

### The RAPID AIRBORNE MINE CLEARANCE SYSTEM (RAMICS) Approach to Entering Flight Test

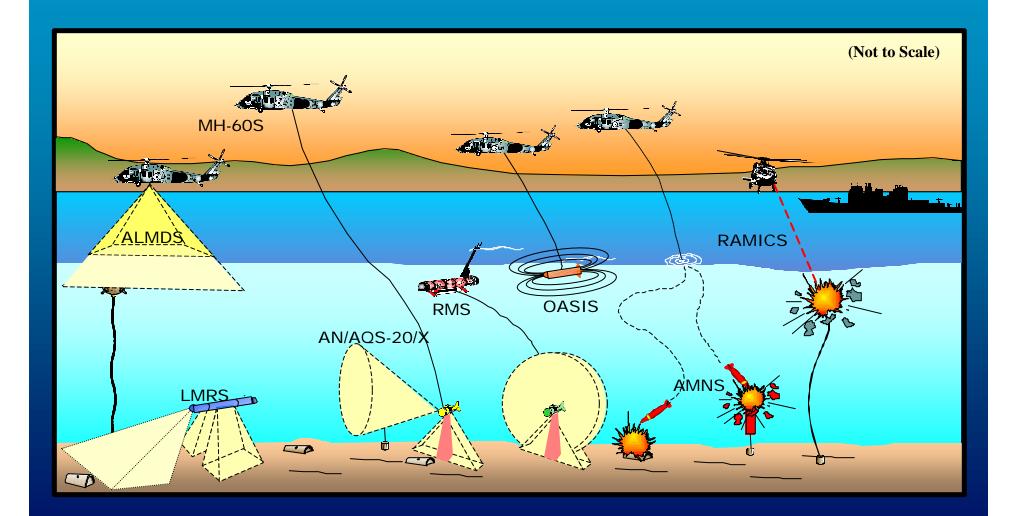
Presented by Mr. Alan K. Jenkins to the 2003 Gun, Ammunition, and Missiles Symposiums & Exhibition 24-28 March 2003

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# TOPICS

- Overview of RAMICS program
- Outline acquisition challenges
- Approach taken
- Lessons learned

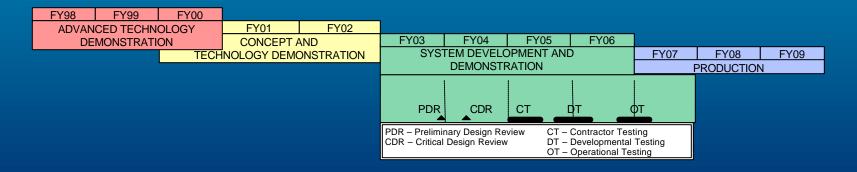
### THE ORGANIC MCM CONCEPT





### **SD&D** TASKING

 Accelerated development program to seamlessly insert RAMICS capability into ongoing OAMCM initiative



### **ACQUISITION CHALLENGES**

- Munition requirements
- Gun subsystem requirements
- System design
- Flight qualification
  - Subsequent DT/OT efforts



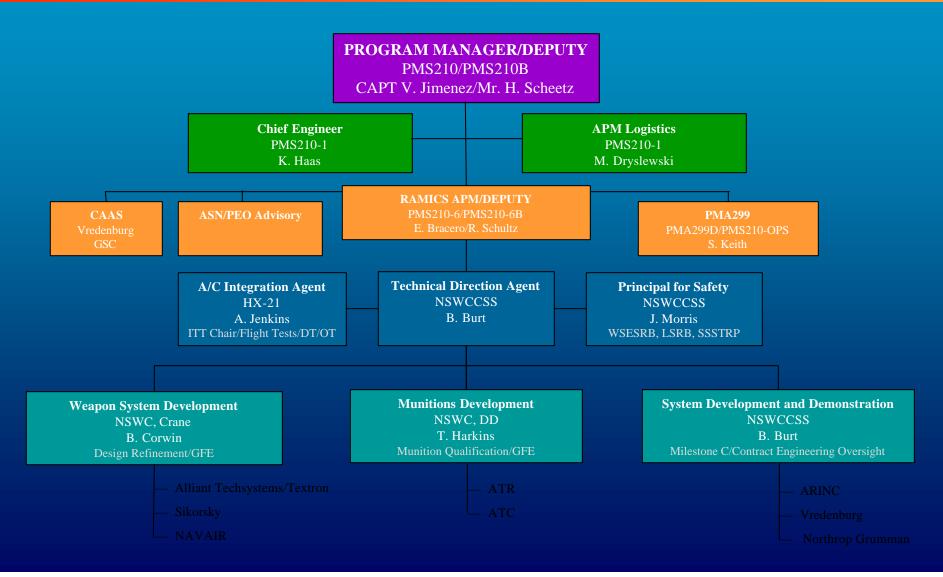
Breadth across components

Experts used for each aspect

Depth within IPT

"Borderless" team

### **RAMICS NEEGRATED PRODUCT** TEAM (IPT)



### APPROACH TAKEN

- Parallel Efforts to Keep Risk Low and Minimize Development Schedule
  - Gov't Develop Gun/Munition
    - Begin qualification efforts
    - Collect firing data in flight to support targeting system development and cut risk
  - Contractor Develop Targeting
    - To include integration of entire weapon system

### **GUN/MUNITION SUBYSTEMS**

- Munition drives gun
- Gun drives munition
- Trade study initiated on munition
  - ATD Program used 20mm
  - Munitions experiments results
  - AoA Results

## TRADE STUDY RESULTS

Parameter	Weight Factor	25mm	30mm
Effective	Critical	G1	LB
(sink/deflagrate)		R <sup>2</sup>	
Integratable	Extremely Important	G	G
Executable	Considerably Important	G	G
Operationally Available	Considerably Important	G	G
Safe	Considerably Important	G	G
Supportable	Considerably Important	G	LB

neutralization depth. If sinking is an acceptable neutralization method, then it minimally meets the performance requirement. <sup>2</sup>25mm cannot deflagrate a mine at the threshold neutralization depth. If a mine must deflagrate in order to be considered neutralized, then the 25mm does not meet the minimum performance requirement.

NOTES:

<sup>1</sup>25mm can sink a mine at the threshold



25mm Weight-Score = 152 30mm Weight-Score = 168 Difference = 10.3%

A difference in weight-scores of at least 10% indicates that there is a meaningful distinction between candidates, according to the DSMC SE Management Guide.

# RAMICS SYSTEM COMPONENTS



Targeting Sensor Subsystem (TBD) (ATD version shown)



Fire Control Subsystem (TBD) (ATD version shown)



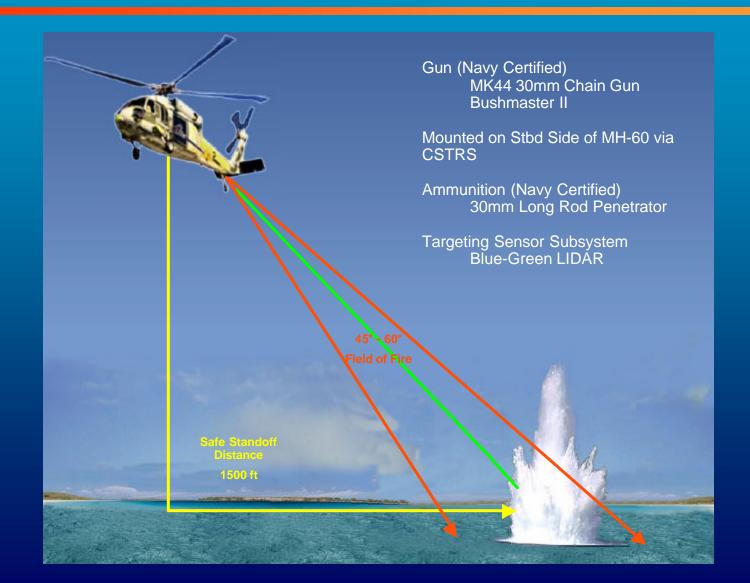






<u>Gun Subsystem</u> – Modified MK44 30mm Bushmaster II Cannon

# RAMICS SYSTEM DESCRIPTION



### CTD PHASE EXIT CRITERIA



DEPARTMENT OF THE NAVY OFFICE OF THE ASSISTANT SECRETARY RESEARCH, DEVELOPMENT AND ACQUISITION 1000 NAVY PENTAGON WASHINGTON, DC 20350-1000

PMSZIO

MAR 1 5 2001

MEMORANDUM FOR THE PROGRAM EXECUTIVE OFFICER (MINE AND UNDERSEA WARFARE)

Subj: ACQUISITION DECISION MEMORANDUM FOR THE RAPID AIRBORNE MINE CLEARANCE SYSTEM (RAMICS)

At the Program Review held on February 26, 2001, I reviewed the RAMICS program status and the Analysis of Alternatives Summary with recommendations. Additionally, I reviewed the ongoing Concept and Technology Development (CTD) efforts and proposed exit criteria.

The RAMICS program is approved to proceed to Milestone B as briefed. The CTD phase exit criteria are as follows:

- Receive Safe Standoff certification from NAVAIR (Code 4.1).
- Determine projectile mine neutralization capability beyond 40 foot depth.
- Develop a reduced-recoil gun/turret design that is acceptable for MH-60S integration (airframe fatigue and deformation, dynamic component wear, cost) and document PMA-299/PMS-210 concurrence.

A. Schneider

Paul A. Schneider Assistant Secretary of the Navy (RD&A)(Acting)

ASN RDA Acquisition Decision Memorandum 15 Mar 01 established the following C&TD Phase Exit Criteria :

**1. Receive Safe Standoff certification from NAVAIR (Code 4.1).** 

2. Determine projectile mine neutralization capability beyond 40ft depth.

3. Develop a reduced-recoil gun/turret design that is acceptable for MH-60S integration (based upon airframe fatigue and deformation, dynamic component wear, cost, crash load constraints and other issues as required) and document PMA299/PMS210 concurrence.

#### **Test and Evaluation**

Exit criteria completed by testing:

- Safe standoff completed Jul 02
- Projectile lethality completed Oct 01
- Reduced recoil conducted Apr 02

### **CRITERIA #1: SAFE STANDOFF**



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MEMORANDEN

From Alit-4.1 PMA-298

Sub: RAMICS SAFE STANDOFF DISTANCES

Ref. (a) Appaisition Decision Memorandum for RAMICS, 15 March 2001 (b) Rapid Airburto Mine Cloatence System Data Parkoge for CTD Plase Exit Orienta #1 Safa Standoff, Jamary 2002 (c) AIR-411.2 RAMICS Arena Tena Safe Escape Reads, draft

(d) AN/AWS-I Rapid Airbarne Mine Clearance System (RAMICS) Safe Steedoff Distances Certification, Alik-4.18 memorandum, 16 April 2012

1. The AN/AWS-I RAMICS consists of a MK44 Bashmuster II 30mm gan and tamor subsystem, a lidar targeting/orchassification subsystem, and an operator console integrated into the MH-606 helicopter weapon system. RAMICS is currently in the Concept and Technology Demonstration Phase (phase prior to Milestone B) and is required by reference (a) to "receiv Safe Standoff ortification from Commander Naval Air Systems Command (COMPAVAJRSVSCOM) (Code 4.17). Personnel from Allb4.1.8 and Alb. 4.1.10 ware assigned to review enforces(rb) and (c) which document related work during: the RAMICS Advanced Technology Demonstration phase conducted at Patazent River, Aberdeen Proving Ground, and the Gulf Test Range neur Panama City. Herida: the three arens tests in Socerce New Mexicox and manifion performance testing in West Freugh, Scotland. Additional data concerning items such as underwater performance profictions and relevance of targats used the anticipated threats is also contained in reference (b).

1. Personnel from AIR-41.8 and AIR-41.10 have reviewed references (b) and (c). Based on these references and the analysis documented in reference (d), the recommended safe anadoff distances are:

1900 feet for shallow mines 700 feet for deep mines

The safe standoff distance is defined as the horizontal distance measured radially from the center of the mise. The depth is defined as the mean depth from the surface to the top of the mine. casing. Training with inort minovirsing shapes can be conducted at the distances noted above or at shorter distances.

Subj: RAMICS SAFE STONDOFF DISTANCES

3. The RAMICS IPT has been extremely conservative in their analysis regarding hazards to the electraft and alectrow. While the current data contained in references (b) and (c) can only support the aforementioned distances, additional data would most likely support reduction in these ranges. When additional data and analysis becomes available to rapport a change in the safe standoff distances, AlR-4.1.8 and AIR-4.3.10 will make reconstrondutions as to the updated distances.

AIR-4.1.8 AID-41 10 • Completed - NAVAIR 4.1 certification signed on 7 May 02 • Results : SSO Distances:

Shallow mines	<b>1500</b> °
Deep mines	700'





### NEUTRALIZATION CAPABILITY BEYOND 40 FT DEPTH



DEPARTMENT OF THE NAVY EDANTAL BYSTEMS STATION COALDREN DIVISION NAVAL, SUBTATE WARRARE CENTER 8703 WEST HIGHWAY 90 PANAMA CITY E. 38697-7001

3900 Ser A21/007 12 MAR 2002

- Prom: Commanding Officer, Coastal Systems Station To: Program Executive Officer, Mine and Undersea Warfare (DMB210)
- Subj: PROJECTILE MINE NEUTRALIZATION CAPABILITY BEYOND 40 FOOT FOR THE AN/ANG-1 RAFID AIRBORNE MINE CLEARANCE SYSTEM (RAMICS)
- Encl: (1) COASTSYSTA doc Data Package for CTD Phase Exit Criteria 42 Beutralization Capability Beyond 40-Poot Depth of Mar 02
  - (2) COASTSYSTA CD Data Package for CTD Phase Exit Criteria #2 Neutralization Capability Reyond 40-Foot Depth of Mar 02

 The Acquisition Decision Memorandum for the RAMICS, of 15 March 2001, astablished three exit criteria for the Concept and Tachnology Demonstration (CTD) phase. One exit criteria states, "Detarmine projectile mine neutralisation capability beyond 40 foot depth." In order to fully comply with this exit criteria the RAMICS Program conducted a series of tasts and analyses, documented in enclosure (1).

2. DoD 5000.2-R, June 2001, Paragraph AP3.2.6 defines Lethality as "the ability of a munition or directed energy waspon to gauge damage that will cause the loss or a degradation in the ability of a target system to complete its designated mission(s)." Consistent with that definition, RAMICS projectile Mine Neutralization capability is defined as "s detonation/deflagration of the explosive to achieve observable kill and sinking due to holing of the mine buoyancy chamber." Based on test data and analysis, the following conclusions are made with respect to the neutralization capability of the RAMICS projectile:

(a) Neutralization of the mine due to <u>deflagration</u> can be achieved down to depths of 40 feet.

(b) Neutralization of the mine due to <u>rapid sinking</u> in less than four minutes can be achieved down to depths of 150 feet.

(c) Neutralization of the mine due to a <u>slow sinking</u> of the mine can be achieved down to depths of 200 feet.

 System neutralization capability will be based on the projectile's capability, targeting, and fire control solution.

Subj: PROJECTILE MINE NEUTRALIZATION CAPABILITY BEYOND 40 FOOT FOR THE AN/AMS-1 RAPID AIRBORNE MINE CLEARANCE SYSTEM (RAMICS)

System capability will be greatly dependent upon the environmental, conditions and should not be considered as typical for the entire RMMCG system.

 The Coastal Systems Station point of contact for the RANICS program is Mr. Bruce Dzadek (A21), commercial (050) 235-5380, DISN 436-5380, PAX (050) 230-7070, cmail: DzadekBr@ncec.mavy.mil

2xt

J. D. HORTON By direction

**Completed - Documented in CSS ltr** ightarrowdated 12 Mar 2002

<u>Results</u>

- 0 40ft Deflagration
- 40 150ft Rapid sinking (less than 4 min.)
- 150 200ft Slow sinking



# GUN/TURRET DESIGN

PMA 299/PMS 210 MEMORANDUM OF CONCURRENCE RAMICS REDUCED-RECOIL GUN/TURRET DESIGN CONCEPT AND TECHNOLOGY DEMONSTRATION PHASE EXIT CRITERIA

 Purpose: The purpose of this Memorandum of Concurrence (MOC) is to document PMA-299 and PMS-210 concurrence on the Rapid Airborne Mine Clearance System Exit Criteria #3.

2. Background: The Acquisition Decision Memorandum for the Rapid Airborne Mine Clearance System (RAMICS), dated 15 March 2001, establishes three Exit Criteria for the Concept and Technology Demonstration (CTD) phase. Exit Criteria #3 states, "Develop a reduced-recoil gun/turret design that is acceptable for MH-60S integration (airframe fatigue and deformation, dynamic component wear, cost) and documented PMA-299/PMS-210 concurrence".

3. During the CTD phase, a reduced recoil gun subsystem design has been completed that reduced gun recoil from 10,000 lbs to under 4,000 lbs. Based on the current test data at this phase of the RAMICS program, PMA-299, and PMS-210 concur that the reduced recoil design for the gun/turret sub-system is acceptable for MH-60S integration. Additional analysis and testing is required to determine other impacts on the aircraft in the DT-IIA configuration (flying qualities/handling, engines, electronic components, dynamic components, system safety, and human factors, as well as follow-on fatigue and crash load analysis) as part of the integration effort.

NA May 02

CDR W. J. Fulton (Date) PMA-299 MH-60S IPT Lead

K. W. Haas ( PMS-210 IPT Lead

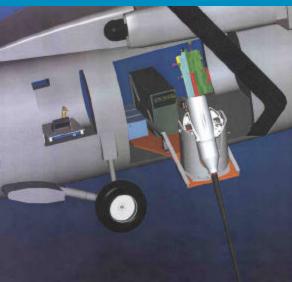
Completed – PMS-210/PMA-299 concurrence signed on 9 May 02 <u>Results</u>

Achieved recoil reduction below 4000lbs for armor piercing and Target Practice rounds



# GUN SUBSYSTEM EVOLUTION

From Concept...



...to Modeling...



...to Mockup...





### FIT CHECKS



RAMICS gun subsystem prototype installed on an MH-60S helicopter. Note the final design has the gun installed on the starboard side of the aircraft.

### -RAMIOS SD&DESIGN CONCEPT

Gun Camera, Boresight Laser Assy. Cradle Assembly –

Standard Mk 44

Gun Turret Assembly / Gun Power Supply LH CSTRS (ALMDS COMMON) / Sensor Pod

Gun Control Unit Turret Control Unit Ammunition Can

### FLIGHT CRITERIA

- Crash Loading
- Structural Fatigue
- Dynamic Effects
- Recoil Effects
- Muzzle Flash
- Case/Link Disposal
- Ammunition Feed

- Electrical Power Requirements
- Exhaust Gas Toxicity
- Mock-Up
- Ground Clearance
- Resonant Freq.
- Software Cert.

### Initial Flight Tests - November 2003

### LESSONS LEARNED

- The right team
- Environment of autonomy and empowerment
- Embrace acquisition reform
- Document everything
- Parallel risk-reduction testing
- Focus on exit criteria