



Tech. NADC
1984

NAVAIRDEVCON FY-84 PROGRAM ACCOMPLISHMENTS FOR ARMING SYSTEM DEVELOPMENT PROGRAM

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1 OCTOBER 1984

PHASE REPORT

DTIC QUALITY INSPECTED 8

Approved for Public Release; Distribution Unlimited

Prepared for
NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, DC 20361

880016

19970612 112

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS N/A	
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for Public Release; Distribution Unlimited	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NADC-84138-60		5. MONITORING ORGANIZATION REPORT NUMBER(S) N/A	
6a. NAME OF PERFORMING ORGANIZATION Naval Air Development Center	6b. OFFICE SYMBOL (if applicable) N/A	7a. NAME OF MONITORING ORGANIZATION N/A	
6c. ADDRESS (City, State, and ZIP Code) Aircraft and Crew Systems Technology Directorate Warminster, PA 18974		7b. ADDRESS (City, State, and ZIP Code) N/A	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Naval Air System Command	8b. OFFICE SYMBOL (if applicable) N/A	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N/A	
8c. ADDRESS (City, State, and ZIP Code) Department of the Navy Washington, DC 20361		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO.	PROJECT NO.
		TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) NAVAIRDEVGEN FY-84 PROGRAM ACCOMPLISHMENTS FOR ARMING SYSTEM DEVELOPMENT PROGRAM			
12. PERSONAL AUTHOR(S) Cheri Wallace, Kenneth J. Melvin, William D. Meiklejohn			
13a. TYPE OF REPORT PHASE	13b. TIME COVERED FROM TO	14. DATE OF REPORT (Year, Month, Day) 1 October 1984	15. PAGE COUNT 39
16. SUPPLEMENTARY NOTATION N/A			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) STOWPACK, NFSC - Nose Fuze Shock Cord	
FIELD	GROUP SUB-GROUP		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Arming System Development for Composite Aircraft.			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION	
22a. NAME OF RESPONSIBLE INDIVIDUAL Cheri Wallace, Kenneth J. Melvin, William D. Meiklejohn		22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL (AIR541, AIR510)

1-7-8

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INTRODUCTION

The F/A-18 aircraft is constructed with composite materials, which have been damaged by arming systems components during store release. Aircraft damage has occurred mainly on wing and tail sections due to flailing arming wires and arming clip impacts. Indirect arming systems are being utilized to help eliminate this type of damage, but some are not as reliable as needed.

This report describes three FY-84 efforts to solve arming system problems for the F/A-18 aircraft: SNAKEYE FIN ARMING SYSTEMS, NOSE FUZE ARMING SYSTEM, and INTEGRAL LINK ARMING UNIT.*

SNAKEYE FIN ARMING SYSTEM

Presently, the indirect store arming wire rigging system (Figure 1) is being utilized for the Mk 15 SNAKEYE Fin. This is an undesirable system, because it has unacceptable reliability, no pilot option, and causes damage to the bomb rack.

The NAVAIRDEVCCEN Stowpack is a new design of an integral arming system for the Mk 15 and the BSU-86/B SNAKEYE Fin. Ground testing and preliminary flight testing show that the Stowpack (1) successfully deploys the fin at the required distance of 36 inches, from the aircraft, (2) does not cause damage to the bomb rack or aircraft, and (3) is an integral and retrofittable system for both fins. Ground testing shows 100 percent reliability for pilot option.

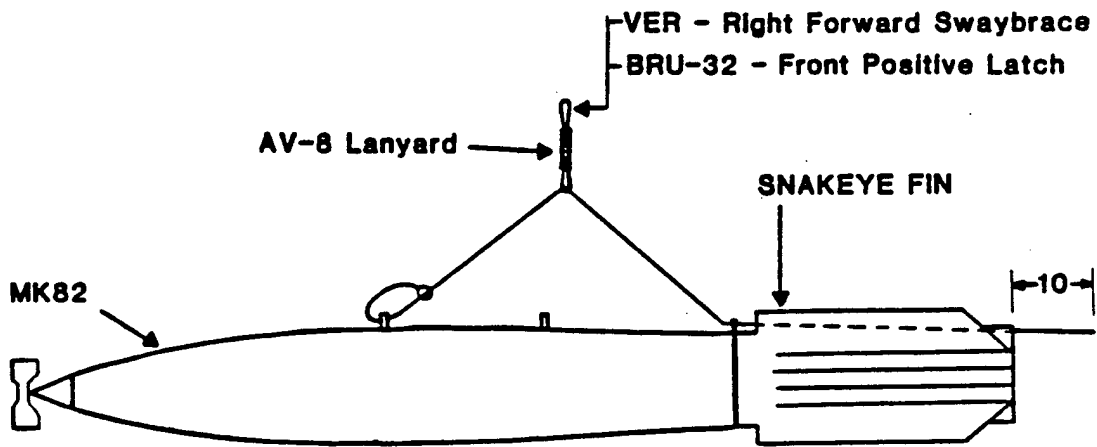
The concept of the NAVAIRDEVCCEN Stowpack originated from the NSWC Stowpack (Figure 2). The NSWC Stowpack was designed by A. G. Fritz of the Naval Surface Weapons Center, White Oak, MD, and is a new lanyard system for delaying the opening of high-drag fins on stores dropped from the bomb bay of such aircraft as the B-52, S-3 and P-3. The NSWC Stowpack has been tested on all three aircraft with no failures. The NAVAIRDEVCCEN Stowpack design utilizes the same concepts, but is modified for exterior stations on such aircraft as the F/A-18, AV-8B, A-6, and A-7.

The components of the NADC Stowpack (Figure 3) are as follows:

1. Kevlar Lanyard. Kevlar cord with a break strength of 1,500 pounds, in accordance with MIL-C-87129. Kevlar must be jacketed for ultraviolet protection.
2. Break Link. MAU-91 breaks at approximately 300 pounds and fits into the arming unit.
3. Dexter Clip. Secures the release latch on the fin band and releases the latch at 35 pounds pulling force.
4. Pouch. Measures 6-3/4" x 1-1/2" x 3/8". Made of nylon webbing type IV 1-1/2" wide, in accordance with MIL-T-5038C.
5. Stitching. The thread used is nonmelting Nomex #00816 Type I Class I, with 10 stitches per inch.

*Sources of funding for this FY-84 effort are as follows:

BSU-86/B	\$ 20K	PMTC	\$ 90K
F/A-18	\$ 50K	NAVAIR	\$ 90K
AV-8B	\$100K		



- Unacceptable Reliability
- No Pilot Option
- Foreign Object Damage (AV-8 Lanyard)

Figure 1. Present F/A-18 Tail Fin Arming System

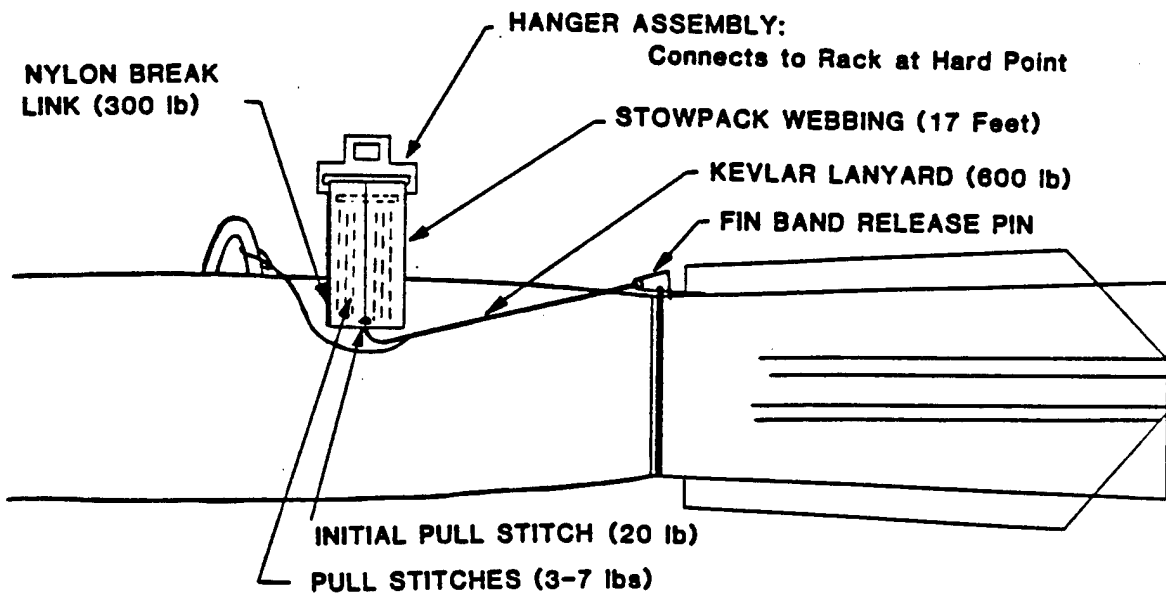


Figure 2. Arming Line Stowpack

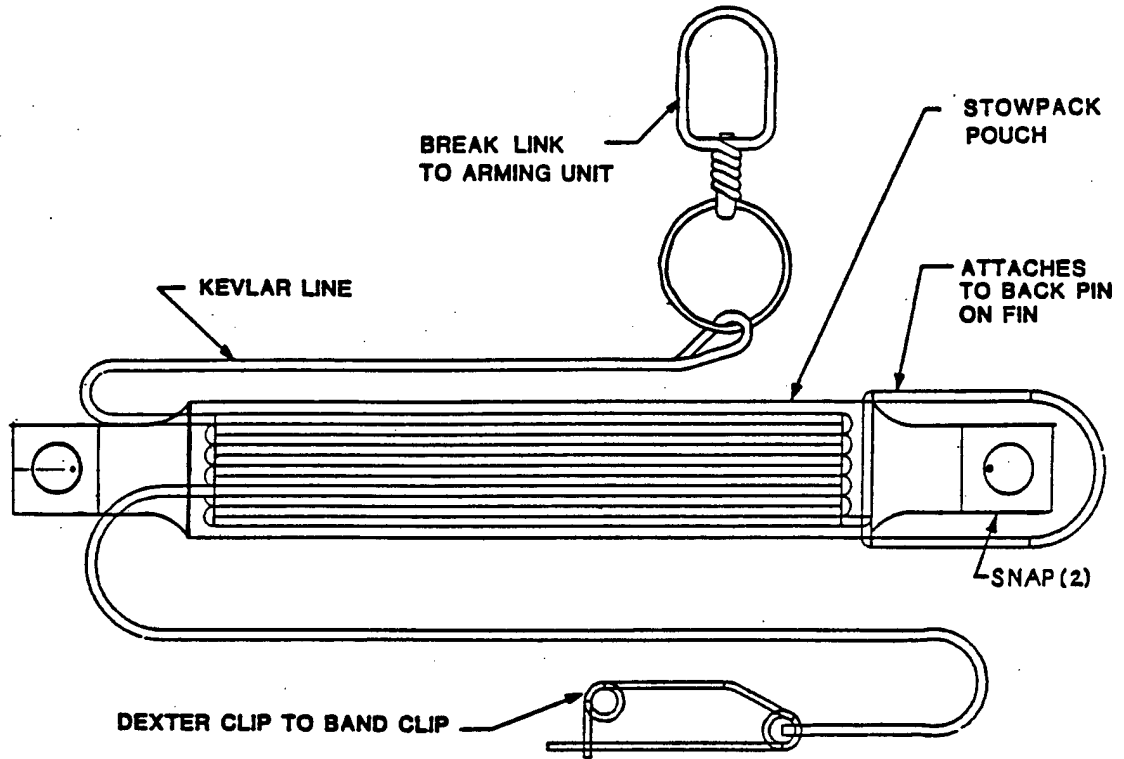


Figure 3. NADC Stowpack

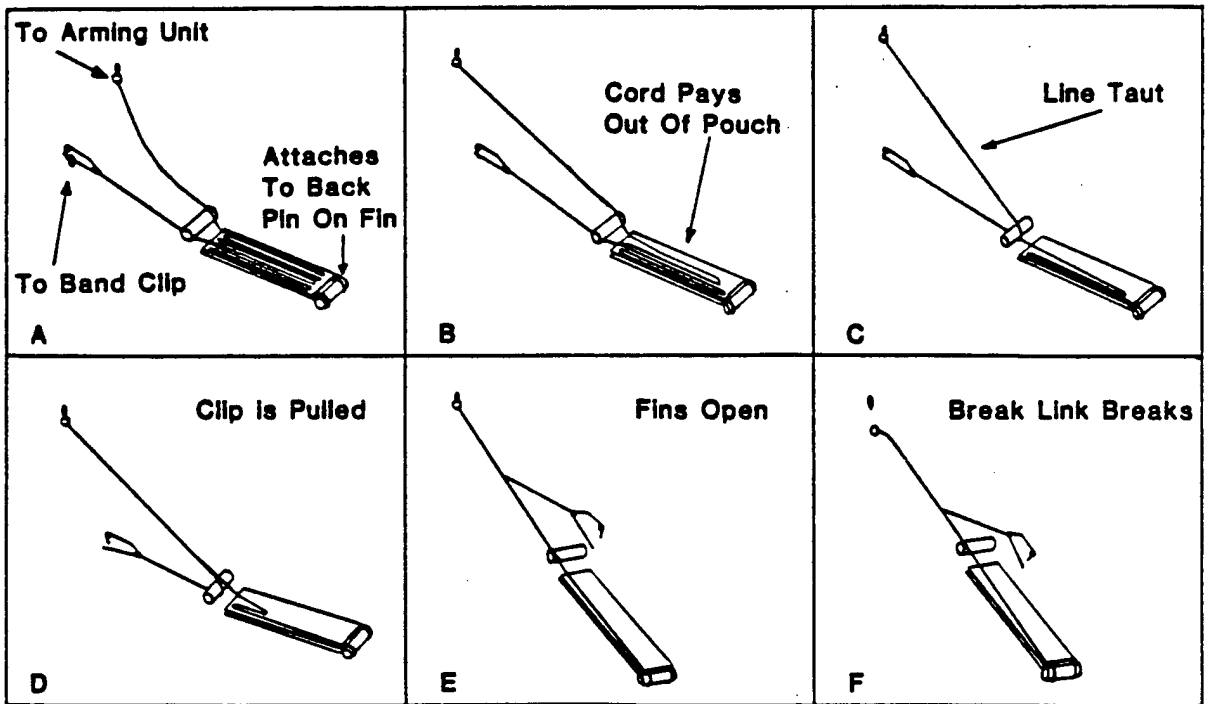


Figure 4. Stowpack High Drag

6. Snaps. Snaps are inserted at both ends to attach Stowpack to fin. One direction pull only ("pull the dot") snaps are used. Part numbers MS27983-1, -2, -3, and MS27980-8B.

For a high-drag fin release, the Stowpack operates in the following manner (Figure 4).

- a. Arming unit energized. Store is ejected.
- b. As store falls cord is paid out of pouch.
- c. At approximately three feet, line becomes taut.
- d. Clip is pulled. Fins open.
- e. Retaining line (end is attached to aft pin) pays out approximately one foot.
- f. Break link breaks, and pouch, line and clip fall with store.

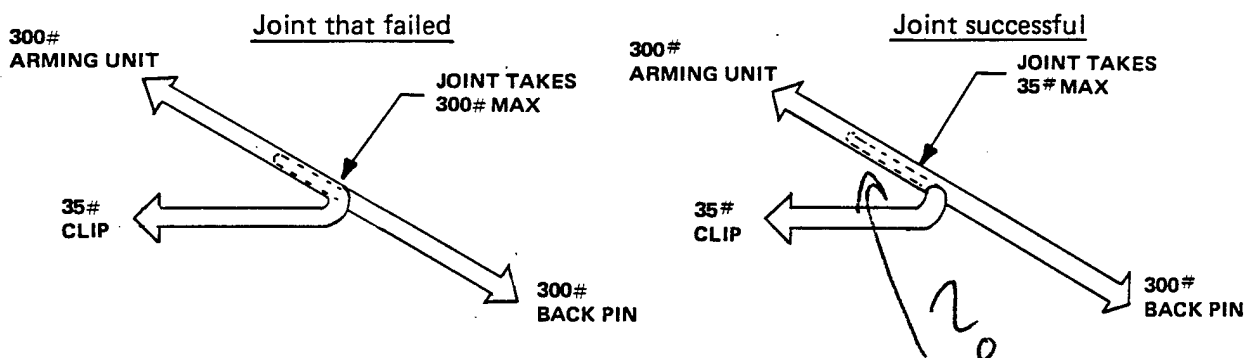
For a low-drag option, the arming unit is de-energized, and a force of 10 to 14 pounds pulls the break link swivel from the arming unit. Swivel, pouch, line and clip fall with store in a low-drag configuration.

The Stowpack has been ground tested and flight tested successfully. The following outlines the testing completed to date.

GROUND TESTING – 7 February 1984

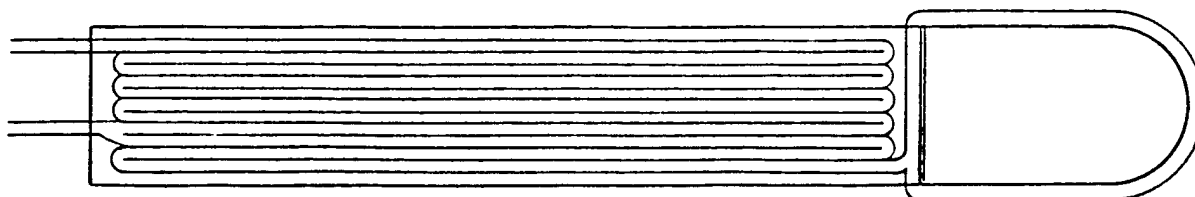
Equipment: VER with 2 CCU-45's, BSU-86/B Fin, 500# Store, each Stowpack of different configuration.

One difference was the force load path on joint:

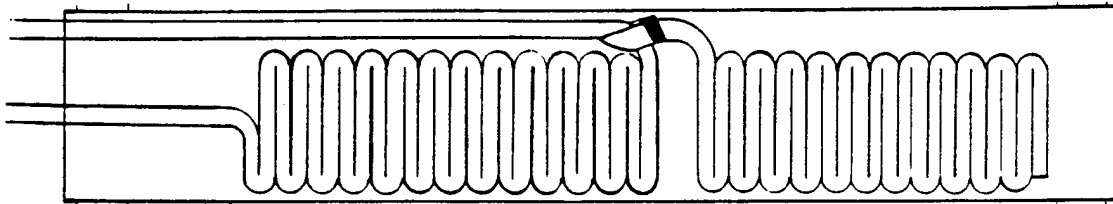


Of the three that were successful, one basic internal difference:

CONFIGURATION A:



CONFIGURATION B:



Testing continued on both configurations. The decision on which configuration to choose will be based on factors such as: pull-out forces, ease of deployment and manufacturing ease.

GROUND TESTING – 16-17 February 1984

Equipment: VER with CCU-45's, BSU-86/B Fin, 500# Store, Ten Configuration A Stowpacks.

Results: 100 percent successful both safe and armed.

Forces shown below:

STOWPACK	SAFE PULLOUT FORCE (lbs.)	ARMED HIGHEST FORCE PRIOR TO BREAK LINK (lbs.)	ARMED BREAK LINK FORCE MAU-91 (lbs.)
25	10	55	180
26	20	50	220
27	10	75	205
28	10	65	210
29	15	75	180
30	15	40	150
31	20	40	150
32	22	50	175
33	16	70	*60
34	12	45	280

*Broke at bottom loop's brazed connection. Also note the inconsistency or Break Link breaking force.

GROUND TESTING – 1-2 March 1984

Equipment: VER with CCU-45's, BSU-86/B Fin, 500# Store, Ten Configuration B Stowpacks.

Results: 100 percent successful both safe and armed.

Forces shown below:

STOWPACK	SAFE PULLOUT FORCE (lbs.)	ARMED HIGHEST FORCE PRIOR TO BREAK LINK (lbs.)	ARMED BREAK LINK FORCE MAU-182 (lbs.)
36	12	70	*240
37	10	120	No Data
38	10	70	120
39	20	110	100
40	20	95	120
41	20	90	100
42	20	80	100
43	20	100	120
44	20	No Data	No Data
45	25	50	125

*MAU-91 Break Link

Conclusions at this point:

- First stitch pull force is lower and more consistent with Configuration A.
- Both have the same ease of deployment.
- Must use MAU-91 Break Link because first stitch pull force is getting close to MAU-182 Break strength.
- Must weld the brazed area on bottom loop of MAU-91.
- Configuration A is easier to manufacture.
- Continue with Configuration A.

A-7 FLIGHT TESTING – 17 May 1984

Equipment: 500# Store, Mk 15 Fin, 2 MERs, 2 BRU-10s, and Ten Stowpacks with pack made of nylon cloth, snap at front pin, and welded MAU-91.

Captive Carriage, in Arming Units, at 550 knots.

Results: 90 percent successful, nylon cloth tore on one pack.

Conclusions: Replace cloth with reinforced nylon webbing.

High Drag Releases, Positively Armed.

Results: Eight went High Drag, and one went Low Drag when slack in line caught on band clip.

Conclusions: Line must be taut from bomb rack to Stowpack.

A-7 FLIGHT TESTING – 30 May 1984

Equipment: 500# Store, Mk 15 Fin, 2 MERs, 2 BRU-10's, and Five Stowpacks with reinforced nylon webbing packs and variable lengths.

Captive Carriage, in Arming Units, at 550 knots.

Results: 100 percent successful.

High Drag Releases, Positively Armed.

Results: 100 percent successful.

F/A-18 FLIGHT TESTING – 6 June 1984

Equipment: 500# Store, Mk 15 Fin, 5 VERs, and Four Stowpacks with variable lengths and waterproof packs.

Captive Carriage, Positively Armed, at 575 knots.

Results: Failure. Variable lengths and waterproof pack tore.

Conclusions: Eliminate present variable length, eliminate waterproof pack, and change configuration at back pin. Stowpack will not be stored on fin, but attached during bomb build up.

F/A-18 FLIGHT TESTING – 1 August 1984

Equipment: 500# Store, Mk 15 Fin, 5 VERs, and Ten Stowpacks with snap at front and back pin, single line to bomb rack.

Captive Carriage, 4 Positively Armed, and 6 in Arming Units.

Results: Positively Armed, five of six successful, one pulled first stitch. In Arming Unit, 0 to 4 successful, all four pulled out of Arming Units.

Conclusions: Reinforce first stitch, and line changed if pilot option required.

F/A-18 FLIGHT TESTING – 15 August 1984

Equipment: 500# Store, Mk 15 Fin, 5 VERs, and Ten Stowpacks with reinforced front stitch.

Captive Carriage, Positively Armed, 650 knots.

Results: 80 percent successful, first stitch pulled on two Stowpacks.

Conclusions: First stitch must be controlled, a hand stitch of 20 pounds will be used.

F/A-18 FLIGHT TESTING – 18 & 21 September 1984

Equipment: 500# Store, Mk 15 Fin, 5 VERs, and Nine Stowpacks with 20 pounds front stitch.

Captive Carriage, Positively Armed.

Results: 100 percent successful.

High Drag Releases, Positively Armed.

Results: 100 percent successful.

Conclusions: Testing, at this point, shows the Stowpack as a successful arming system for the SNAKEYE Fin. High Drag releases on the F/A-18 will continue, until 40 data points are achieved.

PLANS AND MILESTONES

Complete F/A-18 Flight Testing	November 84
Complete Data Package for Stowpack	November 84
Environmental Testing	December 84
1,500 Stowpacks for the F/A-18	December 84
100 Non-Magnetic Stowpacks for Mines utilizing Mk 15 Fin	February 85

NOSE FUZE ARMING SYSTEM

The current Nose Fuze Arming System for the F/A-18 (Figure 5) has a failure rate of 70 percent for safe jettison. System geometry and the dynamic response of the arming units are reasons for failure. Preliminary laboratory testing performed last year showed safe pullout force (static pull force 10-14 pounds) of the arming unit increases as the ejection velocity increased. The chart (Figure 6) shows that with an ejection velocity of 20 fps, that of the F/A-18's BRU-32 and VER, the safe pullout force can reach 100 pounds.

The Nose Fuze Bungee Cord System was a developmental arming system for the F/A-18. A bungee cord was utilized in the system to delay the response of the arming unit and bring the forces down to static. The first iteration of this system was the indirect rigging system shown in Figure 7. A force analysis (Figure 8) of the indirect rigging system showed that the geometry was the cause for failure and that a direct rigging should be utilized.

Continued testing (Figure 7) showed promise with a direct system utilizing a retainer plate. But in June 1984, Captive Carriage on the F/A-18 failed and development changed direction.

Two new systems were to be tested. The Nylon Lanyard System, (Figure 9) which is a direct system, utilizing a retainer plate. It responds to the arming unit as did the bungee, but has a smaller area affected by aerodynamic forces. The High Force Clip System (Figure 10) is a direct

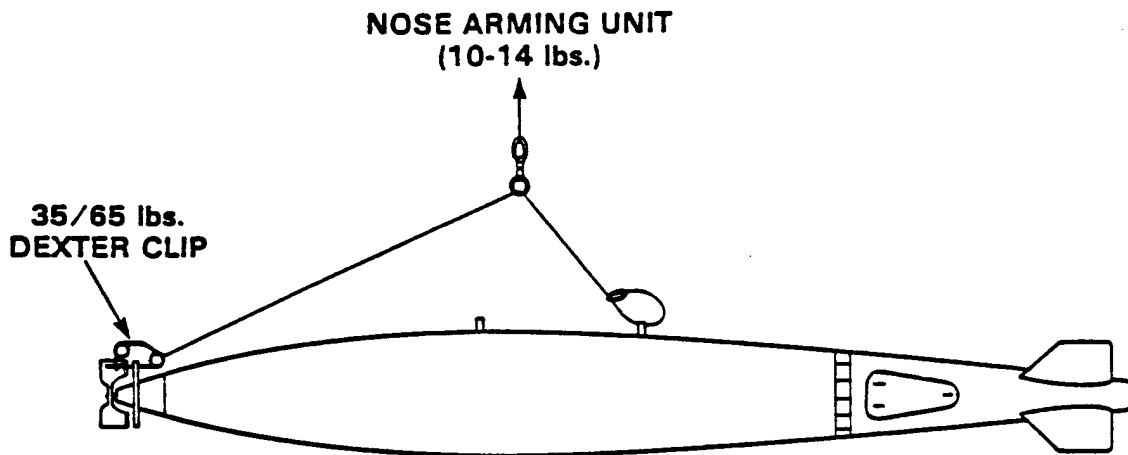


Figure 5. Present F/A-18 Nose Fuze Arming System

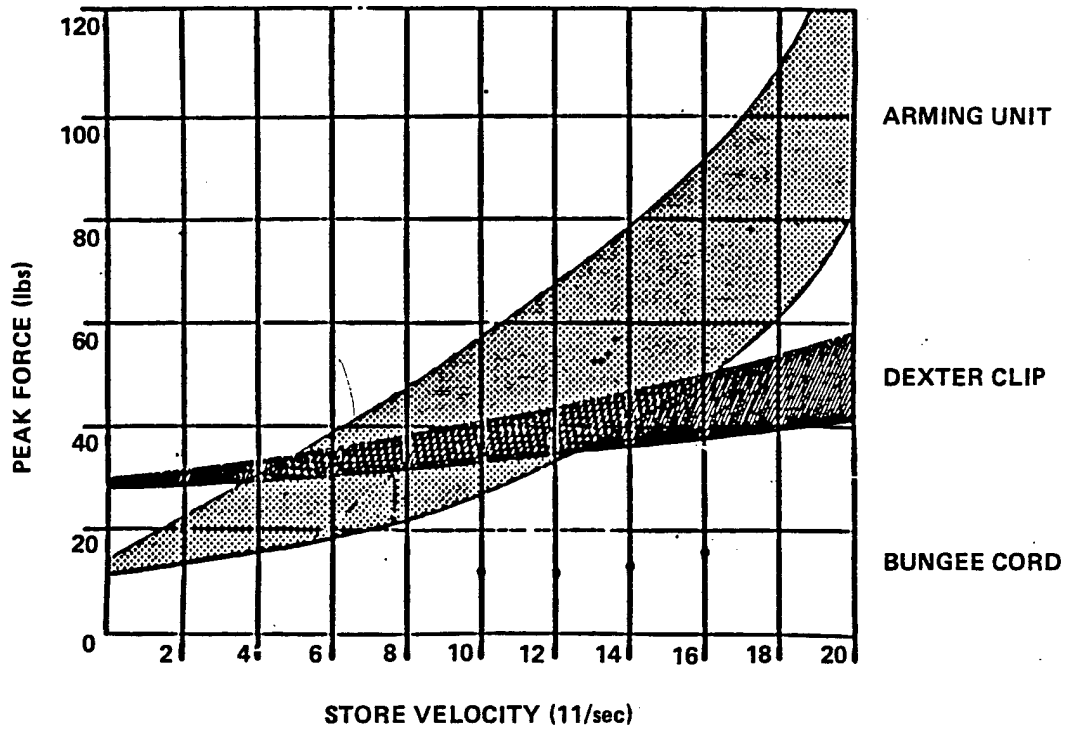
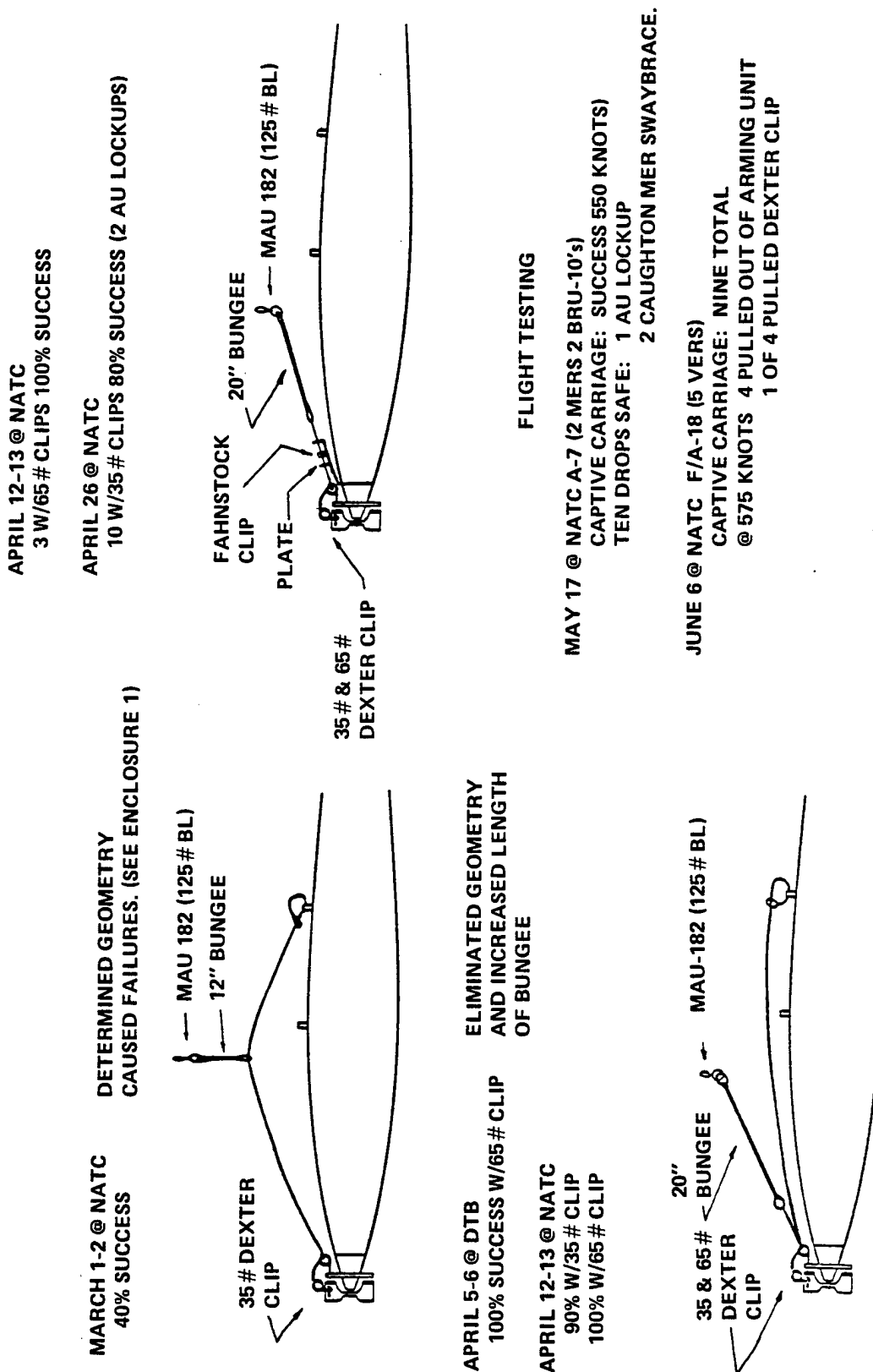


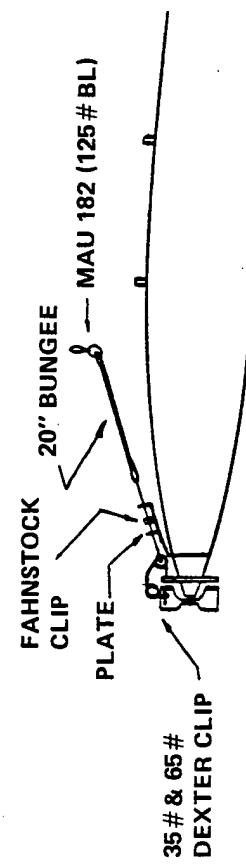
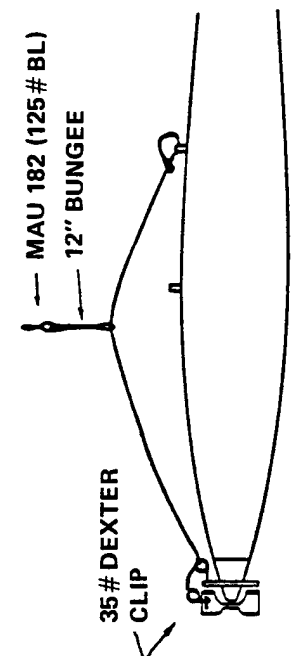
Figure 6. Arming Unit Dynamic Test Results (Vertical Pull)



APRIL 12-13 @ NATC
3 W/65# CLIPS 100% SUCCESS

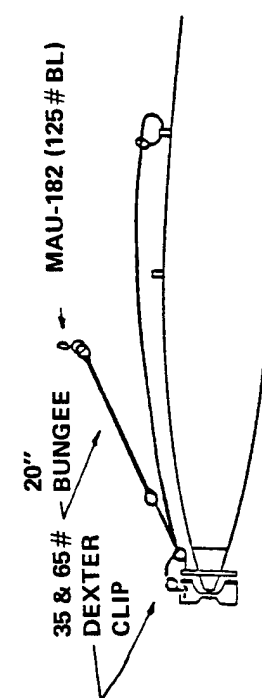
APRIL 26 @ NATC
10 W/35# CLIPS 80% SUCCESS (2 AU LOCKUPS)

MARCH 1-2 @ NATC
40% SUCCESS
DETERMINED GEOMETRY
CAUSED FAILURES. (SEE ENCLOSURE 1)



APRIL 5-6 @ DTB
100% SUCCESS W/65# CLIP
ELIMINATED GEOMETRY
AND INCREASED LENGTH
OF BUNGEE

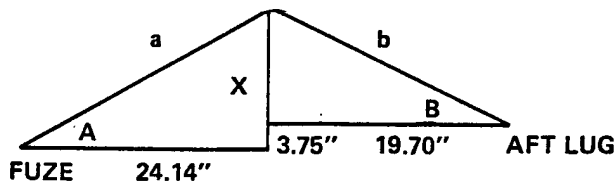
APRIL 12-13 @ NATC
90% W/35# CLIP
100% W/65# CLIP



FLIGHT TESTING
MAY 17 @ NATC A-7 (2 MERS 2 BRU-10's)
CAPTIVE CARRIAGE: SUCCESS 550 KNOTS)
TEN DROPS SAFE: 1 AU LOCKUP
2 CAUGHTON MER SWAYBRACE.

JUNE 6 @ NATC F/A-18 (5 VERS)
CAPTIVE CARRIAGE: NINE TOTAL
@ 575 KNOTS 4 PULLED OUT OF ARMING UNIT
1 OF 4 PULLED DEXTER CLIP

Figure 7. Testing of Nose Fuze Bungee Cord



*SOLVE FOR a and b

$$1) 24.14^2 + X^2 = a^2 \qquad 3) a + b = 48''$$

$$2) 19.70^2 + (X - 3.75)^2 = b^2 \qquad a = 48 - b$$

$$24.14^2 + X^2 = 48^2 - 96b + b^2$$

$$-(19.70^2 + X^2 - 7.5X + 14.06 = b^2)$$

$$24.14^2 - 19.70^2 + 7.5X - 14.06 = 48^2 - 96b$$

$$96b = 2123.41 - 7.5X$$

$$b = 22.12 - 0.078X$$

*PLUG (b into 2)

$$19.70^2 + X - 7.5X + 14.06 = 0.0061 X^2 - 3.46X + 489.29$$

$$0.9939X^2 - 4.04X - 87.14 = 0$$

$$X^2 - 4.065X - 87.67 = 0$$

*SOLVE FOR X

$$X = \frac{4.065 \pm \sqrt{4.065^2 + 4(87.67)}}{2}$$

$$X = 11.61$$
~~$$X = 7.55$$~~

*SOLVE FOR a and b using X = 11.61

$$1) a = \sqrt{X^2 + 24.14^2} \qquad a = 26.79''$$

$$a = \sqrt{11.61^2 + 24.14^2}$$

$$2) b = \sqrt{(X - 3.75)^2 + 19.70^2} \qquad b = 21.21''$$

$$b = \sqrt{7.86^2 + 19.70^2}$$

*SOLVE FOR A and B

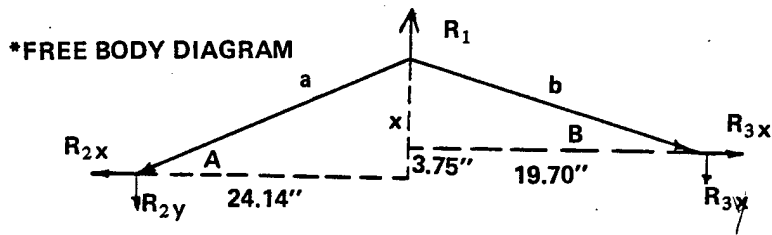
$$4) \sin A = \frac{X}{a} \qquad 5) \sin B = \frac{(X - 3.75)}{b}$$

$$A = \arcsin \frac{11.61}{26.79} \qquad A = 25.68^\circ$$

$$B = \arcsin \frac{7.86}{21.21} \qquad B = 21.75^\circ$$

25° 05' 55"
21° 45' 04"

Figure 8. Force Analysis of Indirect Rigging System



ASSUME $R_1 = 14.00$ lbs.

6) $R_2 \cos A = R_{2x}$

8) $R_3 \cos B = R_{3x}$

7) $R_2 \sin A = R_{2y}$

9) $R_3 \sin B = R_{3y}$

*SUM OF $F_x = 0$

10) $R_{2x} = R_{3x} \implies R_2 \cos A = R_3 \cos B$

$\Sigma F_y =$ 11) $R_1 = R_{2y} + R_{3y} \implies R_1 = R_2 \sin A + R_3 \sin B$

$$R_2 = R_3 \frac{\cos 21.75^\circ}{\cos 25.68^\circ} \quad R_2 = 1.03 R_3$$

$14.00 = 1.03 R_3 \sin 25.68^\circ + R_3 \sin 21.75^\circ$

$R_3 = 17.13$ lbs.

$R_2 = (1.03) (17.13)$
 $R_2 = 17.66$ lbs.

*ASSUME $R_1 = 20.00$ LBS.

11) $20.00 = 1.03 R_3 \sin 25.68^\circ + R_3 \sin 21.75^\circ$

$R_3 = 24.47$ lbs.

$R_2 = (1.03) (24.47)$

$R_2 = 25.22$ lbs.

*ASSUME $R_1 = 30.00$ lbs.

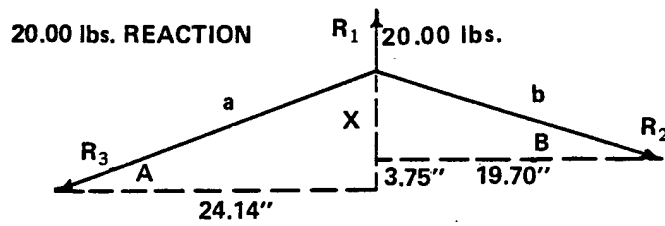
11) $30.00 = 1.03 R_3 \sin 25.68^\circ + R_3 \sin 21.75^\circ$

$R_3 = 36.67$ lbs.

$R_2 = (1.03) (36.67)$

$R_2 = 37.78$ lbs.

Figure 8. Force Analysis of Indirect Rigging System (Continued)



LENGTH OF ARMING WIRE	a"	b"	A°	B°	R ₂	R ₃	X"
48"	26.79	21.21	25.68	21.75	25.18	24.45	11.61
47"	26.24	20.76	23.09	18.36	28.65	27.82	10.29
46"	25.68	20.32	19.95	14.27	33.99	33.00	8.76
45"	25.07	19.93	15.62	8.76	47.94	46.73	6.75
44"	24.25	19.75	5.56	-4.08	776.74	775.19	2.35

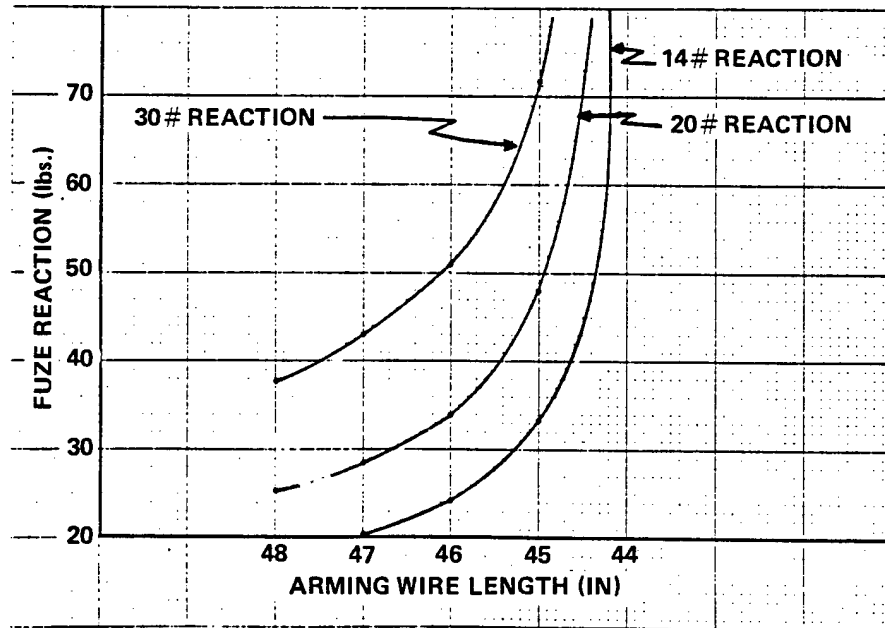


Figure 8. Force Analysis of Indirect Rigging System (Continued)

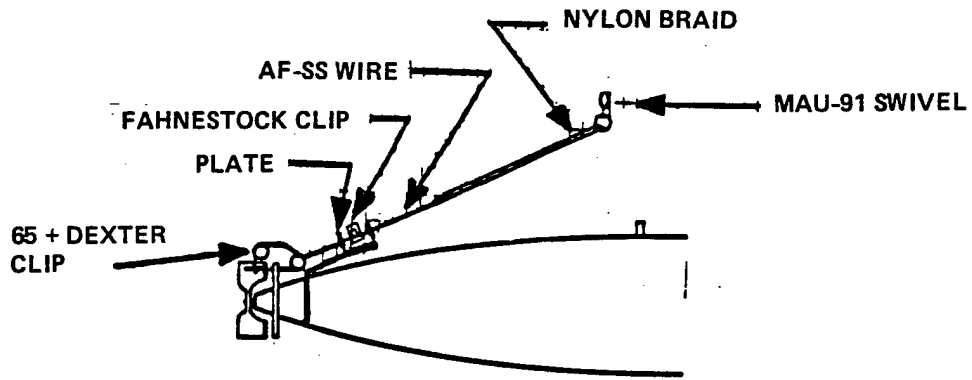


Figure 9. Nylon Lanyard System

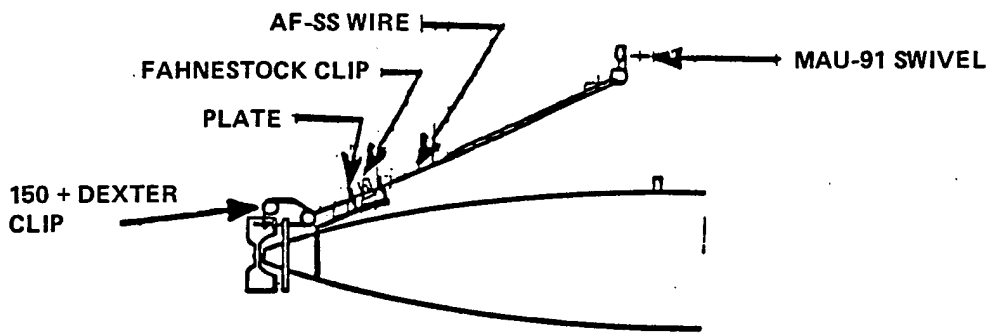


Figure 10. High Force Clip System

system, utilizing the retainer plate. It does not respond to the arming unit as did the bungee, but instead the force to pull the clip, 150 pounds, is higher than the forces, seen in Figure 6, for safe pull out at 20 fps (100 pounds).

Ground testing of the High Force Clip System is limited; fifteen drops, one failure (93 percent successful). This failure was due to the arming unit locking up, which occurs when the arming unit inadvertently functions in the armed mode (300 pounds retention force) without being electrically activated. This failure mode has only been seen in worn arming units and only at the Naval Air Test Center.

Testing of the Nylon Lanyard System is listed in Figure 11. Note that the arming unit lock-up was not seen in ground testing. The Nylon Lanyard System with the 65# Clip, Air Force Stainless Steel Wire, and MAU-91 (300#) Break Link was 100 percent successful.

The Nylon Lanyard was flight tested on 15 August 1984. Captive Carriage was 100 percent successful. Safe releases were 63 percent successful, with two arming unit lock-ups and one pulled clip and pulled out of arming unit, simultaneously.

The arming unit lock-up will not be solved with this or any other arming rigging system. To achieve a totally reliable system, a new Integral Link Arming Unit is being developed.

At this point it has been brought to our attention that the Mine community is in need of arming systems for the F/A-18, and non-magnetic materials for system components must be utilized. Our effort is now being directed towards an arming system that will be compatible with the MK 80 series Bomb and Destructor Mines. The Nylon Lanyard System and the High Force Clip utilize the retainer plate. The plate must be redesigned to fit the MK 904 Bomb Fuze with MK 32 Mine Fuze and to keep the mine body watertight.

INTEGRAL LINK ARMING UNIT

As demonstrated in ground and flight testing, the Nylon Lanyard Noze Fuze System and the High-Force Clip System will not give 100% reliability for safe jettison due to arming unit lock-up. Arming unit lock-up is a generic design deficiency of the current system and solved only by a new arming unit. Therefore, to achieve a totally reliable system an Integral Link Arming Unit (ILAU) is being developed for the F/A and AV-8B bomb racks.

The new arming unit will be mechanically linked with the hook mechanism of the bomb rack. For safe jettison, the hooks will activate the arming unit to release the arming wire swivel at a retention force of zero pounds. For armed drops, the arming unit will hold the swivel at 600 pounds retention force.

The arming unit procurement package, Statement of Work and Specification have been written by NADC, and NAVAIR is handling the contract with MCAIR. NADC is the technical manager of the program and production items are scheduled for January 87.

Progress of this design program is outlined below:

- Prepared Development Plan for F/A-18 and AV-8B arming systems, including long-term solution being the Integral Link Arming Unit.

NADC-84138-60

22 June 84 @ DTB

Five Nylon Lanyards w/Plate, 35# Clips
Ejected from BRU-32 using two CCU-45's
Load Cell at Arming Unit

SAFE DROPS:

Pulled out of Arming Unit at:

12-20 lbs.
20-22.5" from rack
26-28 fps
108-115 ms after impulse

ARMED DROPS:

Dexter clip pulled at:

43-77 lbs.
20.5-24.0" from rack
20-27 fps
110-123 ms after impulse

Break Link broke at:

122-140 lbs.
24.5-27.5" from rack
26-27.5 fps
125-130 ms after impulse

27 June 84 @ NATC

Ten Nylon Lanyards w/Plate, 35# Clips
Ejected from BRU-33 using two CCU-45's
No Load Cell

SAFE DROPS:

8 Success
2 Pulled at same time

ARMED DROPS:

10 Success

19 July 84 @ DTB

Ten Nylon Lanyards w/Plate, 65# Clips
Ejected from BRU-32 using two CCU-45's
Load Cell at Arming Unit

SAFE DROPS:

Pulled out of Arming Unit at:

12-21 lbs.
17-22" from rack
22-23 fps
108-110 ms after impulse

ARMED DROPS:

Dexter clip pulled at:

84-122 lbs.

Break Link broke at:

126-140 lbs.

8 August 84 @ DTB

Ten Nylon Lanyards w/Plate, 65# Clips
MAU-91 Break Link, Stainless Steel Wire
Ejected from BRU-10 using two CCU-44's
Load Cell at Arming Unit

ARMED DROPS: Success 100%

Dexter Clip pulled at:

55-85 lbs.

Nylon broke at:

140-190 lbs.

FLIGHT TESTING OF NOSE FUZE NYLON LANYARD

15 August 84 @ NATC

Ten Nylon Lanyards w/Plate, 65# Clips
MAU-91 Break Link, Stainless Steel AF Wire

Captive carriage on F/A-18 @ Low Altitude, V_{max} :

Success 100%

SAFE DROPS: 5 of 8 Successful

2 Arming Unit Lock-up
1 Pulled Clip & Swivel
2 Electrical Malfunction

Figure 11. Ground Testing of Nose Fuze Nylon Lanyard

NADC-84138-60

- Presented AERMIP funding proposal for the ILAU at Arming Wire Meeting at NAVAIR 28 March 84. This route for procurement was later eliminated.

- Wrote the ILAU Design Specification and Statement of Work. These were included in the PMA-265 letter authorizing MCAIR to proceed with the development.

- NADC is the technical manager of this program and is reviewing MCAIR design concepts for the ILAU.

- The Integral Link Arming Unit Standard is in its preliminary stage and is enclosed as Figure 12.

PLANS AND MILESTONES

- Arming Unit Prototypes Aug 85
- Arming Unit Testing May 86
- Production Items Jan 87

CONCLUSIONS

Ground testing and flight testing show that the Stowpack (1) successfully deploys the fin at the required distance from the aircraft, (2) does not cause damage to the bomb rack or aircraft, and (3) is an integral and retrofittable system for both fins.

The Nylon Lanyard Nose Fuze System increased safe jettison reliability from 30 percent to 80 percent. The remaining unreliability (20 percent) is due to arming unit lock-up.

Arming unit lock-up cannot be solved with the Nylon Lanyard Nose Fuze System or any other rigging system. To achieve a totally reliable system, a new Integral Link Arming Unit is required.

INTEGRAL LINK ARMING UNIT STANDARD

1.0 SCOPE

1.1 Scope. This standard provides the general requirements for the design, development, and testing of an integral link arming unit which is intended for use on the bomb ejector units of all services of the DoD and NATO countries.

2.0 REFERENCED DOCUMENTS

2.1 Issues of Documents. The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

L-P-383 - Plastic Material, Polyester Resin, Glass Fiber Base, Low Pressure Laminated

QQ-A-367 - Aluminum Alloy Forgings

QQ-P-416 - Plating, Cadmium (electrodeposited)

MILITARY

DoD-D-1000 - Drawings, Engineering and Associated Lists

MIL-S-5002 - Surface Treatments and Metallic Coatings for Metal Surfaces of Weapons Systems

MIL-W-5088 - Wiring, Aircraft, Selection and Installation of

MIL-C-5541 - Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys

MIL-C-6021 - Castings, Classification and Inspection of

MIL-H-6088 - Heat Treatment, Aluminum Alloys

MIL-H-6875 - Heat Treatment of Steels (Aircraft Practice) Process for

MIL-F-7179 - Finishes and Coatings, General Specification for Protection of Aerospace Weapons, Structures and Parts

MIL-F-7190 - Forgings, Steel, for Aircraft and Special Ordnance Applications

Figure 12. Integral Link Arming Unit Standard

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- MIL-T-7743 - Test, Store Suspension Equipment, General Specification for
- MIL-B-7883 - Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys
- MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys
- MIL-A-8837 - Coating, Cadmium (Vacuum Deposited)
- MIL-L-8937 - Lubricant, Solid Film, Heat Cured
- MIL-F-18264 - Finishes, Organic, Weapons System, Application and Control of
- MIL-A-21180 - Aluminum Alloy Castings, High Strength
- MIL-A-22771 - Aluminum Alloy Forgings, Heat Treated
- MIL-H-46855 - Human Engineering Requirements for Military Systems, Equipment and Facilities
- MIL-H-81200 - Heat Treatment of Titanium and Titanium Alloys
- MIL-F-83142 - Forgings, Titanium Alloys, for Aircraft and Aerospace Applications
- MIL-C-85485 - Cable, Electric, Filter Line, Radio Frequency Absorptive

STANDARDS

MILITARY

- MIL-STD-9 - Screw Thread Conventions and Methods of Specifying
- MIL-STD-130 - Identification and Marking for U.S. Military Property
- MIL-STD-143 - Specifications and Standards, Order of Precedence for the Selection of
- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts
- MIL-STD-454 - Standard General Requirements for Electronic Equipment
- MIL-STD-810 - Environmental Test Methods
- MIL-STD-838 - Lubrication of Military Equipment
- MIL-STD-889 - Dissimilar Metals
- MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities

Figure 12. Integral Link Arming Unit Standard (Continued)

MIL-STD-1568 - Materials and Processes for Corrosion, Prevention and Control
in Aerospace Weapons Systems

MIL-STD-1587 - Materials and Processes for Corrosion Prevention and Control
in Aerospace Weapons Systems

DRAWINGS

NAVAIR (30003)

2880174 - Detent Tab
1453AS187 - Arming Unit

BuWEPS (1001)

422872 - Loop and Swivel

HANDBOOKS

MILITARY

MIL-HDBK-5 - Metallic Materials and Elements for Aerospace Vehicle Structures

NAVAL BUREAU OF STANDARDS HANDBOOK

H-28

PUBLICATIONS

MILITARY

MIL-BUL-147 - Specifications and Standards of Non-Government Organizations
Released for Flight Vehicle Construction

NAVAL AIR SYSTEMS COMMAND

SD-24 - General Specifications for Design and Construction of Aircraft
Weapons Systems

WR-62 - Naval Weapons Requirements, Specifications and Standards; Use of

3.0 DEFINITIONS

3.1 Integral Link Arming Unit - A device that shall encompass operation from the
bomb rack release linkage mechanism to achieve mechanical release of a standard
arming wire swivel loop when operated in the safe (unarmed) store release mode.

3.2 "Safe" Operational Mode - The process of releasing a store from the aircraft
in an unarmed condition.

Figure 12. Integral Link Arming Unit Standard (Continued)

3.3 "Armed" Operational Mode - The process of removing the safety devices for the release of a store to allow operation, firing or detonation of expendable stores.

3.4 Store - Any device intended for carriage and mounted on aircraft suspension and release equipment, whether or not the item is intended to be separated from the aircraft during flight.

3.5 Ejector Unit - A power-operated device which forces the store away from the aircraft during release.

3.6 Ejection - Separation of the store from aircraft with the assistance from a device, either external or internal to the store.

3.7 Jettison - The intentional separation of a store from aircraft in the safe/unarmed condition.

4.0 GENERAL REQUIREMENTS

4.1 Arming unit types. The arming unit shall be integrally linked with the bomb rack release linkage mechanism to achieve mechanical release of a standard arming wire swivel loop.

4.2 Selection of materials, specifications, standards and drawings. The selection of materials, standard parts, processes, corrosion protection and design features significant in corrosion behavior shall be in accordance with the requirements of Design Specification SD-24, MIL-STD-1568 and MIL-STD-1587.

4.2.1 Materials. Materials shall conform to applicable specifications, be compatible with environmental and service conditions (see 4.3.7) and shall be as specified herein and on applicable drawings. The design shall make maximum use of standard (MS, AN, MIL-STD, etc.) parts, materials and processes, rather than special or peculiar items. Materials not covered by government specifications or which are not specifically described herein shall be of the best quality, and suitable for the purpose intended. Particular care shall be given to close

Figure 12. Integral Link Arming Unit Standard (Continued)

fitting parts in the choice of both materials and corrosion prevention method. Materials should be selected so that wet lubricants or preservatives are not required.

4.2.1.1 Metal parts. All metal parts shall be of the corrosion resistant type or treated in a manner to render them resistant to corrosion. Type AISI 431 corrosion resistant steel shall not be used. Unless suitably protected against electrolytic corrosion, dissimilar metals, as defined in MIL-STD-889, shall not be used in contact with each other. General design information governing usage of metals is furnished in MIL-HDBK-5.

4.2.1.1.1 Heat treatment. Heat treatment of aluminum, steel and titanium parts shall be in accordance with MIL-H-6088, MIL-H-6875 and MIL-H-81200, respectively.

4.2.1.1.2 Castings. Castings used in the arming unit shall conform with the requirements of MIL-C-6021 with appropriate class, grade and critical area notations. In addition, aluminum alloy castings used in critical strength applications shall conform to the requirements of MIL-A-21180.

4.2.1.1.3 Forgings. Forgings used in the arming unit shall conform to the requirements of MIL-F-7190, MIL-F-83142, or QQ-A-367 with appropriate grade and grain flow notations. Forgings used in critical strength applications shall conform to the requirements of MIL-F-7190 Grade A or MIL-A-22771.

4.2.1.2 Non-metallic components. Non-metallic components shall be designed for minimum deterioration caused by abrasion, exposure to sunlight, microorganisms, moisture, temperature extremes, full hydraulic and lubricating oil, or grease and salt spray. Protection shall be provided for those non-metallic components for which strength degradation associated with abrasion, load or exposure-induced deterioration can endanger or jeopardize the performance of the arming unit.

4.2.1.2.1 Reinforced plastic construction. Reinforced plastic materials, if required, shall be specified for Type I materials in L-P-383 and shall be of such

Figure 12. Integral Link Arming Unit Standard (Continued)

character and quality as to be capable of withstanding all service conditions, as specified herein, without degrading the performance of the components of the arming unit.

4.2.1.3 Lubrication. Lubricants and lubrication practices shall conform to the requirements of MIL-STD-838, and MIL-L-8937 as applicable. Lubricants shall function satisfactorily throughout the temperature range from minus 70°F to plus 280°F. Choice of lubricants shall: (a) be compatible with non-metallic components, (b) not damage finishes adjacent to location of lubricant application, (c) eliminate the need for frequent lubrication by field maintenance activities and (d) be non-reactive with the environment. If lubrication is required, choice of lubricant and practices shall be such that lubrication need be accomplished only during post deployment intermediate level maintenance.

4.2.1.4 Fungus-proof materials. To the greatest extent practicable, the materials used in the arming unit shall be non-nutrients for fungi.

4.2.1.5 Potting compounds. Potting compounds employed in the arming unit shall comply with Requirement 47 of MIL-STD-454.

4.2.1.6 Corrosion protection. Corrosion protective practices employed in the manufacture of the arming unit shall be in accordance with the MIL-F-7179 requirements for exterior surfaces. Design of the launcher shall make use of materials which preclude corrosion susceptibility under service environmental conditions without a requirement for hermetic sealing.

4.2.1.7 Finishes. Protective coatings and finishes shall not crack, chip, or scale during normal service or in the extremes of environmental conditions specified herein. Surface treatments, coatings and finishes shall conform to MIL-S-5002, or surface treatments specified herein. General guidance in the application and control of organic finishes is provided in MIL-F-18264.

Figure 12. Integral Link Arming Unit Standard (Continued)

4.2.1.7.1 Anodizing. All non-fatigue critical aluminum and aluminum alloy parts not subject to wear shall have Type II anodic coatings in accordance with MIL-A-8625. Aluminum and aluminum alloy parts subject to wear shall have Type III anodic coatings in accordance with MIL-A-8625.

4.2.1.7.2 Chemical surface treatment. For aluminum and aluminum alloy parts not subject to wear, abrasion or erosion, chemical conversion surface treatment in accordance with MIL-C-5541 may be used in lieu of anodizing.

4.2.1.7.3 Plating. Plating shall be avoided where possible. When required, plating of steel surfaces shall be in accordance with the requirements of MIL-S-5002. Steel parts not subject to wear in contact with aluminum or aluminum alloys shall be cadmium plated in accordance with QQ-P-416, Type II, Class 1, or MIL-A-8837, Type II, Class 1.

4.2.1.8 Wiring. All electrical wiring shall be in accordance with MIL-W-5088 and MIL-C-85485.

4.2.1.9 Soldered or brazed connections. The soldering of contacts shall be in accordance with MIL-STD-454 Requirement 5. When a brazing process is used, it shall be in accordance with MIL-B-7883.

4.2.2 Specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143 and WR-62. A partial listing of approved MIL-STD-143 Group II non-government organization specifications and standards is furnished in MIL-BUL-147.

4.2.3 Drawings. Drawing requirements shall be specified by the procuring activity in accordance with DoD-D-1000 instructions.

4.3 General design requirements.

4.3.1 Arming unit installation. The arming unit shall be designed in accordance with the requirements of this specification and shall conform to the envelope

Figure 12. Integral Link Arming Unit Standard (Continued)

dimensions and mounting provisions of (30003) 1453AS187. The arming unit shall be compatible with loop and swivel BuWeps Drawing 422872-2 and Detent Tab (30003) 2880174.

4.3.2 Threaded parts. All screw threads shall conform to Naval Bureau of Standards Handbook H-28 and MIL-STD-9.

4.3.3 Electrical requirements.

4.3.3.1 Actuating voltage. The arming unit shall operate reliably at a nominal 28 VDC over a range of 18 to 30 VDC.

4.3.3.2 Duty. The arming unit shall be capable of continuous operation at the temperature and voltage specified in paragraph 5.3.1 without damage or malfunction.

4.3.3.3 Current. When the arming unit is tested as specified in paragraph 5.3.2, the current shall not exceed 175 milliamperes.

4.3.3.4 Insulation resistance. When the arming unit is tested as specified in paragraph 5.3.3, the insulation between either terminal and the case at the specified temperature and relative humidity shall be 500 megohms or greater.

4.3.3.5 Dielectric withstanding voltage. When the arming unit is tested as specified in 5.3.4, there shall be no evidence of damage, arcing, breakdown or current leakage in excess of 0.5 milliamperes.

4.3.3.6 Self-generated transients. A temporary voltage surge across the arming unit power input terminals caused by a change in power requirements shall not exceed \pm 45 volts maximum and shall conform to EMI requirements of MIL-T-7743, paragraph 4.23.

4.3.4 Functional requirements.

4.3.4.1 "Safe" operational mode. When the arming unit is de-energized and the store is released from the bomb ejection unit, there shall be zero retention force on the arming wire.

Figure 12. Integral Link Arming Unit Standard (Continued)

4.3.4.2 "Armed" operational mode. When the arming unit is energized, the arming unit shall retain the arming wire with a minimum force of 600 pounds applied within a minimum 120° included cone of operation in the downward vertical direction. Conditions of paragraph 5.3.6.2 apply.

4.3.4.2.1 Arming wires shall be retained after an "armed" operational mode, even after the arming unit is de-energized, until such wires are manually removed.

4.3.4.3 Captive carriage mode (hooks closed). With the arming unit solenoid energized or de-energized and the bomb rack hooks closed, the arming wires shall be retained by the arming unit to its minimum 600 pound limit force. This will preclude unreliable arming unit operation induced by arming wire preload during captive carriage.

4.3.4.4 Inadvertent solenoid activation. The de-energized arming unit solenoid armature shall not inadvertently move to the "armed" position when subject to a 10g upward acceleration.

4.3.4.5 Inadvertent solenoid de-activation. The energized arming unit solenoid armature shall not inadvertently move to the "safe" position when subject to a 10g downward acceleration in the energized condition.

4.3.5 Reliability.

4.3.5.1 Reliability requirements. The arming unit shall be capable of 1,000 cycles of operation without failure - 500 ejections in the "safe" mode and 500 ejections in the "armed" mode.

4.3.5.1.1 The load for the reliability test shall be applied along the vertical axis of the arming unit.

NOTE: A special loop may be required to prevent distortion of the loop during this test.

4.3.6 Human engineering. In addition to complying with MIL-STD-1472 and MIL-H-46855, the following additional requirements shall be incorporated in the design:

Figure 12. Integral Link Arming Unit Standard (Continued)

- a. The anthropometric percentile range for armament ground crew shall be specified by the procuring activity.
- b. Shall be capable of being serviced outside of its aircraft installation without any requirement for ancillary equipment.
- c. Any positional indication and instructions located externally shall be flush with the general outside surface.
- d. All normal arming unit functional operations shall be performed without the use of special tools.
- e. No components shall be accessible externally which would allow accidental or inadvertent operation of the arming unit.
- f. Criteria shall be applied to the design to (1) assure that the equipment can be efficiently, safely, and reliably maintained and operated; (2) assure that adequate handling provisions have been included; (3) minimize human error type failure; (4) assure that design features will not constitute a hazard to personnel.
- g. Early design effort shall include identification of human factor variables which are most likely to require detailed study or research during later design stages, i.e., human performance requirements which may exceed human capabilities, degrade system objectives, reflect possible unsafe practices, or may be prone to human error.
- h. Access with sufficient internal space shall be provided for servicing, adjusting, etc.
- i. The design of the arming unit shall be that there are no protrusions or critically located components that could easily be damaged by normal handling or normal operation of the arming unit outside of a shipping container.

4.3.7 Environmental and service conditions. The arming unit shall function properly under any and all combinations of environments experienced during arming

Figure 12. Integral Link Arming Unit Standard (Continued)

unit storage, ground operation and captive flight. The conditions specified herein shall be in accordance with the climatic criteria of MIL-STD-810 and MIL-T-7743 as modified by the operational service environments of ground operation and captive flight, and shall include:

- a. Altitude: From sea level to 70,000 feet.
- b. Temperature: From minus 70°F to plus 200°F. Transient temperatures are to be determined by the applicable aircraft detail specification.
- c. Humidity: Under all conditions of relative humidity at temperatures from minus 70°F to plus 200°F.
- d. High-G vibration and shock: Under all conditions of high "G" vibration and shock that are present in aircraft during service operation, see applicable paragraphs.
- e. Contaminants: Under all conditions of service or storage.

4.3.8 Maintainability. Except for cleaning, the arming unit shall not require maintenance by the organization level other than for replacement of consumable items and related services. The arming unit shall be designed with sufficient simplicity to permit replacement, adjustment, and repair of consumable items with component accessibility which requires a minimum of maintenance effort and facilities at all maintenance levels. The designer shall provide for ease of assembly with a minimal need for removal of hardware and special tools, test facilities and other support equipment for services.

4.4 Identification and marking. The identification of the arming unit shall be permanently and legibly marked with the manufacturer's name, code identification, part number, operating voltage, serial number and contract number. Paper labels shall not be used. The marking shall remain legible after all tests. MIL-STD-130 130 applies.

4.5 Workmanship. Workmanship shall comply with MIL-STD-454, Requirement 9.

Figure 12. Integral Link Arming Unit Standard (Continued)

5.0 DETAILED REQUIREMENTS

5.1 Responsibility for testing. Unless otherwise specified in the contract, the government is responsible for the performance of all testing specified herein.

5.2 Design approval tests. Design approval tests shall consist of all tests listed in Table I. Quantity of test items shall be six. All six test items shall be tested to Group 1 tests of Table I. Three of the six units shall also be tested to Group 2 requirements of Table I and the other three units of Group 1 shall be tested to Group 3 requirements of Table I. In addition, two units shall be tested to dynamic testing requirements prepared by the contractor and approved by the government.

5.2.1 Design approval. Approval of the arming unit shall be by the procuring activity upon satisfactory completion of all tests.

5.3 Classification of tests.

5.3.1 Duty. The arming unit shall be energized at 28 volts DC and at a temperature of $73^{\circ}\text{F} \pm 18^{\circ}\text{F}$ for a period of 12 hours. The arming unit shall be subjected to and shall meet requirements of paragraphs 5.3.2, 5.3.3, 5.3.4 and 5.3.6.

5.3.2 Current. The arming unit current shall be measured at a temperature of $73^{\circ}\text{F} \pm 18^{\circ}\text{F}$ and at a voltage of 28 VDC. The current shall be measured within 10 seconds of application of the energized voltage and shall meet the requirements of paragraph 4.3.3.3.

5.3.3 Insulation resistance. The arming unit shall be tested in accordance with Method 302 of MIL-STD-202 and shall meet the requirements of paragraph 4.3.3.4.

The following details shall apply:

- a. Test condition letter: A
- b. Conditions: A temperature of $73^{\circ}\text{F} \pm 18^{\circ}\text{F}$ and a relative humidity of 50% or greater.

Figure 12. Integral Link Arming Unit Standard (Continued)

TABLE I. DESIGN APPROVAL TESTS.

GROUP	QUANTITY	PARAGRAPHS	
		REQUIREMENT	TEST
GROUP I			
Insulation Resistance	6	4.3.3.4	5.3.3
Dielectric Withstanding	6	4.3.3.5	5.3.4
Transient Measurement	6	4.3.3.6	5.3.5
Functional	6	4.3.4	5.3.6
- Safe	6	4.3.4.1	5.3.6.1
- Armed	6	4.3.4.2	5.3.6.1
GROUP II			
Duty	3	4.3.3.2	5.3.1
Coil Current	3	4.3.3.3	5.3.2
Inadvertent Arming	3	4.3.4.4	5.3.6.3
Inadvertent Safing	3	4.3.4.5	5.3.6.4
Temperature Shock	3	4.3.4	5.3.7.3
Vibration	3	4.3.4	5.3.7.9
Shock	3	4.3.4	5.3.7.9
Reliability	1	4.3.5	5.3.6.5
GROUP III			
High Temperature	3	4.3.4	5.3.7.1
High Temperature Exposure	3	4.3.4	5.3.7.1.1
Low Temperature	3	4.3.4	5.3.7.2
Humidity	3	4.3.4	5.3.7.4
Altitude	3	4.3.4	5.3.7.5
Salt Spray	3	4.3.4	5.3.7.6
Dust	3	4.3.4	5.3.7.7
Icing	3	4.3.4	5.3.7.8
Reliability	1	4.3.5	5.3.6.5

Figure 12. Integral Link Arming Unit Standard (Continued)

c. Point of measurement: Between either of the two terminals and case.

5.3.4 Dielectric withstanding voltage (DWV).

5.3.4.1 DWV at sea level. The arming unit shall be tested in accordance with Method 301 of MIL-STD-202 and meet the requirements of paragraph 4.3.3.5. The following details shall apply:

- a. Magnitude of test voltage: 1,000 volts RMS
- b. Nature of potential: alternating current
- c. Point of application of test voltage: Between either of the two terminals and case, the leakage current shall be measured.

5.3.5 Transient measurement. The voltage appearing across the arming unit power input terminals shall be monitored at the same terminals with an oscilloscope with a frequency response of 30 Megahertz or greater, or other equivalent test equipment. The limit of error in the test equipment shall not exceed ± 3 per cent. Apply and remove 28 VDC to the arming unit power input terminals. The arming unit shall meet the requirements of paragraphs 4.3.3.3 and 4.3.3.6. The voltage shall be measured at a temperature of $73^{\circ}\text{F} \pm 18^{\circ}\text{F}$.

5.3.6 Functional tests. The arming unit shall be functionally tested while installed in a Navy bomb ejector unit or a BRU simulator fixture.

5.3.6.1 "Safe" operational mode. The arming unit shall apply zero retention force on the loop and swivel when a store is ejected from the bomb ejector rack and the arming unit is de-energized.

5.3.6.2 "Armed" operational mode. The arming unit shall be capable of supporting a load of 600 pounds in the energized condition. Testing shall be accomplished at 18 VDC and 30 VDC. There shall be no movement of the arming units solenoid armature and internal or external release mechanisms when the arming unit is operated in the armed mode. Arming unit "armed" performance shall be assessed while installed in its bomb rack during store ejections and jettisons.

Figure 12. Integral Link Arming Unit Standard (Continued)

5.3.6.3 Inadvertent arming. The arming unit shall be instrumented to detect movement of the solenoid armature and internal or external release mechanisms. In the de-energized mode, no movement of the solenoid plunger shall occur during the store ejections and jettisons. Movement of the arming unit release mechanisms shall not oscillate between the armed and safe conditions during safe store ejections.

5.3.6.4 Inadvertent de-arming. The arming unit shall be instrumented to detect movement of the solenoid armature and internal or external release mechanisms. When energized to 18 VDC, no movement of the solenoid armature or release mechanisms shall occur during store ejections and jettisons.

5.3.6.5 Reliability. The arming unit shall be cycled 1,000 times, as defined in 4.3.5. At completion of the life tests, the unit shall meet the functional tests of 4.3.6 and the electrical tests of paragraphs 5.3.2, 5.3.3, 5.3.4, and 5.3.6.

5.3.7 Environmental tests.

5.3.7.1 High temperature. The arming unit shall be tested per MIL-STD-810, Method 501, Procedure I. The arming unit shall be functionally tested per 5.3.6 at ambient, while at elevated temperature, and immediately following temperature conditioning. The temperature shall be reduced to ambient and the unit shall meet the requirements of 5.3.2, 5.3.3, 5.3.4 and 5.3.6.

5.3.7.1.1 The arming unit shall be exposed to a temperature of $350^{\circ}\text{F} \pm 20^{\circ}\text{F}$ for four hours. The temperature shall be reduced to ambient and the unit shall meet the test requirements of paragraph 5.3.6.

5.3.7.2 Low temperature. The arming unit shall be tested at minus 65°F per MIL-STD-810, Method 502, Procedure I. The unit shall be tested per paragraphs 5.3.3, 5.3.4, 5.3.5 and 5.3.6 at minus 65°F and again tested after being returned to ambient conditions.

Figure 12. Integral Link Arming Unit Standard (Continued)

5.3.7.3 Temperature shock. The arming unit shall be tested per MIL-T-7743, paragraph 4.21. The unit shall be tested per 5.3.6 after temperature shock.

5.3.7.4 Humidity. The arming unit shall be tested per MIL-T-7743, paragraph 4.17. The unit shall be tested per 5.3.3, 5.3.4 and 5.3.6 after humidity test.

5.3.7.5 Altitude. The arming unit shall be tested per MIL-T-7743, paragraph 4.19. The unit while at altitude and temperature shall be tested per 5.3.3 and 5.3.6. The unit must be stabilized at altitude and temperature for each test.

5.3.7.6 Salt spray. The arming unit shall be subjected to the salt spray test specified in MIL-T-7743, paragraph 4.12. At the end of the spray period, the unit shall be removed and allowed to dry for a minimum of six hours and shall be tested per 5.3.6. Deterioration, corrosion, or change in tolerance limits of an interior or exterior part which prevents the unit from meeting the post-test requirements of 5.3.6 shall constitute a test failure.

5.3.7.7 Dust. The arming unit shall be tested per MIL-STD-810, Method 510, Procedure I. After test, the unit shall be tested to 5.3.6.

5.3.7.8 Icing conditions. Arming wire loop and swivel shall be inserted in the arming unit. The temperature of the arming unit shall be reduced to minus 70°F and stabilized. The arming unit shall then be placed in an atmosphere having a temperature of 100°F, 90 per cent relative humidity until all evidence of frost has disappeared. Retaining all the condensation practicable, the temperature of the item shall then be reduced to minus 70°F. One half of the samples, while at minus 70°F shall be tested per 5.3.6.1. The other half of samples shall be tested at minus 70°F per 5.3.6.2.

5.3.7.9 Vibration. The arming unit shall be tested per MIL-T-7743, paragraph 4.6. The arming unit shall be energized for 50 per cent of the resonance dwell time and 50 per cent of the sinusoidal cycle time. During testing the solenoid armature and internal and external release mechanisms shall be monitored to

Figure 12. Integral Link Arming Unit Standard (Continued)

determine if a potential inadvertent arming or inadvertent safing condition occurs. The unit shall be tested per 5.3.6 before and after vibration testing.

5.3.7.10 Shock. The arming unit shall be shock tested three times in both directions along the coil axis and along the internal and external release mechanism axis, per MIL-T-7743, paragraph 4.7. The arming unit shall be instrumented to detect movement of the solenoid armature in both the energized and de-energized conditions, and also any movement of the internal or external release mechanism. An inadvertent arming potential or movement of the internal or external release mechanism to a safe condition shall constitute a failure.

Figure 12. Integral Link Arming Unit Standard (Continued)

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