recent impacts caused by a potent new Army development—the General Support Rocket System (GSRS) are brightening spirits and widening the horizons of many field artillerymen.

The full-up front line fighting system is comprised of six 9-inch diameter free flight rockets packaged in expendable 6-pack containers. These are carried, two containers at a time, by a tracked vehicle that uses modern electronics and mechanizations to place fire on targets over 30 kilometers away.

The GSRS is pushing the total technical state of the art by integrating the ancient rocket form of artillery black magic with present day computers. The overall program is also blasting through a development cycle in less than half the normal time.

It has only been 23 months since award of the validation phase contracts to the competitors, Vought Corp. and Boeing Aerospace Co. Both are now conducting full-up system test firings.

The first rocket to be fired out of its 6-pack launch pod container from a Self Propelled Launcher Loader was launched on 30 March 1979. This was a Vought shot, and was preceded by rocket flights from fixtures and by exhaustive non-firing component and system tests.

Boeing was also soon firing their system at WSMR. These rocket firings constituted contractor engineering design testing completed in August 1979. Fire missions included ballast head rockets with instrumentation and tactical warhead rockets containing either inert or completely live submunitions.

Rockets have been fired separately and in multiples to include six round ripples. Ripple fire has been accomplished with as little as two seconds between rockets. The many warhead shots have each spewed out hundreds of M-42 submunitions that pepper the impact area and illustrate the complete saturation and devastation that the system offers for a battlefield.

Efforts are now intensifying as contractor and government agencies aim for scored firings at WSMR. Plans also include mobility and endurance tests at Aberdeen Proving Ground, MD; electromagnetic effects tests at Redstone Arsenal, AL; and environmental excursions at Eglin Air Force Base, FL.

Each competing contractor has delivered three Self Propelled Launcher Loaders and is completing production of approximately 100 rockets for the validation phase. Plans include engineering design tests (EDT), advanced development verification tests (ADVT), and an operational test (OT-I). The last few months of the 32 month validation phase are reserved for the operational testing.

Troops will conduct non-firing tactical type exercises at Fort Sill, OK, and then complete their OT-I by firing rockets at WSMR. These troops should see their efforts well rewarded in a few years when the finalized GSRS is fielded for their permanent use.

Operation of the self-propelled launcher loader with only three crew members will be a welcome change from usual artillery weapons that require 10 or more men. Automatic computerized and power features will even make it possible for only two crew members to load, move to a firing position, receive and process firing data, aim, fire—singly or in ripples, and then displace for reloading and a repeat of the entire cycle. This can all be done in minutes, round the clock, in all weather conditions, and over terrain where previously tanks would only dare to tread.

The GSRS, with its quick reaction and high volume capabilities, is destined for Europe and will add to the firepower of conventional cannon artillery. GSRS has the potential for attacking a wide range of area targets. These include field and air defense artillery positions, any type of personnel, truck or lightly armored targets, and supporting elements that can be stripped from tank formations.

GSRS rockets dispense masses of M-42 submunitions that both penetrate through light material items and blast out fragments to cause personnel casualties.

GSRS Prototypes Begin Mobility Testing

Prototypes of the Boeing Co. and Vought Corp. General Support Rocket System have been delivered to Aberdeen Proving Ground, MD, and have begun ground mobility and endurance testing. The testing will subject each version to a minimum of 700 miles of running over Aberdeen's complex network of automotive test courses.

The vehicle used to transport both versions is an FMC Corp. carrier adapted by that firm from its Infantry Fighting Vehicle and Cavalry Fighting Vehicle systems. The vehicle, which weighs 30,000 lbs. and carries the 20,000 rocket system, is powered by a 500 horsepower 4-cycle Cummins diesel engine. It reportedly has an overland speed of 40mph and can accelerate from 0 to 30mph in 19 seconds. It can traverse a 60-degree slope, a 40-degree side slope, a 36-inch vertical wall, a 90-inch trench, and can ford 40 inches of water.

The testing will be concerned entirely with vehicle performance and resultant shock and vibration effects on the launcher system.

A decision on which system will be selected is expected May 1980.

Vought Self-propelled Launcher Loader

Boeing Self-propelled Launcher Loader

The system should be ideal for meeting surge type combat conditions.

The need in Europe and the current opportunity to produce an accurate and inexpensive free flight rocket system is also recognized by our European allies. France, Germany, and the United Kingdom concluded a Memorandum of Understanding (MOU) in June 1979. This MOU will allow them to participate in co-development and co-production of the GSRS, or as it is known in Europe, the Medium Multiple Launch Rocket System.

Current plans are to make GSRS a model for NATO standardization. To insure close coordination, the participating countries are providing personnel as a part of the U.S. Project Office staff.

Keep an eye out for the rockets red glare in the Southwest. Also, keep an eye on the clock, for the GSRS program is building momentum on its flight path to an ASARC/DSARC during April/May 1980. A rapid multiple launch into the next phase is planned. This will be a maturation phase with parallel completion of research and development and low rate production.

The GSRS program is meeting the long standing challenge to compress the acquisition time needed to get systems into the field. Keep an eye open also for news on the successes of GSRS. It may mean a great deal more to the Army and our NATO efforts than just the attainment of more massive firepower.

The GSRS program is the responsibility of the Army's Missile Command and is being managed from a project office by GSRS Project Manager COL Richard Steimle. The Training and Doctrine Command System Manager is COL Charles Buel, located at Fort Sill, OK.

Other project managers and government agencies are also providing support. The Infantry Fighting Vehicles Systems Office is working with FMC, San Jose, CA, to provide a derivative vehicle for use as the basic carrier.

The Project Manager's Office for Selected Ammunition at Picatinny Arsenal, Dover, NJ, is coordinating efforts to modify and supply the M-42 submunitions, and Harry Diamond Laboratories, Adelphi, MD, is developing the XM445 electronic fuze for the GSRS. Remember the symbols "GSRS" and keep that extra eye on future program progress.

LTC FREDERICK P. HALBRITTER is assistant project manager of the General Support Rocket System. He was a Department of the Army Systems Coordinator for light and heavy field artillery cannon systems, Office, Deputy Chief of Staff for Research, Development, and Acquisition during 1974-78. He holds a BA degree in mathematics from Eastern Washington State College, and an MS degree in mechanical engineering from the University of Texas (El Paso). He is a 1978 graduate of the Program Management Course offered by the Defense Systems Management College.

Human Engineering Lab Team Tests Digital Fire Control

Would digital fire control technology work well with current Army radio communications systems? This was the key question posed in the latest series of Human Engineering Laboratory Battalion Artillery Tests (HELBAT).

The latest tests—termed HELBAT 7—actually began in February of this year and ended in March when a Ground Laser Locator Designator (GLLD) was used to guide a Copperhead missile to an uparmored manned M103 tank at Fort Sill.

HELBAT was preceded by 18 months of preparation at Aberdeen Proving Ground, MD, before operations began at Fort Sill. Data collected during HELBAT 7 is still being analyzed.

HELBAT tests, which began in 1969, are a joint effort of the U.S. Army Materiel Development and Readiness Command, represented by the Human Engineering Laboratory, APG, and the U.S. Army Training and Doctrine Command, represented primarily by the Field Artillery School at Fort Sill.

HELBAT provides a "test bed" for evaluation of artillery operational doctrine, procedures and materiel, according to Mr. Gary L. Horley, chief of the team.

Since HELBAT's inception to study human error in the field artillery system, Horley said, the field experiments have become an examination of the automated battlefield of the future. In the future, he said, target acquisition, fire control and firing elements will be fully integrated by automatic data processing and digital data communications.

HELBAT began with a test of individual performance in an artillery battalion, according to Mr. Bill Dousa, an HEL human factors engineer. "We found that the biggest source of errors was the forward observer, so we equipped our test observers with GVS3 laser rangefinders and got a tremendous increase in accuracy."

Subsequent HELBATs have developed forward observer procedures incorporating laser rangefinder techniques, defined problems associated with engagement of moving targets by field artillery, demonstrated improved artillery capability through use of a Closed-Loop Fire Control System, and expanded that system to perform additional artillery functions.

Since HELBAT is a joint venture, reports Dousa, it provides DARCOM with information for use in future test programs and gives TRADOC a glimpse of new equipment. This permits TRADOC to develop training procedures prior to the actual fielding of equipment.

Like most DARCOM operations, HELBAT is conducted by civilians and soldiers. Soldiers consist of test personnel from Fort Sill and support people from throughout the Army. HEL technicians and engineers conduct the tests and collect and analyze the data. They also provide the necessary training.

During HELBAT 7, HEL fired 900 conventional unguided artillery rounds at moving and stationary targets, looked at new artillery ammunition resupply concepts, and studied new artillery fire control systems.

Over 30 Army commands and civilian contractors provided hardware for HELBAT 7. Hardware included an experimental howitzer fire control hardware, ammunition resupply hardware, the HELBAT fire direction computer, the battery computer system, the Position and Azimuth Determining System, the Company Fire Support Team Vehicle (FIST), the Ground Laser Locater Designator, a digital message device, a moving target radar, the Remotely Piloted Vehicle data link, the Copperhead missile, and the Hellfire missile.

As part of HELBAT 7, an inert Copperhead laser-guided artillery round, described by Dousa as "a tank killer," was guided to an impact on a specially-adapted M103, an obsolete Marine Corps tank. The vehicle was driven by SSG Robert Sibert, an HEL welder who volunteered for the assignment.

"Sibert was given an area to cross and was told to cross it in a certain direction at normal speed," Dousa said. "With a remotely controlled tank, you have a set speed and course." Sibert was travelling about 7 mph when the missile struck the tank.

The laser designator locates targets for the Copperhead then acts as an "invisible flashlight," guiding the missile to the target, Dousa said. The system has been used to locate targets before, Dousa explained, but this was the first time HELBAT used it to guide the missile to the target. The laser is in the infrared spectrum, so it is invisible to the enemy.

An interim report on HELBAT 7 is not expected until this fall. A final report is expected to be released in the fall of 1980. These reports will contain the conclusions and recommendations of the HEL team. Work will soon begin on HELBAT 8.

MOBA Team Evaluates Effectiveness of Army Field Radios

Improved effectiveness of the Army field radio was the purpose of recent tests conducted by the Military Operations in Built-up Areas (MOBA) team at Aberdeen Proving Ground, MD.

MOBA is a Division of the U.S. Army Human Engineering Laboratory's Systems Performance and Concepts Directorate. "Our objective was to determine the effect of an urban environment on radio communications," explained Mr. Walter McJilton, project manager.

"We ran a pilot study in Havre de Grace, MD. Then we ran an exercise in the open on the eastern shore, centered on the little town of Lynch. After we finished that, we felt we were ready to go into Philadelphia, PA," said McJilton.

Mr. William Mullen, an HEL psychologist, conducted the Philadelphia operation from a van equipped with two R442 receivers and an RT524 receiver-transmitter. There were two simulated command posts. One inside Philadelphia City Hall used a standard AN/PRC 77 infantry radio with a 10-foot whip. The other was outside the building and had a normal 3-foot antenna. Two teams of two men were equipped with standard infantry radios.

Each team and both command posts were equipped with separate sets of random 4-digit numbers. At pre-determined points, one group broadcast a 4-digit number to the three other groups. Everyone recorded the number and the quality of the broadcast.

Another group broadcast a number, until each group had transmitted a number to the other three. The two mobile units then moved to their next broadcasting point. This way several types of communication were tested.

The two mobile teams were sent more than four miles away from the command posts. Since normal range for the radios is three miles, this was far enough to study what happened when we tried to signal farther than the radio's normal range, says McJilton.

"After this exercise," he added, "we worked from building to building, with three radio teams in different buildings. The radios had a range of 30 to 75.95 mHZ. Three different frequencies were used in the experiments, one in the low 30s, one around 50 mHz, and one in the 70s. Right now we're doing a comparison of data from the tests. Our test report won't be completed for a few months."

Although the test results are not yet tabulated, HEL is already modifying its mobile command unit. The lab has ordered a new receiver-transmitter which will allow use of much higher frequencies. Their van has also been carpeted—from the floor to the ceiling—in order to reduce the interior noise levels.

Why are these changes being made after a test is over? McJilton explained that the changes are being made because "the Army is buying a new radio, the PRC 68. We'll do the same testing on these and other radios that we did for the PRC 77."

U.S., U.K. Test Equipment Compatibility

Highly successful tests, recently concluded by a joint British and American Army team at White Sands (NM) Missile Range, have reportedly demonstrated the interoperability between two important NATO laser systems—the British manportable Laser Target Marker and Ranger (LTM), and the U.S. Copperhead artillery Precision Guided Munition (PGM).

Interoperability of this kind, according to spokesmen, is vital if the maximum effectiveness of the NATO force is to be maintained, particularly against armor.

The Copperhead, which is produced by Martin Marietta, is a laser guided shell which can be fired by any of the NATO 155mm guns to ranges in excess of 15 kilometers. During latter stages of its flight, it detects and precisely homes on to the laser energy reflected from a target which has been designated (marked) by a suitable laser system.

Consequently, there is a high probability that, by firing a single round, a moving or stationary target selected by a forward observer will be destroyed. Alternative conventional artillery methods are likely to result in the use of many rounds to achieve the same effect. Several designating systems have been developed separately for the British and American forces.

During the recent WSMR tests, the British LTM, manufactured by Ferranti Limited, was operated by British Army personnel and was used effectively against both static and moving tank targets. The U.S. Army's Copperhead projectiles are guided primarily by a system called the Ground Laser Locator Designator (GLLD) (developed by the Hughes Corp.), or by other ground or airborne laser designator systems.

In the forward air controller role, the British Laser Target Marker and Ranger has been used with other compatible U.S. systems such as the Martin Marietta "Pave Penny" airborne target seeker with which the USAF is now equipping their A-10 and A-7 squadrons, and a Rockwell seeker on a U.S. Army Cobra helicopter. These systems indicate the target position to the pilot.

Tests have also been conducted which successfully demonstrate the compatibility between the U.S. Army Hughes Laser Target Designator (LTD) and the British Ferranti Laser Ranger and Marked Target Seeker (LRMTS). The LRMTS is in squadron service with Jaguars and Harriers of the RAF and is being modified for the British version of the Tornado aircraft.

British Ferranti Laser Target Markers operated by British Army officers at WSMR.

MERADCOM Announces Production Of New Mine Clearing System

Initial production of the new Mine Clearing Roller System, which is capable of all weather, and day and night rapid assault breaching of defended enemy minefields, has been announced by its developer—the U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA.

Produced by Chrysler Corp.'s Centerline, MI, Defense Operations Facility, the system consists of roller assemblies, a removable mounting kit, and two hand winches. It is mounted on a tank which is fitted with hard points available in a separate retrofit kit.

The roller can be mounted by the tank crew in 15 minutes using the winches. After breaching the minefield, the roller can be quickly released from inside the tank by the driver using a hydraulic disconnect system.

The rollers, destined for armor units in Europe, will undergo preproduction testing at the U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, MD. A follow-up evaluation will be conducted by TRADOC.

Allies Achieve Progress in Ammunition Compatibility

Significant progress toward achieving full compatibility of 155mm ammunition and commonality of 155mm test procedures among military forces of four Western allied nations was reported following meetings held recently at Shoeburyness, England.

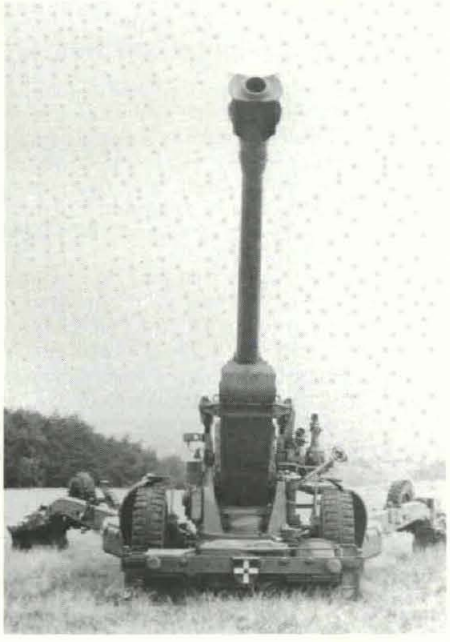
Attending the week-long Third Quadrilateral Safety Working Group Meeting were representatives of the United States, United Kingdom, Federal Republic of Germany, and Italy.

The meeting was combined with a series of demonstration test firings of a 155mm projectile and a 155mm propelling charge, both developed by the U.S. Army, and a 155mm howitzer developed by the three European members of the working group.

The M549A1 Rocket-Assisted Projectile and the M203 Propelling Charge, developed at the U.S. Army Armament Research and Development Command (ARRADCOM) under management of the Office of the Project Manager for Cannon Artillery Weapon Systems (PM-CAWS), were fired from the trilaterally-developed FH70 Towed Howitzer.

Developed jointly by the British, West German and Italian armed forces in a cooperative effort, the FH70 is now being produced in Europe. It is a counterpart of the U.S. Army's M198 Towed Howitzer, which was placed in production last year at Rock Island, IL, by the U.S. Army Armament Materiel Readiness Command (ARRCOM).

Uniform test procedures for 155mm ammunition were developed and adopted at the Shoeburyness meeting. As a result, separate demonstration tests and trials by the four nations, as well as all other members of the NATO planning to deploy 155mm weapons, will no longer be necessary. Results of tests conducted by one NATO member will be accepted by the other members. Therefore, while some NATO members are planning to field the FH70 and others the M198, the ammunition and testing procedures will be interchangeable.



FH70 155mm Towed Howitzer

The working group was formed as the result of a Quadrilateral Memorandum of Understanding. Following the Shoeburyness meeting, its accomplishments were seen as highly significant not only to the 155mm interoperability program, which was its immediate concern, but also to the broader program of NATO Rationalization, Standardization and Interoperability.

Nine representatives of five different Army agencies made up the U.S. delegation at the working group's third meeting. Heading the American contingent was LTC William J. Schumacher of PM-CAWS, product manager for 155mm ammunition.

Mr. Fred H. Menke, a civilian engineer with the PM-CAWS 155mm project, was chairman of the working group sessions.

Others in the U.S. delegation were Mr. Michael F. Fisette, PM-CAWS engineer; Mr. Llewellyn Hagenbuch, ARRADCOM Large Caliber Weapon Systems Laboratory engineer; CPT Glenn Monigold, representing both the U.S. Army Field Artillery School at Fort Sill, OK, and the U.S. Army Training and Doctrine Command; Messrs. Larry Nealley and Grover H. Shelton, U.S. Army Test and Evaluation Command; Mr. Terry R. Giroux, Aberdeen Proving Ground, and Mr. Gary H. Orr, Yuma Proving Ground. Fifteen other participants represented the United Kingdom, West Germany and Italy.

U.S. 155mm weapons and ammunition programs are managed by PM-CAWS, which has its offices at the ARRADCOM Dover Site in New Jersey. This U.S. Army Materiel Development and Readiness Command agency, which also serves as Joint Project Manager for Semi-Active Laser-Guided Projectiles, is headed by COL Ronald E. Philipp.

ARRADCOM Employe Develops GENMOD to Assist Engineers

The problem with computer systems is that traditionally each one is programed in a "language" created solely for a specific purpose. An engineer must learn the vocabulary and grammar of the language and, with a computer expert's help, essentially write a story about the production line for the computer.

Now, thanks to Mr. Ed Loniewski, a mathematician employed in the Product Assurance Directorate at the U.S. Army Armament Research and Development Command (ARRADCOM), Dover, NJ, a computer simulation program has been developed that can help an engineer analyze a design in minutes. And he can do so at little cost and without the aid of a computer expert.

GENMOD, or general model, is reportedly better than the old computer systems because it does not involve any special language and is capable of analyzing any automated production line.

Since its development several years ago, GENMOD has been used to analyze designs used for explosive melt-pouring and for manufacturing grenade metal parts and 8-inch cannon shells.

GENMOD can be plugged into any computer terminal. Being a program instead of a language, all production line parts are treated as data and kept simple. It is written in FORTRAN (formula translation), and universal programing and computer language. Every machine in the production line, buffer (a space between machines), and every other production consideration is represented by a numerical value.

When Loniewski first became involved with computer analysis of automated lines years ago he observed that although each line was modeled by a separate computer program, there was a great deal of repetition among programs. He reasoned that he could write a general program if he could characterize the operations of particular machines and how they operate.

After developing rules for coding all the parts of any line, Loniewski wrote the GENMOD program. It specified lines that could be anlyzed by considering them as data rather than separate lines. One way to understand GENMOD is to envision an entire production line being filmed. In every frame, the program shows the status of every active element. GENMOD does nothing more than quantify all information.

This system is ideally used in the design stage because it can help the engineer predict the performance of a proposed line within minutes, before any money has been spent on hardware. Machinery can be added, subtracted or relocated until the best design combination is determined.

The engineer's program input includes information on every machine's speed, failure and repair rates, product defect rate, and the general performance pattern. Also obtained is information on initial material content, maximum material capacity of each buffer, and raw material availability.

From the output on material consumption, scrap production, machine efficiency and buffer use, the engineer can determine potential bottlenecks and material needs. GENMOD was recently cited as ARRADCOM's best individual system analysis effort.

Construction Engineering Research Lab Issues New Reports

The U.S. Army Engineer Construction Engineering Research Laboratory recently released reports on equipment for military sanitary landfill use, combustion rates of solid refuse-derived fuels, and guidelines for conversion to coal.

"Sanitary Landfill Compactor Evaluation," by Messrs. D. Draybill and B. Donahue, compared different types of sanitary landfill compactors for use in military landfills. The team studied three major types of compaction equipment: tracked vehicles, rubber-wheeled vehicles and steel-wheeled vehicles.

Research results determined relative advantages and disadvantages of specialized landfill compactors, examined various types and brands of compactors available, and provided criteria useful for selection of sanitary landfill compactors. Selection of equipment is site-specific, but these criteria relate landfill size and economic feasibility of specialized equipment versus tracked vehicles.

"Project Development Guidelines for Converting Army Installations to Coal Use," by Messrs. S. A. Hathaway, M. Tseng, and J. S. Lin, provides technical and economic information to help Army facilities and district engineers develop projects for converting installation heating and power systems to using coal as a primary fuel. The report includes a general overview of the coal conversion and supply problem; coal delivery, handling and storage; boiler conversion; boiler replacement; salvage fuels; coal gasification; and air pollution control.

"Thermogravimetric Analysis of Solid Refuse-Derived Fuels and Coal," by Messrs. S. A. Hathaway and J. S. Lin, investigated the ignition and combustion rates of three types of densified refuse-derived fuel (DRDF) and low-volatile Illinois bituminous coal. Temperatures ranged from 600°C to 1000°C with residence times ranging up to 120 seconds.

It was found that DRDF ignition time is up to 12 times less than that of coal, that the temperature required for coal ignition at a given residence time is greater than that needed for DRDF ignition, and that the DRDF: coal time to ignition ratio is expressible as a linear function of furnace temperature.

It was also found that DRDF produced from mixed municipal-residential solid waste has a slower combustion rate than that produced from homogeneous heavy paper stock, and that the combustion rates of all types of DRDF are significantly greater than that of the coal tested at a 99.9 percent level of confidence.

These reports are available through the National Technical Information Service, P.O. Box 1553, Springfield, VA 22151. NTIS accession numbers are ADA067697 for "Sanitary Landfill Compactor Evaluation," ADA068025 for "Project Development Guidelines for Converting Army Installations to Coal Use," and ADA067829 for "Thermogravimetric Analysis of Solid Refuse-Derived Fuels and Coal."

ARRADCOM Fabricates New Small Arms Weapon System

A new heavy general purpose machinegun is the first small arms weapon system to be conceived, designed, fabricated, and tested at the Army Armament Research and Development Command since the command's establishment in 1977.

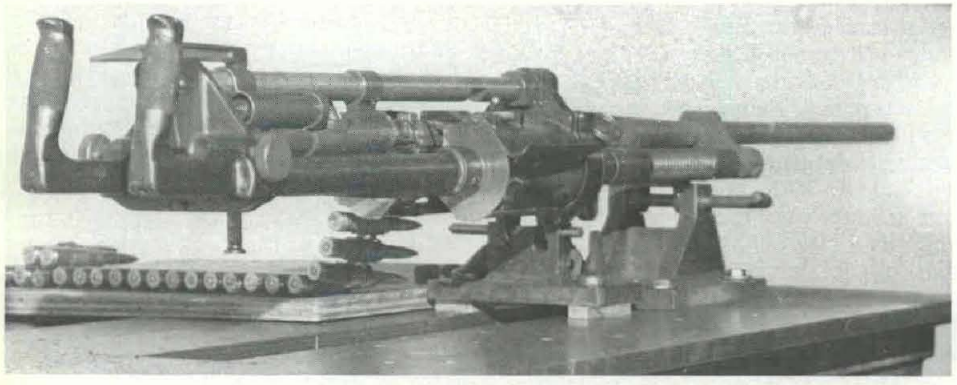
Currently nicknamed the Dover Devil, the machinegun is being developed to replace the 1917 vintage cal. .50 Browning as an antipersonnel, antilight armor, and antiaircraft infantry weapon.

The concept is unique in that it is to have eventually, a 3-modular design that will, through easy and quick interchange of barrel, feeder, and bolt head, allow change from .50 caliber through 20mm.

Additionally, there is a dual feed capability that allows the gunner to selectively fire antipersonnel rounds from one feed belt or antimateriel rounds from another.

The design of the weapon has been deliberately directed toward ease of mass production, requiring fewer skilled craftsmen and less critical machining than do current .50 caliber guns.

The system was conceived by a team of Army engineers and technicians, headed by Mr. Curt Johnson, team leader, crew-served Weapons Team, in November 1977, and by January 1979 the team had begun testing a gas-operated prototype. It is still in the initial test phase, but the goal is to evolve an improved prototype that can then be demonstrated to potential users of all the Services. Official Service interest could then result in a formal requirement and subsequent enhanced funding to allow full scale development.



"Dover Devil," designed to replace .50 caliber Browning.

Improved TOW Goes to Europe

The first shipment of what will eventually total over 700 M901 Improved TOW vehicles have been deployed to Europe. Five of the first seven vehicles will be used at Seventh Army's Combined Arms Training Center, Vilseck, Germany.

COL Charles C. Adsit, project manager for the ITV, commented that the period of time between development and deployment is one of the most rapid in history, going from concept approval in December 1975, to deployment in under 3½ years.

The urgent need to put this system into the hands of troops caused the program to follow a highly accelerated and closely held schedule. The ITV makes maximum use of the existing systems and interfaces their most favorable capabilities.

The ITV is the first Army anti-armor system that allows its operators to use the weapon while totally protected by armor. The vehicle was developed by the U.S. Army Tank-Automotive R&D Command, Warren, MI.

A New Equipment Training Team has been provided and courses in turret maintenance, fire control, operator and crew gunnery, and a special field maintenance technician course will ensure rapid and smooth integration of the ITV into field units.

Fluidics Stabilize Tank Gun

Use of second generation fluidic components to stabilize a tank gun turret was successfully demonstrated recently by the Army Electronics R&D Command (ERADCOM). The system was developed by ERADCOM's Harry Diamond Laboratories (HDL), the Army's lead laboratory for fluidic technology.

The demonstration, using an M48A5 as a test bed, was cosponsored by the Armament R&D Command (ARRADCOM) and held in the test facilities of AiResearch Manufacturing Co., which assembled and installed the fluidic stabilization system.

Success of these tests represent a significant breakthrough in the accuracy, reliability, and low cost of the fluidic stabilization system. The recent demonstration culminates more than four years of critical component and system development by HDL scientists and engineers. The primary feature of the second generation fluidic systems is that they use laminar flow devices to amplify and compensate to keep the gun on target.

BRL, CSL Brief Army Science Board Members

Both the Ballistic Research Laboratory (BRL) and the Chemical Systems Laboratory (CSL) recently briefed the Army Science Board at Aberdeen Proving Ground, MD, on their respective research programs.

The 5-man Army Science Board has the responsibility of evaluating in-house laboratory independent research programs. In addition, it has the responsibility of approving the technical content of research programs as well as appraising the context of a research mission and its relationship to the Army's needs.

Board members are all non-federal professionals from industry, independent research institutions and universities, such as Dr. Joseph Sternberg, senior staff member of R&D Associates, Arlington, VA. Considered an expert in weapons systems development and fluid mechanics, Sternberg was the former scientific adviser to the Supreme Allied Commander in Europe.

The area of interest for Dr. Gene Strull, deputy general manager for Systems Development at the Westinghouse Electric Corp., Baltimore, MD, is in solid state technology, integrated microwave and optics, and defense and space systems.

Dr. Howard C. Curtiss, professor of Aerospace and Mechanical Sciences at Princeton University, is an authority in flight dynamics and helicopter and V/STOL aerodynamics.

Another Board member, Dr. Chris. J. D. Zarafonetis is a professor of Internal Medicine at the University of Michigan Medical School, Ann Arbor. Zarafonetis is an expert in military and tropical medicine, infestious diseases, hematology and clinical pharmacology as well as in the area of protection of human subjects in biomedical research.

Dr. Wilson Kinter Talley is a professor at the University of California, Livermore, Applied Science Department. A former special assistant to the Secretary of Health, Education and Welfare, Talley is an authority on transport theory, applied mathematics, research management and nuclear explosion phenomenology.

Throughout the briefings, the Board particularly scrutinized programs that allowed researchers flexibility and freedom to enhance the Army's technical capability programs.

In addition to laboratory briefings at CSL and BRL, the Army Science Board received scientific and engineering overviews at ARRADCOM's Fire Control and Small Caliber Weapons Systems Laboratory and Large Caliber Weapons Systems Laboratory in Dover, NJ.

Engineers Establish Water Resources Center

LTG John W. Morris, chief of the U.S. Army Corps of Engineers, has announced establishment of the Corps Water Resources Support Center at Fort Belvoir, VA. COL Maximilian Imhoff is the Center's first commander and director.

The Water Resources Support Center, which will be under the supervision of the director of Civil Works in the Office of the Chief of Engineers, Washington, DC, will perform certain operational functions now being carried out by Civil Works Directorate personnel.

These functions include: the dam inspection program; preparation of Volume II of the Annual Report; the streambank erosion control program; Water Spectrum Magazine; hydrological data collection; historical data files; resource allocation and selected project management.

WRSC will conduct and manage water resource studies and provide technical support to other Corps offices in matters dealing with water resource management. The Center will also manage the Corps' dredging program.

COL Imhoff was formerly director of the Civil Works Directorate, Office of the Chief of Engineers. Prior to this assignment, he was with the NATO Central Army Group in West Germany. He has held numerous important assignments in the Corps of Engineers spanning 26 years of commissioned service.

COL Imhoff's areas of expertise include engineer tactical operations with emphasis on atomic demolition munitions employment planning, the logistics field, and education. More than half of his career has been served in Korea, Vietnam, France and West Germany.

COL Imhoff holds a bachelor's degree from the University of Maryland and a master's degree in education from Boston University. He was commissioned through the Engineer Officers Candidate School in 1953, and has attended the Engineer Officers Advanced Course, the Army Command and General Staff College, and the Army War College, non-resident class.

ERADCOM Man Shares Patent for Laser Invention

Mr. Henry E. Sonntag, a physicist employed by the U.S. Army Electronics R&D Command, is the co-inventor of an improved laser of the transverse electric atmospheric type, which uses carbon dioxide or other molecular gases.

He was granted a patent for the invention with Dr. Gregory Osche, also a physicist, who was engaged in research at ERADCOM until this year, but who now is employed in private industry.

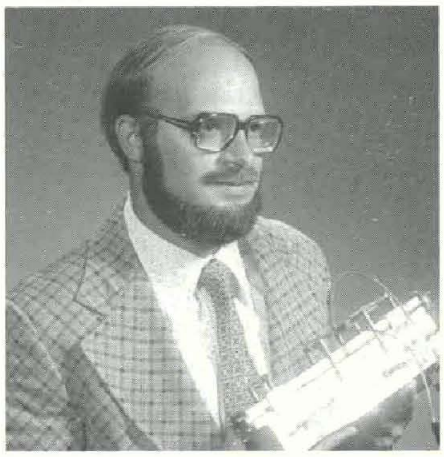
The laser, an acronym for light amplification by stimulated emission of radiation, is being widely applied in military communications, range finding and signaling. In contrast to current efforts to make lasers of this type larger, certain applications, such as range finders, require simple, compact devices.

Researchers attempting to scale down the design of such lasers usually are confronted with several problems. Lasers operating at atmospheric pressure must be pulsed rather than continuous. To obtain a smooth discharge, it is desirable to preionize the gas before each pulse.

According to the patent granted to Sonntag and Osche, a cylindrical arrangement has a very fine wire used as a central electrode, which acts simultaneously as a pre-ionizing electrode while permitting oscillation of low-order modes.

Sonntag is conducting experiments on polarization and ultraviolet atmospheric transmission. He also has done experimental research on carbon dioxide transverse atmospheric lasers and optical heterodyne detection.

He received his bachelor of science degree in physics from Polytechnic Institute of New York, Brooklyn, in 1969 and his master's degree in physics from the same school in 1972. He is studying for his doctorate at Stevens Institute of Technology, Hoboken.



Henry E. Sonntag

Moving—Being Transfered?

To ensure continued receipt of the magazine, persons, both Active and Reserve, who are authorized individual copies, should give timely notice of their new address. Instructions on where to send address corrections are given on the inside of the front cover. DO NOT SEND CORRECTIONS to the magazine editorial office, as mailing labels are provided the magazine by the agencies mentioned in the instructions.

Army Air Cushion Vehicle

By John F. Sargent

The U.S. Army logistical amphibious fleet is now being strengthened with the introduction of air cushion craft. In the relatively short period of 4½ years and at a total program cost of $12 million, two pilot craft were acquired, crews were selected and trained, and the craft were thoroughly tested and evaluated.

Currently, both craft are being rehabilitated for fleet inventory, and negotiations are underway to procure sufficient craft to form the first military air cushion vehicle (ACV) company in the Free World. The USSR has already conducted maneuvers with their ACV units in the Mid-East and Scandanavia.

The program was started in March 1975 when a contract was awarded Bell Aerospace Textron to conduct a military adaptation for their commercial craft, the Voyageur. Prior development concepts were rejected in favor of a Military Adaptation of a Commercial Item approach. Studies confirmed the feasibility of modifying the Voyageur to correct deficiencies found during tests in a Fort Story, VA, operation called OSDOC II (Off Shore Discharge of Containerships).

These modifications included stretching the length 11 feet, adding a turbine air intake filtration system, strengthening the deck for the impact from loading MILVAN containers (a 20′ x 8′ x 8′ box weighing 22.4 tons fully loaded), incorporating a bow surf fence, and providing a self-unloading capability represented by a 30-ton capacity deck mounted swing crane.

These and other pertinent modifications were incorporated into the original Voyageur design to evolve into what is now known as the LACV-30 (Lighter, Air Cushion Vehicle, 30-Ton Capacity).

The LACV-30 is approximately 76 feet long with a beam of about 36 feet. All up design weight is 115,000 pounds, which includes fuel and payload. The cushion is a four feet deep bag and fingers configuration.

The craft is powered by two twin pac turbine engines, each rated 1,800 hp. Each twin pac drives a variable pitch, 9-foot diameter propeller and a fixed pitch 7-foot diameter cushion fan through a transmission.

The hull is a 6,000 series aluminum extrusion material, sectionalized for transportability by land, sea, or air. It has a flat, open cargo deck specifically designed for cargo lighterage in Logistics-Over-The-Shore (LOTS) operations. The craft has been clocked at over 50 mph and has a range of 320 miles. A ramp facilitates movement of rolling stock.

The craft has a reserve buoyancy of 200 percent of its gross weight in case it has to come off cushion over water. Reliability is predicted at Mean Time Before System Failure of 12 hours with a Mean Time to Repair of 2.5 hours.

The LACV-30-1 was completed and shipped to Fort Story in April 1976 for acceptance tests. The LACV-30-2 was completed and shipped to Aberdeen Proving Ground, MD, in May 1976 for acceptance tests.

Problems associated with the air filtration system deferred acceptance of the LACV-30-2 until September 1976 and acceptance of the LACV-30-1 until January 1977. These dates signaled the start of Development Testing II (DT II) and Operational Testing II (OT II), respectively.

While the hardware effort was going on, planning groups were formed. A Test Integration Working Group planned the complex testing of this unique craft to avoid duplication of effort, and satisfy the critical issues.

In addition, a new and novel group, an Integrated Logistics Support Working Group was formed to pre-plan the nine elements of logistics supportability. It should be acknowledged that the scenario must provide all maintenance within its expertise and tools, otherwise component replacement would be conducted.

The low quantity of craft to be procured did not warrant satelliting the maintenance on existing depot facilities, even should they be available on the beach. Therefore, a new concept entitled "Bond Room" will be established.

Simply stated, the Bond Room will be a commercial clearing house for limited parts storage and for return of repairable components to the manufacturer. The Bond Room concept is planned to go into effect 1 Jan. 1980. During DT/OT II MERADCOM acted as the Bond Room.

In addition to all the above, two teams of operating and maintenance personnel for the two craft had to be trained. In the summer of 1975 a screening process was initiated to facilitate selection of a 15-man military crew for each craft. The crew size was kept large since each unit would have to be self-supporting during isolated tests.

After the teams were selected and their military tour of duty stabilized to insure availability during the entire test, a training program was initiated. It was initiated within the constraints of funding and yet was sufficiently effective to permit transition to a high performance-type craft. This program addressed training of each maintenance skill required for the craft by classroom, by subcontractor, manufacturer, and by on-the-job training.

For the operators, a total of 100 hours "stick-time" as a minimum was required. For each navigator, a total of 35 hours "stick-time" was required. Each operator and navigator was given a comprehensive solo test before being certified by the contractor.

Approximately the first half of training was conducted at the U.S. Naval Coastal Systems Laboratory (USNCSL), Panama City, FL. It was conducted in the fall of 1975 by Bell Aerospace Textron using their Voyageur 001 craft.

The second half of the training was conducted at respective LACV-30 test sites by each crew on their own LACV-30. It should be noted that the USNCSL is the most advanced air cushion testing facility in the world. It is located in a moderate climatic area, with two radar towers located up to 12 miles off shore which establish a tracking printout.

Shore installations include a modern hangar with one end that can be opened to berth the large 80-90 foot U.S. Navy Amphibious Assault Landing Craft. Parking facilities permit easy access to the sea. This is clearly one of the most outstanding marine test facilities.

Anyone who has had to establish a water speed curve by repetitive test runs over a measured mile course will appreciate the "instant" recording, on a graphical printout, of not only speed, but acceleration, turning circles, crash stop distances, etc., all complete with weather and sea conditions, and as offered by USNCSL.

Operational Test II was conducted in total at Fort Story.

Lighter, Air Cushion Vehicle, 30-Ton Capacity

These were mission oriented tests conducted entirely by a military team previously trained for that mission. The test site was located on Hampton Roads, Norfolk, VA.

Simulated missions carrying containers were conducted between Fort Story, and Fort Eustis, VA, which is on the James River. This is a distance of about 45 miles. Also, behind the beach were sand dunes which were negotiated for gradability tests. The LACV-30-1 was the only craft fitted with the swing crane.

The Operational Test site was a severe application due to the shifting sand and lack of adequate berthing. However, this was the testers perogative since they felt it was a typical locale.

Although this environment took its toll on exposed equipment, it was relatively benign to the skirt system. It is expected to obtain over 600 hours with the OT II skirt fingers and cones. However, a maximum of 300 hours is all that can be expected with the propellers based on bollard thrust performance degradation from sand erosion.

It was encouraging to note that the air filtration system will enable the turbines to live 1,000 hours without major overhaul when subjected to that environment.

Development Test II were conducted at four test sites, Aberdeen Proving Ground; U.S. Naval Coastal Systems Laboratory; Eglin Air Force Base, FL; and Camp Pendleton, CA. Sufficient performance data were generated at APG to permit a safety release for the OT craft. The craft was then rail transported to Panama City. This movement was part of the transportability tests.

Through the courtesy of the U.S. Navy, the Army leased from the U.S. Naval Coastal Systems Laboratory the use of their magnificent sea tracking range, ACV hangar, and concrete ramps. While at that site, continuous operation on the tracking sea range was conducted and printouts of each were provided for analysis.

While being tracked by the U.S. Navy radars, a craft data acquisition package was time indexed with the tracking printouts. This allowed range performance (speed, acceleration, etc.) to be correlated with craft operation (power, fuel consumption, cushion performance, etc.).

Prior to use of either the Voyageur or the LACV-30 in the Panama City area, an Environmental Impact Statement had to be prepared and approved. This was an intensive report in which Canadian experiments, with ACV passes over vegetation without damage, were cited. The statement was finally approved. This paves the way for other ACV operations in that area.

Upon completion of tests at NCSL in June 1977, the LACV-30-2 was rushed through Eglin Air Force Base cold chamber tests. This was in order to participate in Joint- LOTS tests in August 1977 at Fort Story.

The craft was driven to Eglin Air Force Base, placed in the chamber and immediately soaked in a temperature of (−)40°F. After successful testing in that temperature (starting, hovering, and operating controls), the craft was driven to Mobile, AL, for a Challenger-type ship lift to Norfolk. Fifty minutes after arrival in Norfolk, it was berthed in the Fort Story test site, 30 miles away ready for a mission.

The Joint-LOTS test was an Army, Navy, Marine Corps joint effort conducted in August 1977 to evaluate various concepts of ship-to-shore resupply of containerized cargo. It was a 3-week test in which the LACV-30 was only one of many concepts. As a result, its full potential was not realized, yet, despite this, the two craft transported 31.9 percent of the containers moved during the bare beach test.

Following this test, the LACV-30-2 was transported to the West Coast where over 8-foot plunging surf was negotiated. The craft was then deck loaded aboard an ocean going craft and transported back to Fort Story.

During the period that the one craft was undergoing surf tests, the LACV-30-1 was subjected to air transportability tests conducted by the Transportation Engineering Agency. It is significant to note that no serious accidents occurred during any of these tests.

After DT/OT II was completed and evaluated, a Reliability Improvement of Selected Equipment (RISE) test program was initiated to improve reliability and maintenance. Both test evaluations concurred in the acceptability of the LACV-30.

The RISE program, however, was initiated on the philosophy that for minimal investment an improvement in RAM could be obtained without affecting performance. The tests are continuing at this writing and have borne out the philosophy.

During the period December 1977 through March 1978, the LACV-30-1 was involved with the U.S. Coast Guard ice breaking mission on the Illinois River near Peoria, IL. Although this type mission is commonly performed by Canadian ACVs and has been a major factor in keeping the St. Lawrence Waterway open during winter by the Canadian Coast Guard using a Voyageur ACV, it is new in the U.S.

Not only did the LACV-30 free tugs and barges frozen in, but also did yeoman duty in flood control work. The ACV, by use of its air cushion, can break ice of at least 25 inches deep at a speed of 15-20 mph. It rides the edge of the ice, which propagates cracks in all directions. The stern of the craft then breaks up the ice as it passes over.

In August 1978 the Development Acceptance In-Process Review was held. Both combat developer and the materiel developer concurred in type classification as Standard A. However, the Logistics Evaluation Agency non-concurred on the presumption that logistical supportability required additional testing.

The matter was elevated to HQDA where an executive decision meeting, held 15 Jan. 1979, resulted in agreement to type classify the LACV-30 as Standard A and to enter full scale production.

A request for proposal on LACV-30 production was released 31 May 1979. This response is currently being evaluated. It is planned to procure four craft per year with a total of 30 craft targeted for inventory, including the two pilot craft.

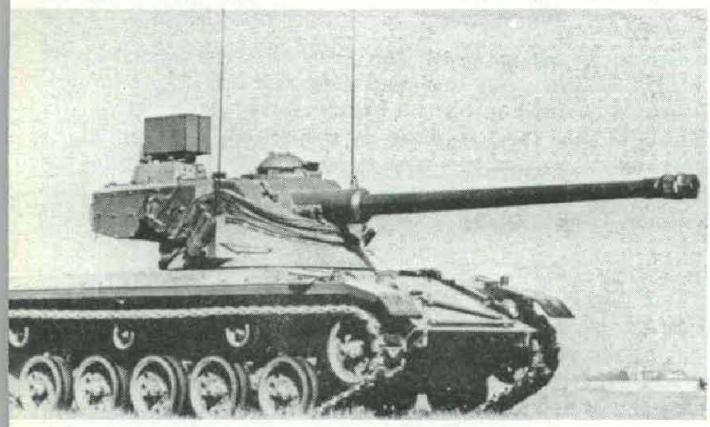
It is important to recall what is stressed in the annals of military history—*the success of a sustained amphibious operation is founded on logistical resupply, since all the sophisticated gadgetry that can be offered is of no value unless it is delivered to the troops.*

Prior planned delivery tonnage of 720 tons per day by the LARC-V and LARC-XV can be eclipsed by the 6,000-7,000 tons per day promised by the LACV-30 delivering containerized cargo. The U.S. Army is meeting its commitment to the troops.

JOHN F. SARGENT is a project engineer for R&D with the Marine and Bridge Laboratory, U.S. Army Mobility Equipment R&D Command, and has been associated with the LACV-30 program since 1972. He has also worked with the Floating Machine Shop, Landing Craft Retriever, LARC-5, LARC-15, Air Boat and Hoverbarge programs. His training includes a 5-year apprenticeship in marine engineering design at the Newport News Shipbuilding and Dry Dock Co. and studies at Virginia Polytechnic Institute and the University of Virginia.

Sixth in a series of foreign weapons and tactical vehicles, this photospread was prepared by Messrs. John R. Aker and Edwin W. Besch of the U.S. Army Foreign Science and Technology Center. The photos illustrate some of the many foreign gun or antitank guided-missile tank destroyers, many which share common chassis with IFVs or APCs already in service. Dates the vehicles or conversions entered service are shown in parenthesis.

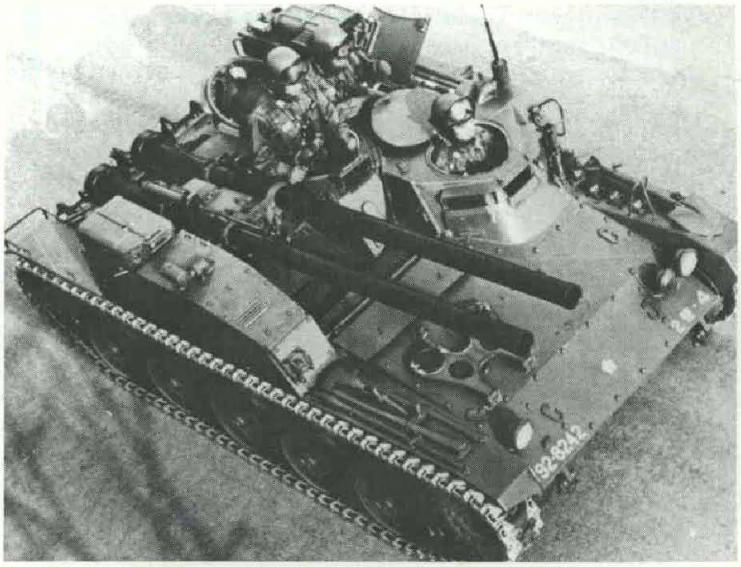
vedish IKV–91 90mm gun tank destroyer has a laser rangefinder. he vehicle is used in support of Swedish infantry brigades (1974).



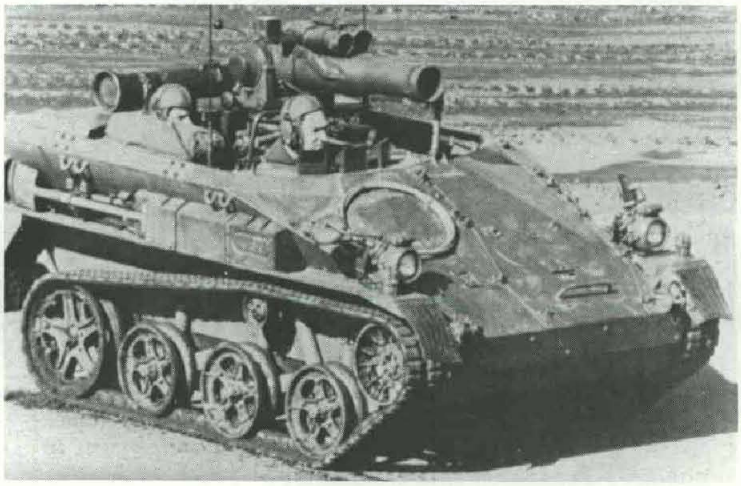
ustrian Kuerassier 105mm gun tank destroyer mates French MX–13 light- tank turret with SPZ–4K4FA IFV chassis (1972).

Vest German Thyssen-Henschel-Bofors Begleitpanzer 55mm/HOT or OW ATGM was designed for tank destroyer and antihelicopter roles rototype 1977).

rwegian NM–116 90mm gun destroyer is upgunned, dieselized U.S. 24 light tank (1944, 1975).



Japanese Type 60 dual 106mm recoilless rifle tank destroyer is based on USMC Ontos concept (1961).

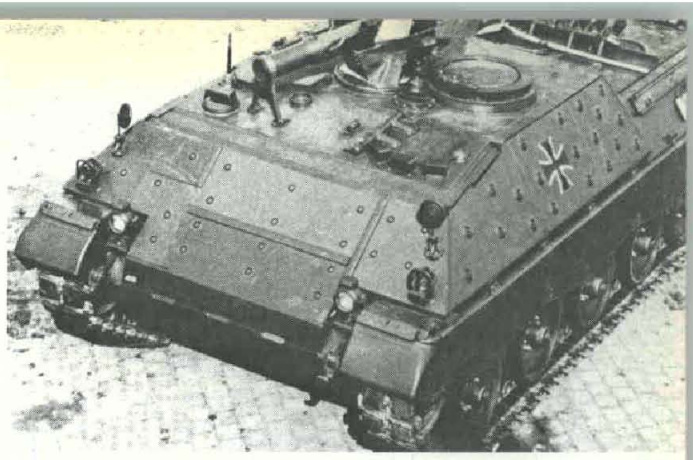


German Wiesel/TOW airmobile tank destroyer (prototype 1977). Two of the vehicles can be carried on a CH–53E helicopter.

Russian BRDM–2, mounting AT–5 Spandrel, is the latest Soviet ATGM tank destroyer version of BRDM–2 (1977 or earlier).

K DESTROYERS

Previous issues include: July-August—Foreign Combat Engineer Technology; May-June— Russian Infantryman's Arsenal of Weapons; March-April—Foreign Infantry Fighting Vehicles; September-October, 1978, Advances in Foreign Transportation Technology; March-April, 1978, Photos of 1977 Red Square Parade.



West German Jaguar 2/TOW ATGM is converted 90mm gun t destroyer (1965, 1980).

France produces the M3B VRC–TH/HOT ATGM tank destroyer (1979) for Iraq.

Brazilian tank destroyer mounts Cobra ATGM on EE–11 Urutu A (1976).

French VPX–110/MILAN or HOT ATGM tank destroyer weighs only 4 tonnes (prototype 1978).

Striker-firing Swingfire ATGM is used by British and Belgian Arm (1977).

West German Jaguar 1 rearmed with HOT ATGM and fitted with automatic loader and bolt-on armor (1968, 1978).

Belgian 90mm gun tank destroyer is licensed copy of West Gern vehicle (1975).

From 'Committee of Safety' to the M16!

It can be said with a pretty good degree of certainty that there are two broad topics sure to have high Army-wide, often intense interest: uniforms and small arms.

The story of U.S. Army small arms development reads, in large part, like an account of early attempts at "RSI" or case histories to refute the "N.I.H." theory. The borrowing of foreign designs in our musket and rifle development was common practice from Revolutionary War days until relatively recent years.

Such muskets as did exist in 1775 were largely legacies of brief individual service in earlier Colonial Wars—principally the French and Indian War, 1755-1763. These muskets were a variety of types—British Long Land Service Model muskets, captured French pieces, even Spanish muskets retrieved from an expedition to the Indies.

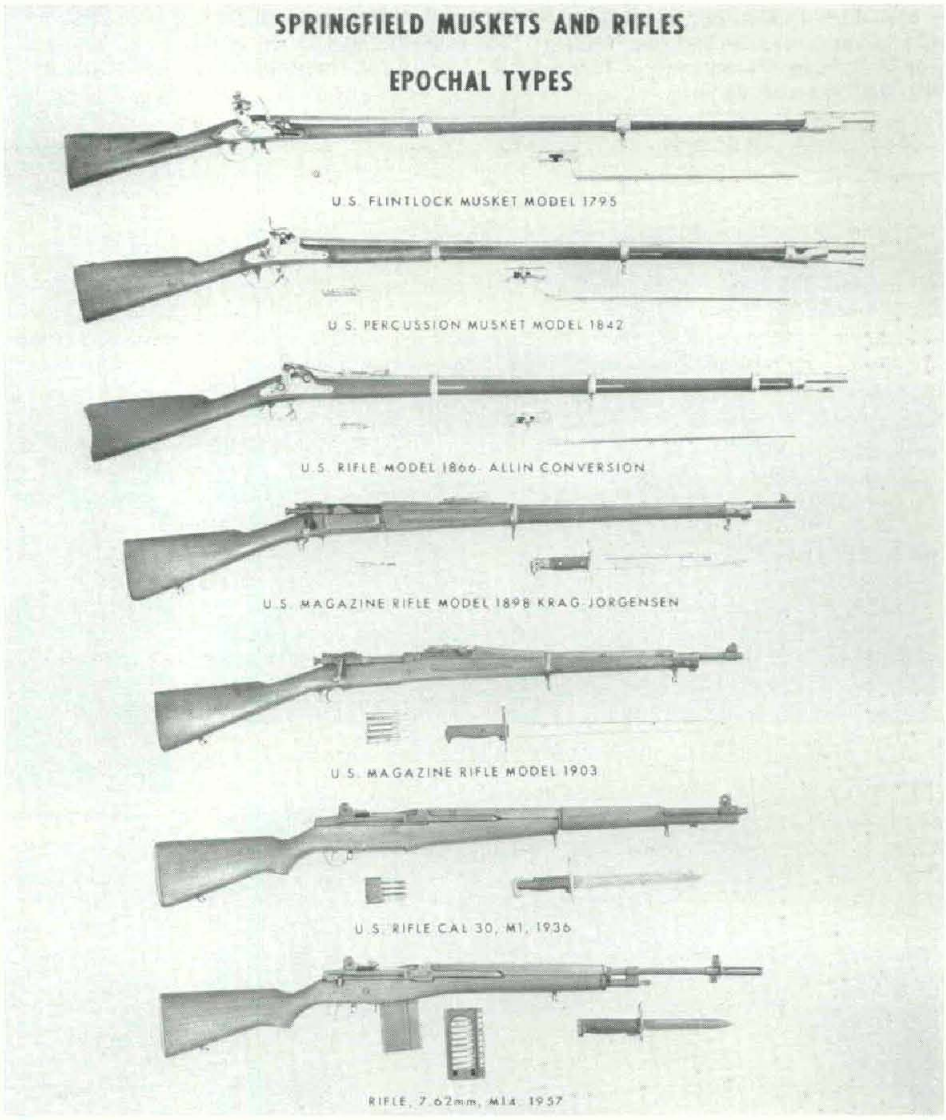
Only on the frontier and in the back country where hunting and the continuing threat of the war-whoop were an everyday part of life, was a serviceable weapon—often a rifle in these territories, a part of a household. And even here, a standard model or caliber was the exception rather than the rule. Rifles were hand-made by a number of gunsmiths—mostly in Pennsylvania, and the calibers varied from the high .40s to the .60s. And even here, the technology was European born.

As a result, even before the moment of declared independence, the New England colonies, principally Massachusetts, began establishing gunworks to turn out what were called "Committee of Safety" muskets—nothing more than a virtual carbon copy of the newer British Short Land Service Model musket, also called the Brown Bess. While captured British ammunition and bayonets would fit, interchangeability of parts was still awaiting Eli Whitney's demonstration in the early 1800s of the practicality and workability of mass production interchangeability.

What were probably the first "official" U.S. muskets, were built in 1777-1778 at the Springfield, MA, "Elaboratory." They were assembled there from contract-made parts copied from the standard French Charleville muskets, numbers of which were being smuggled into the colonies.

The issue arm then, of much of the early Continental Army was a British design, .75 caliber, flintlock musket, weighing 9½ pounds, and capable of being fired by a trained soldier using paper cartridges at a rate of four shots per minute. Accuracy out to 50 yards was fairly good, but beyond this point Jimmy the Greek would have given good odds on survival of a target.

But the lack of manufacturing facilities in the agrarian-oriented New World, hampered the Revolutionary effort. The cause was saved though, by the desire of the French Government to seek revenge for its defeat in 1763 by the English by aiding the rebellious colonies. At first covertly, and after 1777, overtly, a flow of French muskets, now called "Charlevilles," began reaching Washington's troops.



The Charleville, so-called because its lock bore this name—the arsenal at which they were made, was a new design. Military defeats of the French and Indian War had forced the French to take a hard look at their weapons. One result was a new musket, lighter and sturdier than its predecessors or the British Brown Bess. The caliber was reduced from .75 to .69, a caliber that would remain standard in U.S. service until 1855.

The barrel of the Charleville was fastened to the stock by metal bands rather than the method used on the Brown Bess of pinning the barrel to the stock by slender metal pins slid through the stock and loops on the under side of the barrel. Banding allowed a thinner and lighter stock but a musket considerably stronger. The cock, or as it is frequently called today, the hammer, was made of double strength in contrast to the one slender arm of the Bess' cock.

In the years immediately following the war, there was no compelling urge in the U.S. to undertake any small arms development. No new technological advances were standing to the forefront urging adoption, and now surplus but highly serviceable weapons were on hand. Not until the 1790s when the United States looked to overhauling its Militia Act and updating some of its defenses was a positive step taken with the creation of the Springfield Armory.

In 1795, after the authorization for the Springfield Armory to manufacture arms for U.S. service, the Model 1795 musket was produced—again a U.S. copy of the Charleville. The Charleville design with

its metal bands would be the basis for all subsequent U.S. musket models, and the band method of securing the barrel would persist through the Model 1903 "Springfield."

Military firearms technology, however, advanced but little in the period of 1700-1830s. Rifled weapons for general military issue were still regarded as too time-consuming in operation, too difficult to maintain, and their delicate locks too fragile for heavy military use.

Further, the traditional heavy octagon barrels and the stock extending to the muzzle precluded the use of a bayonet—the ultimate weapon of the 18th Century battlefield. Weapons still had to be muzzle-loaded, and ignition of the powder charge was by flint striking sparks into a small powder pan on the side of the barrel.

A number of minor modifications to the basic 1795 musket were carried out over the next 47 years, i.e., shortening the barrel from 44 to 42 inches, bayonet studs, etc., but none were of truly technological consequence. Two official models were produced nonetheless in this time frame, the Model 1822 and the Model 1840, sometimes called the Model 1842.

All of these models were smoothbore, .69 caliber, and manufactured at the Springfield and Harpers Ferry arsenals and under contract. However, the striking similarity in outward appearance of the 1842 model with the original Charleville reflects the serviceability of that original design.

While rifled weapons were not an item of general issue, they had limited official sanction. The rifle battalion of the Continental Line carried some built under contract and carrying the "U.S." stamped on their locks. Later, in 1804, Congress authorized a new rifle regiment, and the Harpers Ferry arsenal began manufacturing these on a .54 caliber design. Its major difference in appearance was that the Model 1804 was a half-stock model, i.e., the wood stock forearm did not extend virtually to the end of the muzzle but about half-way down the barrel.

A new version, called the Model 1814, was made under contract only, and differed only from the 1804 by having a full stock. Perhaps as many as 8,000 of the two models were manufactured. But rifles were still considered special purpose weapons, not issued to every unit.

A significant technological advance was begun in 1819, when the Army did adopt the .52 caliber breech loading rifle design developed by COL John H. Hall. While the idea was not unique, there being similar approaches under development in Europe at the time, the Hall was a more practicable working design.

Despite advances of breechloading and of rifling, the ignition mechanism was still the slow and unreliable flintlock, a technology then approaching a century old. The Model 1819 Hall weapon remained the standard U.S. issue rifle until 1841, and its manufacture continued until about 1848. A modification was made in 1841 to caplock ignition when the U.S. began its official transition from flintlock to percussion cap weapons.

This technological transition to caplock weapons by all major armies of the world was brought about primarily by the efforts of Scottish clergyman, the Rev. Alexander Forsyth. He perfected, in 1807, the fulminate of mercury percussion cap. This advance created the gate by which all hand-held firearms moved from flintlock to the far more efficient and reliable caplock system.

The first U.S. designed percussion rifle was the .54 caliber Model 1841, popularly known as the Mississippi Rifle. The name resulted from its being the arm supplied to a regiment of riflemen from the state that fought in the Mexican War under COL Jefferson Davis, later President of the Confederacy.

The Model 1841 fired the traditional round lead ball. It was the same basic technology used in the earlier Hall system. Its advance rested in the sights, percussion lock, the heavier barrel with improved rifling, and greater accuracy. It was the last rifled weapon to use the round patched ball.

The next major step in U.S. military small arms progress came in 1855 with the adoption of the .58 caliber rifled musket. While the percussion cap had now been pretty well matured in design, the U.S. Ordnance Department decided to incorporate in its Model 1855, a lock designed by a Dr. Edward Maynard and patented in 1845.

The Maynard lock used a roll of paper caps fitted into a doored-recess in the lock. The mechanism was quite similar to that used today on toy cap guns. Readily subject to moisture and breakage, the Maynard lock was soon replaced in 1861 by the more reliable type that required the manual placing of a metalic cap on the nipple.

The technological advance that led to the adoption by the U.S., of a rifled weapon for general issue was that credited to a French captain, Charles Minié. Breech loading was still not considered technologically sound during the 1830-1850s. While inventors were trying to perfect incorporation of the percussion cap into a self-contained cartridge, the military kept the tried and true muzzle-loading system.

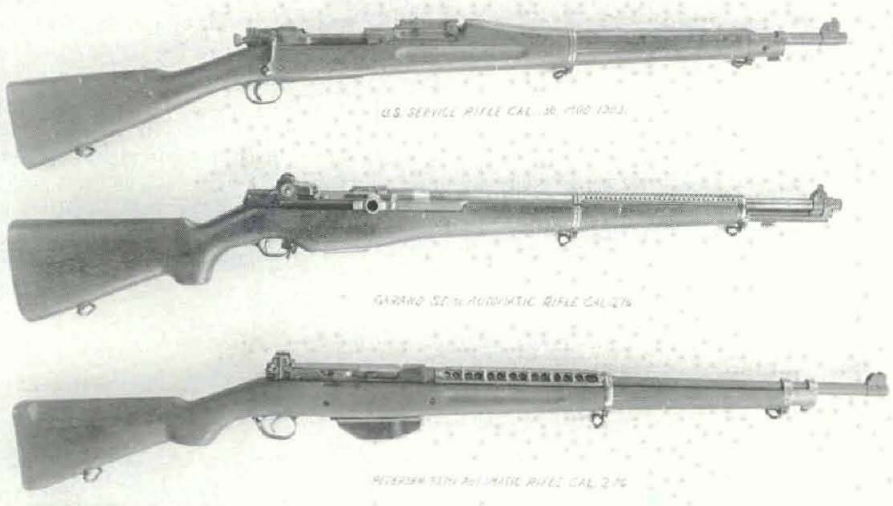
However, it is interesting to note that Secretary of War John B. Floyd in 1859, stated that "True policy requires that steps should be taken to introduce these arms (breechloaders) into our service. . .the long habit of using muzzle-loading arms will resist what seems to be so great an innovation. . . ."

But the Army's Ordnance Department during the period just prior to and in the initial years of the Civil War, fought stubbornly against the official adoption of such untrustworthy, unnecessarily complex, costly, and "unproven" innovations as breechloaders and repeating rifles and carbines.

The Secretary of War was informed by COL H. K. Craig of the Ordnance Department in 1861, that "It is not believed that what are called repeating arms are desirable for infantry. . .or riflemen. They are more complicated. . ., more liable to get out of order, and more difficult to be repaired than the muzzle-loading musket and rifle. . . ." Then, commenting on the argument in favor of the increased rate of fire of magazine weapons, the colonel noted, "Excessive rapidity of fire is not the great desideratum for military guns. The soldier can carry only a certain weight of ammunition, which to be used with effect should be expended with deliberation."

Official adoption of such weapons would come about only because of the desperate

(Continued on page 18)



From 'Committee of Safety' to the M16!

(Continued from page 17)

need in 1861-65, for serviceable weapons of any type. Thus, several dozen privately developed breechloading and repeating type rifles and carbines were purchased by the Ordnance Department for issue to Northern troops.

Meanwhile, the solution to attaining a system to permit easy loading of a muzzle loading weapon yet have the projectile engage tightly the rifling upon discharge, had been sought since the end of the 18th Century. A number of systems appeared, but the one most practicable, and the one adopted in 1851 by Great Britain, was that of French Captain Charles Minié.

The Minié system used a conical shaped projectile rather than a ball, and the base of the projectile was hollow. Into this hollow base Minié inserted an iron cup. Upon firing, the cap was thrust ahead and expanded the lead bullet against the rifling.

As adopted by the U.S., the Minié system was modified to eliminate the plug, relying on the force of the gases alone to expand the projectile. These then, are the millions of "Minny Balls," as they came to be popularly mispronounced, of Civil War fame.

Union troops during the Civil War, and to a considerable extent Confederates when the "supply" was available, were issued Springfield manufactured or Springfield pattern .58 caliber rifled muskets built by contract. They fired the .58 caliber Minié bullet that gave a remarkably good degree of accuracy out to 300 yards.

The models of 1861, 1862, and 1864 were simply modifications to the basic 1855 version. The first eliminated the Maynard lock. The second two modified the barrel bands to meet mass production manufacturing needs. While both sides used other designs as well, such as Tower or Enfield, Belgian, Austrian, etc., the official arm of the U.S. service was the Springfield Model 1861. Like its 1855 parent, it still reflected some lines of its Charleville great grandparent.

At the conclusion of the war, a number of facts caused the Army to update its official small arms policy. Technology of metallic cartridge manufacture had progressed to reasonable reliability, and other armies of the world were adopting cartridge weapons. On the other hand, the U.S. had in its possession in excess of a million muzzle loading rifled muskets. Also, the mood of the country, as is the case after every war, was little disposed to spend large sums for the purchase of new weapons.

What followed then, was the creation of a board in 1865, convened at the Springfield Armory, to look at breech loading carbines, for cavalry and light infantry use. Sixty-five designs were submitted. The approach selected was to limit consideration to five systems that allowed alteration of existing weapons.

The one selected was the design of Mr. E. S. Allin, Master Armorer of the Springfield Armory. This conversion altered the existing .58 caliber muzzle loading Springfields into .50 caliber breech loaders. These were the Model 1866 Allin Conversion Springfields; whereby a trap door mechanism at the breech opened by a catch on the right side of the lock.

This so-called "trap door" type Springfield would go through several modifications, as new models were built from scratch in 1873 and in 1884. The new model used a new .45 caliber black powder metallic cartridge that became known as the ".45-70." This was the official issue arm of U.S. troops, in both carbine and rifle versions, from 1866 through the period of the Indian Wars, and up until the 1890s.

In 1872 another special board was convened to look at new breech-loading designs. One hundred and eight designs were submitted. Only nine were of foreign origin, a rather significant thing in the view of one expert.

The noted small arms authority, W. H. B. Smith, pointed out that in the period of transition from muzzle loading to repeating cartridge guns, American arms designs were the soundest. Germany had the best military machine but was hampered psychologically by the fact that she was winning wars with her "Needle Gun" and had no time to consider changes.

Further, said Smith, the French were handicapped by their national psychology and by studying Prussia to the exclusion of others. English inventors realized the War Office's stubborn position that any cartridge with a self-ignition device was too dangerous and impractical, and that any breech loader would be a useless expender of large quantities of ammunition. The English route then, was to try to product improve the cap lock muzzle loader.

In America, by contrast, noted Smith, the civilian hunting and sporting market absorbed and promoted new American designs. In 1882 then, still another board met to review small arms progress. For the first time, bolt-type mechanisms and buttstock and detachable magazine weapons were presented for serious consideration. Tests of the buttstock magazines for large caliber cartridges were unfavorable and detachable magazine were too costly to manufacture. This position was maintained until WW II, when greatly improved manufacturing techniques for the M1 carbine allowed a change of attitude.

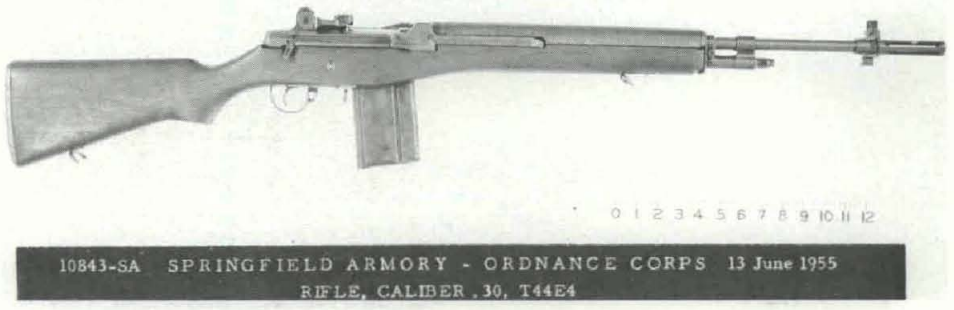
Nonetheless, by 1890 every major power in the world had gone to a magazine rifle of some type. A new Army Ordnance Board was convened to look at the technology available. Fifty three U.S. and foreign systems were reviewed. The one selected was the bolt action Norwegian Krag-Jorgensen system. Even so, the design would pass through five modifications before it was finally accepted.

Adoption of this design flew in the face of better technology. The Krag-Jorgensen system used a single locking lug on its bolt, and a cumbersome box magazine projected from the right side of the receiver. However, the far stronger dual lug Mauser bolt was then on the market, as was the proven Mannlicher strip-clip system of magazine loading. But the U.S. was not alone in its slowness to adopt the Mauser-Mannlicher system. Neither Germany nor Great Britain were as yet convinced of their worth.

The Krag rifle used a smokeless powder .30 caliber bullet, a caliber determined by several foreign powers to be the most efficient for military use. The Krag round, however, called the .30-40 Krag, was a rimmed cartridge and the drawbacks to rimmed cartridge were already beginning to appear.

The initial U.S. Krag system was not all that was hoped for. Its accuracy, for one thing, left something to be desired. Springfield Armory worked hard to correct its deficiencies. By the time the Spanish-American War broke out in 1898, the rifle was developed to the limits of its design.

Regular U.S. troops armed with the new Krags found the Spanish Mauser outranged and out-shot their rifles! At San



10843-SA SPRINGFIELD ARMORY - ORDNANCE CORPS 13 June 1955
RIFLE, CALIBER .30, T44E4

Juan Hill a garrison of but 700 Mauser-equipped Spaniards took a toll of some 1,400 Americans in an attacking force of over 15,000!

No wonder then, that captured Spanish Mausers were soon undergoing tests in 1900 and 1901. Studies were also being made of the new German Mauser officially adopted in that country as the "Gewehr 98."

The result was the purchase from Mauser for $200,000 of manufacturing rights to their new design. The first new rifle, with modifications over the Mauser design, built at Springfield and at Rock Island Arsenals, and chambered for a new .30 caliber rimless cartridge, proved little better than the Krag.

Issued to troops in 1904 and 1905, it was designated the U.S. Rifle Model 1903. However, a big jump in performance came with the development of the new 1906 cartridge, based on experiments with the 1905 German pointed "Spitzer" bullet.

As a result, the redoubtable, reliable, and gracefully lined "Springfield," as the weapon became and is still popularly known, remained the issue rifle of U.S. troops until 1936 when the new M1 Garand was officially adopted. At that time, over 1.5 million Springfields had been produced, and the plant at Springfield ceased production in order to retool for the new M1.

But the design would not die. As the war clouds appeared on 1939's horizon, production was resumed and continued, with modification, and under contract, finally ceasing for all time with the end of the war in 1945.

While the '03 had proven to be an extremely accurate, reliable weapon, experience in World War I had clearly pointed out the need for a shorter range heavier firepower weapon in the hands of the individual rifleman. Even during that war the Ordnance Department had commissioned Mr. J. D. Pedersen to develop an automatic mechanism for the '03 rifle. His device, that utilized a modified .32 automatic pistol cartridge, did not succeed.

Later, in 1922, in response to a continuing Army interest in a semi-automatic rifle, Pedersen presented a new design. Consequently, he was hired and sent to Springfield Armory to do design work. He was given unusual latitude to design his own cartridge for the weapon. The Pedersen model used a .276 caliber cartridge, but feed problems and other technical difficulties precluded its adoption.

At the same time Pedersen was doing his work, another Army Ordnance man, Mr. John M. Garand, had been doing some experimenting. During WW I, Garand had worked on a concept for light machinegun actuated by the setback force of the primer in the cartridge case.

In 1919, Garand transferred this technological approach to a potential primer actuated rifle. However, due to adoption of a new slower pressure powder, Garand dropped this approach. Instead, he began experiments in 1926-1929 with a gas operated, rotating bolt rifle.

T48 (FN)

CHARACTERISTICS	M1	T44	T48 (FN)
WEIGHT - BASIC RIFLE (w/Empty Mag. -Less Sling)	9.6 #	8.7 #	9.7 #
WEIGHT - RIFLE READY TO FIRE (Fully Loaded - w/Sling)	10.3 # (8 Rds)	10.0 # (20 Rds)	11.0# (20 Rds)
LENGTH - w/ FLASH HIDER	43.6 " (w/o F.H.)	44.25 "	44.5 "
MUZZLE VELOCITY	2800	2800	2800
WEIGHT - AMMUNITION (20 Rds)	1.18 #	1.04 #	1.04 #
WEIGHT - BAYONET	.88 #	.70 #	0.63 #
WEIGHT - GRENADE LAUNCHER	.81 #	.31 #	0.34 #

Garand's design was mature enough by 1929 to be one of seven, including Pedersen's, to be tested at Aberdeen. Only Garand's utilized the then standard .30-06 cartridge, though the Ordnance Department had earlier decided to adopt Pedersen's .276 round.

The decision was to adopt the Garand in .276 caliber, and to build and test 20 of the new Garands. Fortunately, for the nation from a manufacturing point of view in the WW II years ahead, GEN Douglas MacArthur—then Chief of Staff, vetoed the .276 in favor of the existing .30-06 round.

The new Garand in .30 caliber passed its tests. In January 1936, it was adopted as the U.S. Rifle Caliber .30, M1. Production began in August 1937, and by August 1939 some 50,000 had been turned out by Springfield Armory. With subsequent demands of pre-war U.S. rearmament and WW II, production of M1s soared.

GEN George S. Patton reportedly said the M1 was "the greatest battle implement ever devised." Nonetheless, there was, by 1944, an Ordnance Department project underway to modify the M1 to allow either full or semi-automatic fire. In 1945, after the war, the Army Ground Forces Equipment Board—the so-called Stilwell Board, determined the M1 to be too heavy. The War Department in 1946, agreed.

The project to modify the M1 was terminated in 1948 in favor of a new rifle to replace four existing weapons—the M1, the Browning Automatic Rifle, the M2 Carbine, and the M3 sub-machinegun. The weight of the new rifle was not to exceed seven pounds.

At the time the decision to terminate the M1 modifications was made—there were actually five modification designs underway. There were three other projects in the books that were utilizing a new rifle. These projects were labelled the T25, the T28, and the T31. All were being designed to feature selective full or semi-automatic fire, and to utilize the Cal. .30 Light Rifle T65 cartridge. This cartridge, derived from the .300 Savage round, would later become the 7.62mm NATO round.

Beginning in 1949, five additional projects were started, known as the T33, T34, T35, T36, and T37. All were basically upgradings of earlier efforts to product improve the M1. One of these, the T37, had a lightweight barrel, a gas port about four inches from the muzzle, a light wood stock, a lightweight stabilizer and flash suppressor, a bolt buffer to shorten travel distance, and a one-piece band guard and an aluminum butt plate. It fired the new developmental T65 round, later considered for possible adoption by NATO. The T37's weight was about 8 pounds.

In tests at Aberdeen in 1950, a number of faults were discovered, but the accuracy of the T37 was comparable to an M1 firing the 7.62mm cartridge; the T37 was more accurate than the standard M1 firing standard .30-06 ammunition. As a result, it was recommended that the possibility of developing a suitable lightweight

(Continued on page 20)

From 'Committee of Safety' to the M16'

(Continued from page 19)

rifle, capable of being manufactured with existing production tools, be investigated.

Development of the weapon continued and the T37 underwent further modification. One version, designated the T44 in December 1950, had two barrels. Using a light barrel, it would replace the M1, the M2 carbine, and the M3 sub-machinegun. A heavy barrel version would be used to replace the Browning Automatic Rifle or BAR.

The new T44 thereupon underwent its share of modifications and tests during the next 18 months. In late 1952 a number were turned over to the Army Field Forces Board No. 3 for testing. The Board's finding in April 1953 were less than startling. It was reported that the T44 was always less effective when fired automatically. It was also too heavy to serve as a replacement for the carbine, and when fired on full automatic was less accurate than the M3 sub-machinegun.

On the plus side, the Board found the T44 to be more durable and reliable than the M1. Also, the adoption of one basic weapon system would simplify the logistics problem. The Board recommended no further study be given to an automatic-firing feature for the rifle to replace the M1. Further, the Board rejected the idea of a removable box magazine for such a rifle.

Again the T44 went back for modifications, though the features of a provision for full automatic fire and for use with the 20 round detachable box magazine were retained.

Concurrent with the development of the T44, were two other competing programs called the T47 and T48. The T48 was a modified Belgian FN rifle chambered for the 7.62mm round. The T47 was a modification of a program called the T25, begun in September 1945.

To the U.S. at this point, the issue was that of selecting a totally new system—weapon and cartridge. Competing cartridges were two. The first was the 7.62mm which was begun by the U.S. in late 1944 as means of taking advantage of improved powder technology to attain a smaller case with no loss in performances over the existing .30 caliber round.

The second was the British developed .280 caliber cartridge, for which the Belgian FN factory had chambered some of its standard FN rifles. Most of NATO had pretty well decided on adoption of the FN rifle. Their only question was simply that of the caliber. Since the U.S. in 1947 had agreed with Canada and the U.K. to exchange and test each others developments in small arms, the U.S. was committed to look at the .280 round.

As it turned out, the .280 round did not perform as well as the 7.62mm, and the T48 FN rifle faired badly in initial tests against the T44—the T25 never being a serious contender. Further development and improvement of both the T44 and T48 followed, until April 1956, when both were considered ready for production. However, the home product—the T44, was considered to be lighter and easier to produce, since it used components based on the M1.

On 1 May 1957, the decision was made to adopt the T44 rifle in the 2-barrel versions, using the 7.62mm cartridge. The two versions were called the M14 and M15 rifles. The latter would be the heavy barrel selective fire weapon. The former would be issued as a semi-automatic model using a lighter barrel.

Two years later, the M15 version was abandoned in favor of a selector mechanism to be fitted to a proportion of the M14s. Other minor modifications to the M14 system followed as the weapon remained the basic issue for Army troops until 1967.

There was another ongoing R&D effort begun in the late 1950s that sought a major technological jump in small arms development. It was the outgrowth of efforts in the early 1950s to increase the hit probability of the average rifleman under battlefield conditions. Initial efforts were wrapped up in a program called Project SALVO. It looked at a variety of bullet loadings, i.e., simpler, duplex and other multiple projectile rounds.

Emerging from this program was one called SPIW—standing for Special Purpose Individual Weapon. This title, it was often said, was adopted to forestall Congressional criticism of Army efforts to develop another new rifle when it was then in the process of adopting the M14.

Actually, the concept was revolutionary and pushed the state-of-the-art. It utilized a fin stabilized flechette fired at very high muzzle velocity. The muzzle impulse would be very low due to the very small mass of the flechette, resulting in a weapon capable of controlled bursts of fire with a very high probability of target hit. By 1962, definite system development was planned for the following year. There were those in the Army R&D community who believed the SPIW had the real potential to be the next generation individual weapon.

During this period, the U.S. involvement in Vietnam increased, and with it came extra-Army interest in a new lightweight weapon. Called the AR15, it was developed initially by a Mr. Eugene Stoner of the Armalite Division of Fairchild.

The AR15 was a direct outgrowth of Stoner's work with Armalite to develop an ultra-light survival rifle for the U.S. Air Force. The Army also had on its list of future needs a 1957 approved requirement for a follow-on system for the M14. Many no doubt expected the SPIW would be the answer to this requirement.

The AR15, firing the smaller 5.56mm cartridge with a high muzzle velocity, seemed to meet many specifications of the requirement.

Ten AR15 rifles were provided the Infantry Board in March 1958, and underwent tests at Aberdeen. Findings indicated that the AR15 demonstrated a potential that might make it acceptable as a replacement for the M14.

However, simultaneous with the AR15 testing was the meeting of the so-called Powell Board—all general officers, convened to review the entire Army rifle program. The Board was to resolve, if possible, the issues of big versus small bore high velocity schools of thought.

The Board suggested that no further consideration be given to the 5.56mm round, that the M14 be retained for the automatic rifle role, and that development of an AR15 type weapon chambered for a .258 cartridge be expedited to replace the M14 in the rifle role.

In January 1959, the Army announced its decision to retain the M14 as the standard rifle. The decision was based upon the Powell Board findings and the political ramification of the 1953 NATO standardization agreement on the 7.62mm round.

Army interest then, in the AR15 slowed down, but the issue refused to die. Details of the Army's struggles to reach a decision on its future rifle were covered by COL Shelton's article in the May/June 1979 issue of this magazine.

The Army tried to be objective, and to undertake thorough studies, tests and analysis. It tried to avoid hasty decisions. It was whiplashed by the Office of Secretary of Defense for lack of objectivity. It clung to the hope that its SPIW would finally mature. It got caught in a crossfire of other service's decisions to go the AR15 route. Finally, the Army felt and reacted to intense pressures in favor of the AR15 emanating from deeper U.S. involvement in Vietnam where a lightweight high velocity type weapon was found to be desirable.

As the result of Vietnam experience, and the findings of a 2-year small arms study program (1965-66), the Army made the decision in November 1966, to adopt the XM16E1 rifle as the modified AR15 was now called in Army terminology. On 23 Feb. 1967, the rifle was type classified as the M16A1.

'VuPoints'

Diesel Fuels in Helicopters?

To the Editor:

In the July-August article "Why the Army Should Use Diesel Fuel in Helicopters," Finnerty and Dehn advocate shifting from JP–4 to Diesel fuel. The purported benefits are (1) lower cost, (2) reduced vulnerability to fire, (3) greater tactical flexibility, and (4) it will be forced on us anyway by fuel availability so we might as well do it now.

There's another side to this proposal that needs to be considered.

Given the present state of flux in fuel costs, price comparisons can be difficult. Nevertheless, a good set of bench marks are the Defense Fuel Supply Center (DFSC) stock fund prices, which cover about 87% of the fuel used by DOD. The per gallon prices that DFSC charges the using units are 55¢ for JP–4, 63¢ for JP–5, 83¢ for JP–8, and 61¢ for DF–2.

The savings from using DF–2 instead of JP–8 are 22¢ per gallon, rather than 44¢ cited in the article. Furthermore, the savings are applicable only to fuel burned in Europe because CONUS aircraft will continue to use JP–4 for some period of time in the future.

From the standpoint of fire vulnerability, both JP–8 with a flash point of 100°F and DF–2, with a flash point of 125°F, are safer than JP–4, which has a flash point well below zero. The safety advantage of DF–2 over JP–8 is much less significant. If DF–A or DF–1, both of which have 100°F flash points, are used, there would be no advantage over JP–8.

The proposed option of refueling helicopters from a GOER one or two kilometers behind the FEBA seems to ignore the high mobility of the helicopter. A refueling point 20 kilometers back is only ten minutes away and a lot less vulnerable to enemy fire.

The argument that a diesel-like future fuel with high aromatic content will be forced on us also needs reexamination. A shale-derived JP–5 recently tested for NASA contained 23.1% aromatics. Similarly, a shale-derived JP–8 being tested at the Army Fuels and Lubricants Research Laboratory contained 21% aromatics. Both values are within the 25% maximum imposed by current jet fuel specifications.

It is *not* inevitable that future jet fuels will decline to the quality of today's diesel fuel. The two samples of shale-derived jet fuel were refined with today's technology and they can be made as good or better in the future. As to the question of who, civilian or military, gets the fuel when it is in short supply, the answer is, except for emergency conditions, whoever pays the price. The safety of Army personnel is no less important than civilian safety, and if the civilian economy is prepared to pay more for aviation fuels, the Army must do so too.

One of the problem areas in using diesel fuel is low-temperature operation. A 1973 survey by the Coordinating Research Council revealed that 60 of 92 companies reported cold weather fuel system difficulties, the most common problem being that the vehicle started and ran, but later stalled. This problem is serious with vehicles, but could be disasterous with helicopters.

Any aviator knows that an engine failure can ruin the whole day! The start-run-stall syndrome is caused by an accumulation of wax and/or ice in the fuel filter, followed by fuel starvation. True, the problem can be solved by the use of heaters, but at the cost of added weight, greater complexity, and more failure modes.

The most important argument against using diesel fuel in helicopters is that it is too low in quality for aviation use. Diesel fuel is allowed to have *eight* times as much particulate contamination as JP–8, and nearly twice as much sulfur. Other important limits on jet fuel that are *not controlled* in diesel fuel include thermal stability, gum, and water separation index.

The high particulates in diesel fuel would require modification of the on-board filters to handle an 8-fold increse in contaminants, with a corresponding penalty in weight and bulk. Thermal stability is critical to prevent carbon formation where fuel contacts hot engine components (i.e., heat exchangers and fuel nozzles). Gum limits are needed to prevent sticking of close-tolerance fuel control parts.

The water separation index is extremely important because it is related to the ease of coalescing and removing emulsified water. Diesel fuel, because of its high surfactant level, is notoriously poor in this respect. The higher sulfur content of diesel fuel can contribute to corrosion. Those whose lives depend on reliable operation of aircraft deserve the cleanest, highest quality fuel available.

The primary driving force behind the USAF (and eventually Army) conversion from JP–4 to JP–8 is the need for NATO interoperability. There is no doubt that the change will increase fuel costs, but the tactical and logistical advantages of interoperability, together with increased safety because of JP–8's higher flash point, far outweigh the cost factor.

Based on the factors discussed above, we feel that fuels of the future should continue to be made from the highest quality portion of the crude (or syncrude) barrel, and other products, including diesel fuel, should be made from the rest.

Maurice E. LePera
Chief, Fuels & Lubricants Division
Energy & Water Resources Laboratory
U.S. Army Mobility Equipment Research
& Development Command
Fort Belvoir, VA

Clements Discusses Progress on the 2-Way Street

Mrs. Sally Clements, Deputy for Materiel Acquisition Management in the Office of the Assistant Secretary of the Army (Research, Development and Acquisition) was a featured speaker earlier this year before the Greater Baltimore (MD) Chapter of the National Contract Management Association. Her address, titled "Progress on the 2-Way Street," dealt with the impact of international considerations on the acquisition of U.S. defense articles and services.

Clements stated at the beginning of her presentation that in the past 25 years we have seen the entire range of international arms and technology transfer programs grow from a level of relative dormancy to the point where the White House, the Congress and the public pay rather close attention to the directions that these programs take.

She noted that when decisions are made at each milestone in the life of a system or procedure, several factors must be taken into consideration. These include the reaction of our allies and our adversaries, the potentials for sales for foreign production, and the economics of marketing any and all components of the system.

Clements devoted a substantial portion of her address to the various international programs such as data exchange, technology transfer, offset procurements, coproduction, licensing, and international research and development.

U.S. security assistance support to allied and friendly nations, she stressed, has become an important as well as a very controversial instrument of U.S. foreign policy, and an essential element of our defense program and U.S. global security planning.

Although the U.S. Security Assistance Program holds advantages for both the customer and the U.S., in terms of quality, delivery, service, support, standardization, and training, the economic advantages of the programs are weighted almost entirely toward the U.S.

This perception of a "one-way" street on the part of some of our customers and a realization that a broadened industrial base and greater commonality of equipment would be advantageous to allies in wartime, have led to a collection of programs, particularly in NATO, often called standardization programs, she said.

The materiel acquisition deputy emphasized that for many years, the nations of the Atlantic alliance did not address the problems of long-term military economic cooperation. Now, she added, the economic strains of the one-way street and the advantage of integrated efforts are encouraging action that can maximize use of our limited resources.

The U.S., she continued, is now faced with new realities which require new ways of thinking, and new approaches to more effective use of alliance resources. The first reality is that military equipment costs a lot of money. Said Clements: "We simply don't have the money to equip and modernize the Active, National Guard, and Reserve forces as quickly as we would like."

This same reality is true for our NATO allies. If the cost of each item can be reduced, we can have more to go around—and improve our readiness. In short, she noted, we may be able to reduce the trade-off between readiness and modernization.

The second reality is that the alliance nations have proliferated too many types of equipment. Consequently, there are now seven different families of main battle tanks, 22 different families of antitank weapons, 8 families of armored personnel carriers, 11 types of combat aircraft, 36 different types of radar, and an unending list of greater profusion. Each item also requires its own spare parts, maintenance, training, and operational support and the inefficiencies that come with this.

The third reality, discussed by the deputy, is the desire of America's allies to benefit from the economic aspects of military preparedness. Until recently, she said, the U.S. has failed to recognize that its advocacy of standardized armaments is based primarily on alliance purchase of U.S. equipment.

Too often, U.S. examples of proposed cooperation with Europe have occurred so late in the development cycle that the European participation has proven to be uneconomic. As a result, mutual benefits from technology participation or transfer have not been possible.

European nations have been questioning the possibility of working equitably with the U.S. Because they believe that traffic from Europe to America will always be small, Europe appears to be heading towards a self-sufficiency in arms development and production.

Clements cautioned that the danger now exists that Europe may seek less reliance on the great R&D strength in America. Fundamentally, the concept of the 2-way street is a concept of economic balance needed for long-term economic stability.

The predominately one-way flow of products and technology between America and Europe, in the view of the European nations, cannot be allowed to continue. European members of the alliance, she stressed, feel that there must be a 2-way street of greater economic and technological equity, and that it must be built very, very soon.

Clements stated that equitable transatlantic cooperation in defense procurement can be attained in three ways:

- We can equitably divide procurement of armaments.
- There can be a balance of U.S.-made armaments sold to Europe and U.S. purchase of technically advanced commercial products from Europe.
- The 2-way street can be primarily a flow of ideas and drawings, with the result that, frequently, the same product will be produced both in the U.S. and Europe.

Limited experience with similar approaches, said the deputy, does not argue well for any of them. The first approach is the most difficult to achieve. The second has not been successful, and the third approach has yet to be fully explored.

Proposals made for a 2-way street of technology and plans can probably work, she explained. Roland, the short-range air defense system which the U.S. adopted from Europe, is an example. Although the Roland experience was not without its faults, it did result in a precedent that can work again either way across the ocean, she added.

Clements pointed out that there is increased emphasis at the DOD and Department of the Army level to give our NATO allies a fair chance to compete in fulfilling U.S. military equipment needs. For example, at the DA level, an International Rationalization Office—headed by a general officer—has been established to direct and oversee all NATO related matters.

Standardization and interoperability are also affecting testing, systems acquisition review, and cost and operational effectiveness analyses, she said. Although we haven't yet attained equity on the 2-way street, she added, the pressure is there to reach it.

The materiel acquisition deputy then discussed some of the various procurement practices which are designed to support NATO standardization. These include government-to-government Memoranda of Understanding, and coproduction and licensing programs.

She cautioned that procurement agreements between countries don't necessarily mean that the procurements take place. The procedure is not easy, she explained, particularly when you consider the normal problems in soliciting and receiving bids from domestic producers, and dealing with foreign producers, who are sometimes totally unfamiliar with U.S. procurement practices.

International coproduction encompasses commercial licensing, she noted, and refers to a country-to-country arrangement which permits a foreign government or designated commercial producer to acquire the know-how to manufacture, assemble, repair, maintain, or operate a specific defense system.

Coproduction agreements, she stressed, have had a long and generally successful history. The Army, for example, has 28 such agreements with 11 countries and two NATO organizations. These agreements cover items ranging from the M-16 rifle to the M60A1 tank, and include helicopters, ammunition, artillery, missile systems, and electronic hardware.

Clements concluded her remarks by stating that the challenge for government and industry is to negotiate contracts that span different cultures, procurement systems, national objectives, competing licensing, royalty and patent interests, and different cost arrangements, yet insure that bathtubs are suspended from the ceiling if that is what the law of the land of the producing country requires.

Capsules...

Contract Calls for M110A2 Product Improvement

Rock Island Arsenal, Rock Island, IL, has been awarded an $11.5 million contract to build product improvement kits for the M110A2 self-propelled howitzer. Production is scheduled to begin January 1981 and be completed by December 1981. The program includes 11 modifications, most of which were recommended by troops in the field.

The package includes an adjustable gunner's seat to assist the crewman in the use of the gunsight and to reduce fatigue; an external warning light added to enable the driver to monitor the pressure and temperature of the engine, transmission and radiator coolant while outside the vehicle; remote indicators to warn of possible hydraulic filter blockage or breakdown; and a redesigned parking brake to prevent failure during firing.

Also included in the modifications are newly designed lockout cylinders and isolation individual shock absorbers to allow the crew to bypass a single defective shock absorber and remain in service. These changes will allow an improved stabilized firing platform and prevent damage to the road wheels and other suspension parts that would result from a broken shock absorber.

The vehicle will also be modified so that all types of projectiles can be stowed aboard. There is now no stowage capacity for some new type projectiles. These major changes and others will increase the reliability and maintainability of the M110A2 self-propelled howitzer.

Army Type Classifies Water Purification Unit

Type classification of the Reverse Osmosis Water Purification Unit, developed by the U.S. Army Mobility Equipment R&D Command, has been announced. The new unit can produce 600 gallons of pure water per hour and be used with salt water, brackish or polluted water, or water contaminated by nuclear, biological or chemical agents.

Reverse osmosis separates contaminants from water by passing it through a thin, spiral wound semipermeable membrane. The process requires a pressure difference between the source or contaminated water and the pure or product water. Purified water passes through the membrane while dirt, dissolved salts and pollutants are discarded.

The design of this reverse osmosis unit is termed an important technological breakthrough, not only for the Army, but also for the civilian community. It provides the capability of purifying sea water in remote areas with a compact, highly mobile piece of equipment.

A thin film dry composite membrane, developed under Army auspices, can be stored dry, wet-dry cycled, or even freeze-thaw cycled without hampering its desalination capability or water production capability. Plans call for an initial production contract for 30 units.

Natick Computer Stores Stress-Strain Test Data

Results of unclassified tension stress-strain tests conducted by the Materials Properties Branch (MPB), Engineering Standardization Division, U.S. Army Materials and Mechanics Research Center, Watertown, MA, are being stored in the Natick R&D Command's (NARADCOM) UNIVAC 1106 computer. The computer-stored information is a data-base of individual test results and the analyzed data can be retrieved at demand terminals by authorized users of the NARADCOM computer.

According to Ralph Papirno of the Engineering Mechanics Division, data from individual tests are reduced by a computer-assisted procedure. Coded results are then analyzed and stored in the computer. An authorized user of the computer data bank may retrieve tabular information for tests of a specific material using a self-instructing computer program on either teletype or cathode ray tube demand terminals.

In addition, Papirno says, the stress-strain curve for any test optionally may be displayed on the screen of a graphics terminal. By mid FY79, data for over 1,000 tests were stored for tests performed since July 1977 with continuous updating as more data are obtained.

Authorization for release of the unclassified stored data, for external use in reports and papers or in response to external requests from government or private organizations, must be obtained from the chief, AMMRC Materials Properties Branch.

The procedure for data reduction and analysis, coding, storage, and retrieval was developed in a joint program, with MPB by the Engineering Mechanics Division. The procedure is described in three reports: AMMRC TR 79-16, TR 79-17, and TR 79-18.

Helicopter Rotor Deicing System Tested

Ice on helicopter rotors may eventually be of less concern, according to news out of AVRADCOM, St. Louis, MO. A recent release from that command describes successful testing of a prototype fiberglass blade deicing system. The testing, done by AVRADCOM's Engineering Flight Activity, Edwards Air Force Base, CA, employed natural and artificial icing conditions, using a CH-47 helicopter at St. Paul, MN.

The testing program was conducted in two phases; when the blade deice system was permitted to operate automatically in a protected condition, and when the blade deice system was in a standby status in an unprotected condition. These rotor blades underwent 18 flight hours of tests in natural and artificial icing conditions.

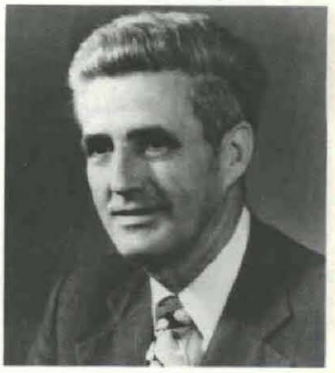
This fiberglass rotor blade system was evaluated in conditions varying from light to moderate icing conditions and at temperatures ranging from minus 4 to minus 16 degrees centigrade. Time in the icing environment varied from 28 to 145 minutes.

Results of the testing program indicate the protected rotor blade system operated satisfactorily, providing good deice protection and the concept appears feasible. The unprotected rotor blades also operated satisfactorily under similar limited test conditions.

Reports indicate the unprotected blade test results were encouraging and that low ice accretion and minimal asymmetric shed characteristics were observed. However, further testing is planned to fully define both protected and unprotected flight envelopes and will include an expanded range of temperatures and icing conditions.

LaBerge Chosen as USD (R&E) Principal Deputy

Dr. Walter B. LaBerge, Under Secretary of the Army since July 1977, assumed new responsibilities in September when he was appointed as a Principal Deputy to Under Secretary of Defense for Research and Engineering Dr. William J. Perry.



Dr. Walter B. LaBerge

Dr. LaBerge served during 1976 as assistant secretary general for Defense Support, North Atlantic Treaty Organization, following an assignment from 1973-76 as assistant secretary of the Air Force (Research and Development).

Earlier assignments with Philco-Ford Corp. included vice president Electronics Group; division vice president, Western Development Laboratories (WDL), vice president, R&D Corporate Staff; director, Houston Operations; and director of Engineering, WDL.

Dr. LaBerge has a BS degree in naval science (1944), a BS degree in physics, and a PhD in physics, all from the University of Notre Dame. Professional memberships have included the Air Force Scientific Advisory Board, and the Naval Operations Industry Advisory Committee.

Assistant Secretary of Defense for Communications, Command, Control and Intelligence Dr. Gerald Dinneen will continue as the other Principal Deputy to Dr. Perry. The appointment of Dr. LaBerge reportedly provides significant additional management capability and experience to the office.

CSL Will Use MCPE on Missile Minder System

The U.S. Army Armament R&D Command's Chemical Systems Laboratory's (CSL) will soon deploy Modular Collective Protection Equipment (MCPE) for worldwide use on the Army's AN/TSQ-73 Missile Minder, an all-microelectronic air defense system.

MCPE is designed to provide the means for operating crews to work unencumbered in a toxic-free environment. The "collective" protection aspect means the individual soldier need not wear a restrictive protective mask or clothing. This enables him to work in a "short-sleeve" operation.

Engineering development of this chemical defense system was begun more that 11 years ago at Edgewood Arsenal. A gas particulate filter and protective entrance are the heart of the on-line MCPE system. It is designed to provide sufficient decontaminated air to the shelter.

The filter unit, contains both gas and particulate filters as well as air flow valves and controls. It purifies and pressurizes the air supply to the shelter and protective entrance.

Protection to the operating crew is maintained by "over-pressurizing" the shelter. This provides a continuous leakage of filtered air outward to prevent the infiltration of outside airborne contaminants.

Since the AN/TSQ-73 Missile Minder has been hailed as the most advanced Army air defense command post yet devised, the addition of the MCPE system for protection in a chemical-biological environment is considered a vital defensive feature.

Mr. John Kurtz, an engineer in CSL's Physical Protection Division, is managing the procurement of the MCPE equipment for Missile Minder and TACFIRE. Current plans call for a 2-man Army team from Edgewood to go to Germany as technical advisers.

Surplus Equipment Provides New Facility at CSL

The old adage "One person's trash is another person's treasure" was certainly made evident during the development of a neutron generator facility at the Armament R&D Command's Chemical Systems Laboratory (CSL). The facility, literally built from discarded equipment, cost very little to build and it has reportedly provided CSL scientists and engineers with a much-needed capability.

It was assembled largely from surplus equipment valued at more than $325,000. Actually, only $35,000 in funds were required to put the facility in operation. Scientists and engineers who put the facility together did much of the work during after-duty hours and on weekends.

Mr. Don Bowie, a research chemist who spearheaded the drive for the facility in CSL's Research Division, said the radiation lab answers a need. "For about 10 years," he notes, "we were engaged in studies of the effects of nuclear radiation on chemical materiel and during that time all of our research relied on other agencies equipped with nuclear reactors, accelerators, or intense isotopic radiation sources."

"Our current facility," Bowie said, "can perform neutron activation analysis as well as nuclear vulnerability studies. We have a neutron generator capable of producing 3.0 or 14 MeV neutrons as well as devices for simulating the mixed radiation field from a nuclear weapon. In addition, the facility includes a moderate size cobalt-60 source for gamma radiation exposures, plus a wide range of safety devices, radiation monitors, and a sophisticated computer-based gamma ray spectrometer."

New Water Tables Ease Working Conditions

Welders of the Materiel Testing Directorate's Technical Shop Section, Aberdeen Proving Ground, MD, can work under greatly improved conditions thanks to a new technique of using water tables.

Previously, the cutting of heavy steel armor plate generated considerable smoke, dust, and dirt as the steel was cut on conventional tables. Slag, dirt, and grime not only permeated the air, but built up under the cutting tables. The accumulated debris had to be removed manually.

The new technique uses two new water tables, each designed to hold a piece of steel 6 x 12 feet and up to 5-inches thick. By the use of recirculating water, at a rate of 700 gallons a minute, the debris is flushed into specifically designed cages. The water level is about one foot below the rigid slats built strong enough to hold the heavy steel.

According to Mr. Silas A. Hubbard, chief of the section, there are times when two or three workers are continuously cutting armor plate for eight hours a day. With the new water tables providing a cleaner working environment as well as eliminating the flying sparks, morale of the operators has improved.

At the present time steel plate thicker than five inches can't be cut on the water tables as the temperature of the flame required to heat thicker metal would be so intense that it would melt the slats holding the plate above water.

Index Lists FY 1978 Top Military Contractors

The following is an index listing, in descending order, of 100 companies which, with their subsidiaries, received the largest dollar volume of miliatry prime contract awards during Fiscal Year 1978.

General Dynamics Corp.; McDonnell Douglas Corp.; United Technologies Corp.; Lockheed Corp.; General Electric Co.; Litton Industries, Inc.; Boeing Co.; Hughes Aircraft Co.; Raytheon Co.; Grumman Corp.; Rockwell International Corp.; Textron, Inc.; Chrysler Corp.; Sperry Rand Corp.; Northrop Corp.; R.C.A. Corp.; Honeywell, Inc.; Westinghouse Electric Corp.; Martin Marietta Corp.; Fairchild Industries, Inc.; American Telephone & Telegraph Co.; Texas Instruments, Inc.; Reynolds R. J. Industries, Inc.; General Motors Corp.; Tenneco, Inc.; and

Ford Motor Co.; International Business Machines Co.; LTV Corp.; Todd Shipyards Corp.; FMC Corp.; TRW, Inc.; Amerada Hess Corp.; Exxon Corp.; Congoleum Corp.; Singer Co.; Teledyne, Inc.; International Telephone & Tel Corp.; Standard Oil Co. of California; American Motors Corp.; Bendix Corp.; General Tire & Rubber Co.; British Petroleum Co. LTD.; Engelhard Minerals & Chemicals Corp.; Harsco Corp.; Petroleos Mexicanos; General Telephone and Electronics Corp.; Royal Dutch Shell Group, Mobil Corp.; Ret-Ser Engineering Co.; Ogden Corp.; and

Goodyear Tire & Rubber Co.; Signal Companies, Inc. (The); Coastal Corp.; Hercules, Inc.; Gould, Inc.; Asip Spa; North American Philips Corp.; E. Systems, Inc.; Guam Oil & Refining Co., Inc.; Johns Hopkins University; Chamberlain Mfg. Corp.; Sun Co., Inc.; General Cable Corp.; Avco Corp.; Motorola, Inc.; Aerospace Corp.; Sanders Associates, Inc.; Emerson Electric Co.; Massachusetts Institute of Technology; Thiokol Corp.; Control Data Corp.; Eastman Kodak Co.; Pan American World Airways, Inc.; Harris Corp.; Vinnell Corp.; and

Standard Oil of Indiana; Lear Siegler, Inc.; Beech Aircraft Corp.; Pacific Resources, Inc.; U.S. & South American Enterprises; Charles Stark Draper Labs, Inc.; Dupont E I De Nemours & Co.; Sverdrup & Parcel & Associates, Inc.; Norris Industries; TransAmerica Corp.; Bethlehem Steel Corp.; Gulf Oil Corp.; Computer Sciences Corp.; Atlantic Richfield Co.; Mason & Hanger Silas Mason Co.; Loral Corp.; Hewlett Packard Co.; Mitre (The) Corp.; Rich, March & Co.; International Harvester Co.; Burroughs Corp.; Day & Zimmerman, Inc.; Cubic Corp.; Natomas Co.; and United Industrial Corp.

Conferences & Symposia . . .

Conferees Discuss Chemicals Decontamination

More than 50 Scientists representing a cross section of the nation's academic, government and research activities have completed a workshop at Raleigh, NC, on problems associated with the decontamination of toxic chemical agents.

The workshop was organized by Dr. Joseph Epstein, who is chief of Applied Chemistry at the Chemical Systems Laboratory (CSL), an ARRADCOM research activity in Aberdeen (MD) Proving Ground, and Dr. Bernard Spielvogel of the Army Research Office, Durham, NC, who also cochaired the 2½-day meeting.

The meeting was prompted by Under Secretary of the Army Dr. W. LaBerge, to involve the CSL scientific community in problems of chemical agent decontamination.

Dr. Ralph Siu, chairman of the Army's Scientific Advisory Committee established by Dr. LaBerge to review the CSL R&D decontamination program also attended the meeting. Subjects ranged from physical and chemical decon principles to the detection of decontamination.

The twofold objective of the workshop was to give broader visibility to problems in the decon of chemical agents and to review and encourage new ideas, as well as new approaches to decontamination problems. Mr. Elmer Enquist and Mr. Bernard Gerber, two other CSL researchers discussed the chemistry of chemical agents related to decontamination and the physics of removal of agents.

Dr. Epstein said the spirited and lively sessions at the meeting resulted in many new approaches to solving decontamination problems. A similar symposium is planned for 1980 relative to chemical and physical methods of decontaminating toxic agents.

MRC Announces Two 1980 Technical Conferences

More than 20 lectures by invited speakers will comprise two conferences, scheduled during Calendar Year 1980, at the Mathematics Research Center, University of Wisconsin-Madison.

A conference on recent developments in the theories of singular perturbations and singular-points asymptotics of differential equations and their applications to the sciences will be held 28-30 May. A detailed program will be available in February.

Recent developments and trends in the study of transition and turbulence in fluids and their applications is the theme of a later meeting from 13-15 Oct. Late transition phenomena and new turbulence research will be emphasized.

Additional information on these meetings may be obtained from Mrs. Gladys Moran, Mathematics Research Center, University of Wisconsin, 610 Walnut Street, Madison, WI 53706.

DCSRDA to Sponsor 12th Army Science Conference

The 12th U.S. Army Science Conference, sponsored by the Deputy Chief of Staff for Research, Development, and Acquisition, Department of the Army, will be held at the U.S. Military Academy, West Point, NY, 17-20 June 1980.

Ninety-six technical papers chosen from among summaries submitted by Army civilian and military scientists and engineers will be presented during the 3-day meeting. Authors of the most outstanding papers will receive special achievement certificates, medallions, and honoraria.

An expected audience of 400 U.S. Government and allied government defense officials and key scientists and engineers will provide a forum for discussions. Dr. Ivan R. Hershner Jr., assistant director for Research Programs, Directorate for Army Research, DCSRDA, is chairman of the Army Science Conference.

Awards . . .

3 Aberdeen MTD Personnel Receive Awards

Three persons assigned to the Materiel Testing Directorate (MTD) at the U.S. Army's Aberdeen (MD) Proving Ground recently received awards in recognition of outstanding contributions to the MTD mission.

Mr. Gary M. Jastrab, a general engineer with the Automotive and General Equipment Division, received the Director's Award for his work as sole test director for the Lighter, Air Cushion Vehicle—30 Ton Playload.

The 17-month project, which began in May 1976, was conducted at five test sites in the U.S. Jastrab was responsible for the overall program, including scheduling, and funding and personnel activity corordination. His award citation stated that his planning and organization were "impeccable."

MAJ David C. Robinson, a test and evaluation officer with the General Equipment Division, received the Crozier Award for his performance as officer in charge of XM1 and M60A3 tank firing programs and as range coordinator for turret fire control testing at the H Field Tank gunnery complex.

MAJ Robinson reportedly improved the tank turret testing capability, increased productivity of H Field, managed MTD resources, and conducted command level briefings and demonstrations. He has been assigned to MTD since 1975.

Mr. Timothy G. Shrader, an electronics technician with the Measurements and Analysis Division, received the Groak Award for his work on the Roland Missile, LACV-30, and XM1 Tank programs. The Groak Award, established in 1969, honors the late George Groak, a former MTD employe who is credited with enhancing the reputation of APG's technicians

Navy Recognizes Electronics Command Chemist

Otto C. Wagner, a chemist of the U.S. Army Electronics Research and Development Command's Electronic Technology and Devices Laboratory, Fort Monmouth, NJ, recently received U.S. Navy recognition as a coinventor of a new binary additive mixture for silver-zinc batteries.

The new additive consists of two elements of the group comprised of lead, indium, thallium, gallium, tin, and cadmium. It replaces a hazardous mercury additive which was formerly used in Navy ship batteries.

Wagner is currently working on the development of an improved, cost-effective, nickel-zinc battery that will reportedly have wide-ranging application for the Army, Navy and the Department of Energy.

Prior to joining federal service in 1967, Wagner was employed in private industry. He holds seven U.S. patents, has published numerous articles, and is a member of the Electrochemical Society, American Chemical Society, and the American Association for the Advancement of Science.

BRL Scientist Gets Technical Director's Award

Donald F. Menne

Mr. Donald F. Menne, a research physical scientist in the Ballistic Modeling Division of the Ballistic Research Laboratory (BRL), Aberdeen (MD) Proving Ground, has been named the recipient of the Technical Director's Award by the Army Armament R&D Command (ARRADCOM), Dover, NJ.

The annual award is granted for outstanding contributions in engineering through systems approaches. It acknowledges excellence in engineering development. MG Bennett L. Lewis and Dr. Robert E. Weigle, ARRADCOM's command and technical director respectively, as well as Dr. R. J. Eichelberger, BRL's director, made the presentation.

Menne was praised for his vital contributions to the design development and evaluation of the Army's new main battle tank and for his efforts in attaining a high level of survivability for the XM1 tank system and crew.

Since 1972, he has had the overall responsibility for the high priority work performed at BRL on the XM1 system. He directed and actively participated in the design and evaluation of armor, development of novel design guidelines for ammunition stowage, and vulnerability reduction and analysis of the vehicles.

Heading a team of experts, Menne reportedly led the way for the development of new armor designs that required a change in vehicle design philosophy that improved the structural integrity of the vehicle while meeting the protection requirements.

Ware Elected Fellow of Microbiology Academy

Lawrence L. Ware Jr.

Mr. Lawrence L. Ware Jr., chief, Scientific Information Office, U.S. Army Medical Research and Development Command (USAMRDC), Fort Detrick, Frederick, MD, was recently elected a Fellow in the American Academy of Microbiology.

Ware has been scientific information officer, USAMRDC, since 1966. His previous assignments have included area laboratory director, Office of the Division of Indian Health, Phoenix, AZ (1959-1965); research microbiologist, Fort Detrick (1951-1959); and the University of Chicago (1946-1951).

He has served as editor of "Laboratory Topics," a monthly newsletter of the PHS Indian Hospital. He has also authored numerous articles on microbiological subjects ranging from immunity of Asiatic cholera to mycotic biodeterioration.

Listed in *American Men in Science*, Ware serves on various committees of the American Society for Microbiologists, National Registry of Microbiologists, Association of Military Surgeons of the United States, Society of Industrial Microbiology and is the secretary for the Sigma Xi Branch at Fort Detrick.

He is the Army Medical Department's representative for Scientific and Technical Information to the Department of Defense, and on the Federal Laboratory Consortium for technology transfer of scientific information to the civilian sector for the National Science Foundation.

WES Engineering PM Chosen as ASTM Fellow

Woodland G. Shockley

Mr. Woodland G. Shockley, a program manager for Military Engineering at the Waterways Experiment Sation, Vicksburg, MS, has been named a Fellow of the American Society for Testing and Materials. He also received the ASTM Award of Merit.

The Award of Merit is granted to individuals for distinguished service in advancing the cause of voluntary standardization. Shockley was cited for his work on ASTM Committee D-18 on Soil and Rock for Engineering Purposes, and for outstanding contributions in the field of geosciences.

A research general engineer, Shockley is responsible for coordinating military research in the four WES laboratories. His duties include analyzing work load and sponsor requirements. He also coordinates inhouse and contracted research to assure timely and satisfactory accomplishments.

Author of numerous technical papers, Shockley is a member of the National Society of Professional Engineers and a registered professional engineer in Mississippi. He is listed in *Who's Who in Engineering* and in *American Men of Science*.

2 PM Smoke Employes Get Commander's Medal

Mr. V. Eugene Bowman and Mr. Joseph E. Steedman, both employed in the Office, Project Manager, Smoke/Obscurants, at Aberdeen Proving Ground, MD, are recent recipients of the Army Commander's Medal for Outstanding Civilian Service.

They were cited for contribution to the advancement of test technology and its application in field testing of electro-optical devices in a smoke/obscurant environment. The vast data base resulting from their efforts is being applied by EO Systems developers in analysis of their systems for advanced design, vulnerability and modeling validation.

Both men, working as a team in the Product Assurance and Test Division of PM Smoke, were responsible for field tests to quantify the smoke/obscurant environment; and the coordination of the use of smoke/obscurants in the development and operational field testing of all systems using electro-optical components. They also served as principal advisers to EO developers on degraded visibility test issues.

Additionally, they planned, arranged and conducted three smoke symposiums to act as a form in organizing the representatives of the smoke, atmospheric sciences, EO, test, intelligence and user communities. The initial symposium established goals, policies and responsibilities in smoke/obscurant testing. A follow-up symposium updated the communities on actions taken and progress made.

The "Smoke Week" concept calls for a periodic test sponsored by PM Smoke to provide an instrumented range where EO developers can evaluate system performace in a characterized degraded visibility environment. Smoke Week I was held in 1977 and Smoke Week II was held in 1978. Smoke week III is tentatively planned for September 1980.

Bialo Receives Army Commander's Award

Mr. John M. Bialo, acting project manager, Remotely Monitored Battlefield Sensor Systems, is a recent recipient of a Department of the Army Commander's Award for Civilian Service, one of the highest honorary awards for civilian employes.

He was commended for outstanding leadership and exceptional accomplishment in creating a procurement strategy to achieve an immediate $21 million cost savings. The award citation also cited his efforts which resulted in a total redirection of the Platoon Early Warning System (AN/TRS-2) procurement.

A federal employe since 1965, Bialo has searved for 3½ years as REMBASS deputy PM. He has served also as technical director of the SAM-D Vulnerability Studies Office, and as technical adviser (electronics) to the Army Test and Evaluation Command.

A member of several professional and honor societies, he has published technical and managerial papers, and is a licensed professional engineer in New York, New Jersey, Ohio, and Mississippi. His other civilian honors have included letters of appreciation, and Sustained Superior Performance and Outstanding Performance Awards.

DOD Presents DCSA to WES Technical Director

Mr. Frederick R. Brown, technical director of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, was recently awarded the Distinguished Civilian Service Award in a ceremony at the Pentagon, Washington, DC. The award is the highest honor the Defense Department can give a civilian employe.

Presented annually to a very small number of civilian employes, the award recognizes the employes whose careers reflect exceptional devotion to duty and extremely significant contributions of broad scope in scientific, technical, or administrative fields to increase the effectiveness of operations of the Department of Defense.

Brown was presented the award in recognition of his supervision of work programs at Waterways over the past 10 years. A 45-year veteran of Waterways, Brown began his service there as a laborer and has worked himself steadily upward to his current position.

Personnel Actions . . .

Griffith Chosen as Ohio River Division Engineer

MG Harry A. Griffith has succeeded MG Louis W. Prentiss as division engineer for the U.S. Army Corps of Engineers' Ohio River Division in Cincinnati, OH. MG Griffith has been serving as chief of the Joint U.S. Military Assistance Group, Korea, since May 1977.

MG Griffith was graduated in 1949 from the U.S. Military Academy where he was the highest ranking cadet, with a bachelor's degree in military engineering. In 1955 he received a master's degree in civil engineering from the California Institute of Technology. He is also a graduate of the Army Command and General Staff College, the Armed Forces Staff College and the National War College.

Prior to his assignment in Korea, MG Griffith was director of Development and Engineering for the U.S. Army Materiel Development and Readiness Command, Alexandria, VA. He served with the Office, Chief of Engineers as division engineer for the Southwestern Division from 1973 to 1974, and as district engineer for the Mobile District from 1970 to 1973.

Other major assignments have included: commander, 35th Engineer Group (Construction), Vietnam (1969-1970); chief, Nike-X and Space Division, later redesignated Missile Defense Ranges and Space Division, Office, Chief of Research and Development, Washington DC (1968-1969). His military awards are two awards of the Legion of Merit, the Bronze Star Medal, Air Medals, and two Army Commendation Medals.

Stubblebine Takes Over as ERADCOM Commander

BG Albert N. Stubblebine

BG (P) Albert N. Stubblebine, commander of the Army Intelligence Center and School since August 1977, has succeeded MG Charles D. Daniel Jr. as commander of the U.S. Army Electronics Research and Development Command.

A 1952 graduate of the U.S. Military Academy, BG Stubblebine holds an MA degree in chemical engineering from Columbia University, and is a graduate of the Army Command and General Staff College, and the National War College.

Some of his more recent assignments have included director of Tactical/Strategic Intelligence, Office of the Assistant Chief of Staff for Intelligence, and director, Intelligence Systems, Directorate for Battlefield Systems Integration, HQ DARCOM.

BG Stubblebine has served also as executive officer, Office, Chief of Research, Development, and Acquisition, Department of the Army; and as assistant chief of staff, G2, 25th Infantry Division and chief, Operations Branch, J2, Army Military Assistance Command, Vietnam.

He is a recipient of the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, the Meritorious Service Medal with two OLC, the Air Medal with OLC, and the Army Commendation Medal with OLC.

Bunyard Departs CORADCOM for USD (R&E) Office

BG Jerry M. Bunyard

BG Jerry M. Bunyard, a veteran of more than 24 years of active military service, is the new deputy director of Defense Test and Evaluation, Office, Under Secretary of Defense Research and Engineering, Pentagon, Washington.

BG Bunyard was previously assigned as project manager, Tactical Fire Direction System/Field Artillery Tactical Data Systems, U.S. Army Communications R&D Command. During 1975-77 he commanded the U.S. Army Yuma Proving Ground, AZ.

From 1974-75 he served at Fort Belvoir, VA, first as assistant to the scientific adviser, and later as chief, Technical Support Division, U.S. Army Operational Test and Evaluation Agency. he has served also in the Army Office of the Assistant Vice Chief of Staff as an operations research analyst and as coordinator of Army Programs Presentations.

BG Bunyard has a BS degree in animal husbandry from Oklahoma State University, and an MS degree in international relations from George Washington University. His military schooling includes the Command and General Staff College, National War College, and the Field Artillery School advanced course.

He is a recipient of the Legion of Merit, Distinguished Flying Cross with Oak Leaf Cluster (OLC), Bronze Star Medal with two OLC, Meritorious Service Medal with two OLC, Air Medals Joint Service Commendation Medal, and the Army Commendation Medal.

Palladino Heads Fort Worth Engineer District

The U.S. Army Corps of Engineers has announced that COL Donald J. Palladino is the new Fort Worth, TX, district engineer. He replaces COL John F. Wall Jr., who has been reassigned as deputy director of Military Programs in the Office, Chief of Engineers, Washington, DC.

Palladino formerly served as deputy division engineer for the Corps' Middle East Division (Rear) at Berryville, VA. He served earlier with Allied Forces, Central Europe, in the Netherlands, and from 1971 to 1973 he was involved with the Safeguard Antiballistic Missile Program as deputy assistant division engineer for Huntsville Division, Huntsville, AL.

He is a 1958 graduate of the U.S. Military Academy, and earned a master's degree in civil engineering in 1964 and a doctorate in civil engineering in 1971 from the University of Illinois. He is also a graduate of the Army War College and the Army Command and General Staff College, and is a member of the Society of American Military Engineers and the American Society of Civil Engineers.

Among his military awards are the Legion of Merit, Meritorious Service Medal with Oak Leaf Cluster (OLC), Joint Service Commendation Medal, Air Medal, and Army Commendation Medal with OLC.

Dorris Departs DCSRDA for MERADCOM Assignment

COL Albert F. Dorris

Commander, U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA, is the new title of COL Albert F. Dorris, following a tour of duty as chief of the Plans, Policy and Test Division, Office, Deputy Chief of Staff for Research, Development, and Acquisition, DA.

A graduate of the U.S. Military Academy, he holds a PhD in civil engineering from the University of Illinois. He is also an honor graduate of the U.S. Army Command and General Staff College, and a registered professional engineer.

COL Dorris commanded the 78th Engineer Battalion (combat) from 1974-76, and has served as operations officer of the 34th Engineer Group in Vietnam, and as a battalion operations officer in Germany. He was the U.S. Army engineer standardization representative to Great Britain from 1972-74, and chairman of the NATO Combat Engineer Working Group.

During the early 1960s, he served as the commander of an engineer float bridge company in Korea and a construction company in Germany. Other assignments have included project engineer, Army Engineer Waterways Experiment Station, and assistant professor, Department of Engineering, USMA.

COL Dorris is a recipient of the Legion of Merit, the Meritorious Service Medal, the Air Medal, and the Army Commendation Medal with two Oak Leaf Clusters.

Cuthbertson Takes Over Natick R&D Command

COL Robert J. Cuthbertson is the new commander of the U.S. Army Natick (MA) Research and Development Command, following service since 1975 as chief of the U.S. Army Materiel Development and Readiness Command's Office of International R&D.

Graduated from the University of New Hampshire (Distinguished Military Graduate) in 1955 with a BA degree in history, COL Cuthbertson has an MA degree in public administration from Pennsylvania State University. He has also completed requirements of the Command and General Staff College and the Army War College.

Listed among his previous assignments are executive officer, Directorate for Development and Engineering; action officer and Programs Branch chief, Programs and Budget Division, Office, Chief of R&D (now RDA); and commander, 426th Supply and Service Battalion, 101st Airborne Division, Vietnam.

Glock Heads DARCOM International R&D Office

COL Howard G. Glock, chief, Ground Combat Systems Division, Office, Deputy Chief of Staff for Research, Development, and Acquisition, HQDA, from September 1977 until August 1979, has assumed new duties as chief, Office of International R&D, HQ U.S. Army Materiel Development and Readiness Command.

A 1956 graduate of the U.S. Military Academy, COL Glock received an MS degree from Georgia Tech in 1964, and he has com-

pleted course requirements of the U.S. Army Command and General Staff College.

Prior to joining DARCOM, COL Glock also served from August 1974 to September 1977 as Department of the Army systems coordinator for the XM1 Tank System, Washington, DC, and from January 1971 to July 1972 as commander, 1st Squadron, 11th Armored Cavalry Regiment, Fulda, Germany.

From November 1969 to October 1970 he was commander B53, 5th Special Forces Group, 1st Special Forces, Camp Long Thanh, Vietnam. COL Glock served also from July 1965 to August 1968 as heavy equipment transporter coordinator (HET-70), U.S./German (MBT-70) Main Battle Tank Program, Warren, MI.

Eure Chosen as Army Smoke Project Manager

COL Samuel L. Eure

COL Samuel L. Eure has been named project manager for the Army Smoke/Obscurants Program, Aberdeen Proving Ground, MD. He succeeds COL Henry R. Shelton who retired on 30 June 1979. The PM for Smoke/Obscurants reports directly to HQ DARCOM, Alexandria, VA.

COL Eure was commissioned as a second lieutenant in the Chemical Corps in September 1956 after graduating from Virginia State College with a BS degree in chemistry. He also holds a master's degree in physics which he received in 1966 from the U.S. Naval Post Graduate School in Monterey, CA. His military schooling includes the Chemical Officer's Basic and Advanced Courses, the Infantry Officers Basic Course, the Armed Forces Staff College and the Army War College.

In addition to platoon and company command experience, COL Eure's assignments have included test officer, Dugway Proving Ground, UT, personnel staff officer, ODCSPER, HQDA, and commander, Holston Army Ammunition Plant, Kingsport, TN. COL Eure holds the Legion of Merit, Bronze Star, Meritorious Service Medal, and the Expert Infantryman's Badge.

Weckel Heads CSL Physical Protection Division

COL Edward C. Weckel

COL Edward C. Weckel has been named chief of the U.S. Army Armament R&D Command's Chemical Systems Laboratory's (CSL) Physical Protection Division in the Edgewood area of Aberdeen Proving Ground, MD.

COL Weckel was assigned to CSL following a year's tour at the National War College, Fort McNair, Washington, DC. A 1958 graduate of West Point, he holds a BS degree in physics from the Naval Post Graduate School and an MS degree in financial management from George Washington University.

A European tour took him in 1973 to the Operations Division, J-3 Directorate, U.S. European Command in Stuttgart, Germany. A year later, he assumed command of Combat Equipment Battalion East. He returned to Washington, DC, in 1976, where he was assigned as chief of the Planning, Programing, and Budgeting Team in the Office of the Deputy Chief of Staff for Operations and Plans.

COL Weckel's decorations include the Bronze Star, the Meritorious Service Medal with three Oak Leaf Clusters, the Joint Service Commendation Medal and the Senior Parachutist Badge.

Circeo Directs Construction Research Lab

COL Louis J. Circeo Jr. is the new director of the U.S. Army Corps of Engineers' Construction Engineering Research Laboratory, Champaign, IL. He was formerly a staff officer in the Nuclear Plans Section at the Supreme Headquarters of Allied Powers Europe, Belgium.

A 1957 graduate of the U.S. Military Academy at West Point, COL Circeo received a master's degree in soils engineering at Iowa State University. He has a doctorate in civil engineering from the same university. He is also a graduate of the Armed Forces Staff College.

His previous assignments have included commander, 20th Engineer Battalion (Combat), Fort Campbell, KY; community affairs officer, 101st Airborne Division, Fort Campbell, KY; research and development officer, Defense Nuclear Agency, Arlington, VA; and R&D officer, Defense Atomic Support Agency, Washington, DC.

COL Circeo has been awarded the Bronze Star Medal, Legion of Merit, Meritorious Service Medal, and three Army Commendation Medals. He is also a registered professional engineer in the District of Columbia.

WWII Plutonium Container Never Saw Service

After spending more than 33 years resting in a ditch providing shade for desert wildlife, Jumbo has moved into the limelight. No, Jumbo is not an elephant.

Jumbo is a huge steel jug or bottle built during the latter days of World War II to preserve plutonium in case the first atomic bomb fizzled at Trinity Site. The 16 July 1945 test proved successful without Jumbo.

Jumbo was actually a 200-ton jug designed to contain the initial TNT blast that was to set off the chain reaction for the first nuclear blast. If the chain reaction failed, Jumbo would hold the plutonium so it could be used again in another test.

Nuclear materiel was scarce in 1945. In fact the U.S. only had enough to build three bombs, history books now reveal. One bomb was tested at Trinity Site on White Sands (NM) Missile Range and the other two were dropped on Japan.

Jumbo, now resting at the main entrance to Trinity Site, was constructed in Ohio and shipped to WSMR by rail. It was hung in a tower, but never used. A week before the test, scientists decided not to put the bomb in Jumbo. They had gained more confidence in their design, plus they worried about the effect Jumbo would have on measuring the strength of the blast.

Jumbo came through the Trinity test unscathed. Later a munitions test managed to blow the ends open, which turned Jumbo into a simple cylinder with eight inch walls.

Recently, with a bulldozer and lowboy trailer, workers from the WSMR's Facility Engineering Directorate moved Jumbo from a ditch where it had rested for more than 30 years. Range officials wanted to make Jumbo more accessible for guests during the annual trek to Trinity each October. This year the tour will be conducted 6 Oct.

Moving the giant wreck wasn't easy, range engineers said. A ramp was dug under Jumbo. Then a bulldozer pushed the jug onto the lowboy. A similar ramp was dug at the new resting spot and Jumbo was rolled off the truck by bulldozer.

JUMBO can now be found at the front entrance to its originally intended home—Trinity Site, White Sands Missile Range, NM.

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DARCOM Copes With Congressionally Mandated Grade Controls

By Charles B. Einstein

This article by Mr. Einstein is a logical follow-up to his DARCOM Baseline Study article (Army RDA Magazine, *January-February 1979), as it discusses an associated personnel problem. The same Study Group was called upon to perform an analysis of the Congressionally mandated reduction in the number of high grades. This article discusses that analysis.*

In a seemingly unending series of personnel constraints imposed upon the U.S. Army Materiel Development and Readiness Command, DARCOM faces yet another. Having been in a state of reduction and reorganization for years, the most recent situation stems from a Congressionally directed civilian high grade reduction program caused by the enactment of Public Law 95-79, the Defense Appropriation Authorization Act, 1978. The Congress, reacting to a widespread belief that civilian grade escalation is out of hand within the government, passed PL 95-79 to arrest escalation and save taxpayer money.

Provisions of the Act have the following implications:

- A requirement to reduce general officer and civilian high grade (GS-13 and above) employes by approximately 6% during the period FY 1978-80.
- The civilian ceiling was based upon the on-board strength, as opposed to authorized strength, as of 30 July 1977; the date of enactment of the law.

To assure that the Military Departments would make proportionate reductions in all high grades, the Office of the Secretary of Defense (OSD) directed that *two* ceilings, not *one* as stipulated by the law, would be imposed. Therefore, a ceiling was established for GS-13s, and a second for GS-14s and above. The objective was to avoid a disproportionate reduction of high grades.

Headquarters, DARCOM, realized that 332 people would be directly affected by this action. Consequently, DARCOM determined the personnel and management impacts of ceilings established by OSD and the Department of the Army (DA). As in the recently completed DARCOM Manpower Baseline Study, the Baseline Task Group was called upon and performed the analysis. This group was augmented by Mr. Joseph Meick, chief, Position and Pay Management, Directorate of Personnel, Training and Force Development.

The study revealed some interesting facts.

- Over the past ten years, DARCOM has been operating under tight grade controls in the form of a combination of average grade and high grade ceilings plus significant organizational realignments. DARCOM's track record in preventing grade escalation is good inasmuch as high and low grade reductions have been relatively balanced.
- DARCOM was assigned ceilings by DA, implementing guidance from OSD. The objective was to lower the number of high grade positions—GS-13 and above. DARCOM complied by reducing high grade positions—GS-13 and above—by 567 during the period 31 July 1977-30 Sept. 1978—11,115 to 10,548.
- The civilian high grade population has declined more than 18% in ten years and continues to decline at a time when workloads are rising sharply, as evidenced by the large number of new weapon systems being readied for fielding.
- DARCOM's most productive years (1970-1972) came at a time when its supervisor-to-worker ratio was the lowest. Because high grade civilians usually are supervisors, PL 95-79 strikes at the heart of productivity by increasing the span of control.
- Because of continued reductions in DARCOM high grades, this command's ability to attract, employ, train and retain young, technically qualified people has been seriously impaired. As a result, the workforce grows older (seniority is not bad—its just that an aging workforce requires employment of younger people to maintain a proper age balance). Young professionals, including interns, leave DARCOM because potentially there is little opportunity at the top. This command could also lose required specialized expertise due to grade reductions of employes engaged in research work (where additional GS grade credit is given for individual's total qualifications, scientific contribution, or recognition and professional standing).
- The ultimate impact of the high grade reduction requirement on DARCOM cannot be determined precisely until the full ramifications of the recently enacted Civil Service Reform Act (CSRA) have been identified. This law has the potential of being incompatible with PL 95-79 inasmuch as the Public Law directs reduction of high grade positions, and CSRA provides grade retention for incumbents whose positions are downgraded through no fault of their own. However, there would be no conflict in the two laws if the reductions were made only through attrition.

DARCOM continues to be concerned about its ability to execute its RDA and readiness missions. Difficulties are being compounded by the introduction of new weapon systems, such as the Patriot, new mechanized fighting vehicles (XM1, IFV, CFV), new family of helicopters (UH-60, AAH-64), large scale introduction of tactical digital computers and associated software, intelligence materiel, and advanced artillery munitions. Hence, attendant workloads which cut across the entire functional spectrum require much experience, technical judgment and top level management. Cuts in these areas cannot be beneficial to this command.

A manifestation of DARCOM's mission increase is evidenced by the increase in RDT&E and Procurement Appropriation (PA) funds since Fiscal Year 1975. RDT&E constant dollars projected to FY 1980 (the year DARCOM's civilian reduction program is to be completed) will rise by more than two hundred fifty million dollars, and PA by more than one billion eight hundred million dollars. High grade reductions are counterproductive to the effective management of these critical funds.

The most revealing aspect of the study was brought out by the cost/savings analysis. This portion identified costs to be incurred as a composite of resources required to process personnel actions, retire, recruit, train or relocate affected people. Savings were computed by estimating differences in salary and government contribution to benefits between the old grades and the new grades. These savings were insignificant because of grade and pay retention provisions of the Civil Service Reform Act. The break even point would be reached 8.3 years from the date of the reductions. But, as history teaches us, the break even point may never be reached because of subsequent reorganizational changes which may be required in the supervisory structure and the impact on the cost of effective management.

The study concluded:

- High grade ceilings would compound the effects of DARCOM's continued organizational instability.
- The dual ceiling would magnify the impact on DARCOM.
- Reductions are unrealistic in light of DARCOM's increasing workloads.
- High grade reductions have been balanced over time through proper position management.
- High grade cuts would result in few, if any, savings.

The Acting Assistant Secretry of Defense for Manpower was provided a comprehensive briefing by DARCOM, the Acting Director of Civilian Personnel, and the Assistant Deputy Chief of Staff for Personnel on 20 Dec. 1978. Two days later OSD lifted the dual ceiling requirement for Fiscal Years 1978 and 1979. The questions of further reductions and considerations of the dual ceilings for FY 1980 are unresolved.

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