

PRIME ITEM PRODUCT FUNCTION SPECIFICATION  
FOR THE KEYLESS  
DIRECT / INDIRECT FIRE CUE  
(DIFCUE)  
P/N 148300-2

prepared under Cubic contract no.: D66110LC

**SDRL B005-002**

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## Table of Contents

<u>Section</u>	<u>Title</u>	<u>Page</u>
1.	SCOPE.....	5
1.1	Scope.....	5
2.	APPLICABLE DOCUMENTS.....	5
2.1	General.....	5
2.2	Government documents.....	5
2.2.1	Specifications, Standards and Handbooks.....	5
2.2.2	Other Government Documents, Drawings and Publications.....	6
2.3	Non-Government Publications.....	7
2.4	Order of Precedence.....	7
3.	REQUIREMENTS.....	7
3.1	DIFCUE Definition.....	7
3.1.1	DIFCUE Block Diagrams.....	8
3.1.2	DIFCUE Pyrotechnic Definition.....	8
3.1.3	Major Component List.....	8
3.2	Characteristics.....	8
3.2.1	Performance Characteristics.....	9
3.2.1.1	Fire Control Unit.....	10
3.2.1.1.1	Indication of Rounds.....	12
3.2.1.1.2	Fault Detection.....	12
3.2.1.2	Firing Unit.....	12
3.2.1.2.1	SAFE-Wheel.....	13
3.2.1.3	Firing Sequence.....	14
3.2.1.4	Firing System Reset.....	14
3.2.1.5	Firing Capacity.....	15
3.2.1.6	Operating Voltages.....	15
3.2.1.6.1	Vehicle Power Source.....	15
3.2.1.6.2	Internal Power Source.....	15
3.2.1.7	Power On/Off Condition.....	15
3.2.1.8	Safety Interlock.....	15
3.2.1.8.1	Loading/Unloading Interlock.....	16
3.2.1.8.2	Safety Interlock Status Indicators.....	16
3.2.1.9	Warning Whistle.....	16
3.2.1.10	Audio/Visual Cue.....	16

3.2.1.10.1	Flash.....	16
3.2.1.10.2	Smoke.....	16
3.2.1.10.3	Bang.....	16
3.2.1.11	Pyrotechnic.....	16
3.2.1.11.1	Replacement of Pyrotechnic.....	16
3.2.1.11.2	Pyrotechnic Interchangeability.....	16
3.2.1.11.3	Fragmentation.....	16
3.2.1.11.4	Pyrotechnic Interface.....	17
3.2.1.12	Transit Case.....	17
3.2.1.13	DIFCUE External Interface Requirements.....	17
3.2.1.13.1	Interface Description.....	17
3.2.1.13.2	Vehicle Power Interface.....	17
3.2.1.13.3	Vehicle Interface Description.....	17
3.2.2	Physical Characteristics.....	18
3.2.2.1	Weight.....	18
3.2.2.2	Size.....	18
3.2.2.3	Finish And Color.....	18
3.2.2.4	Circuit Card Assemblies.....	18
3.2.2.4.1	Coating/Protection of Circuit Card Assemblies.....	18
3.2.3	Reliability.....	18
3.2.4	Maintainability.....	18
3.2.5	Environmental Conditions.....	19
3.2.6	Transportability.....	19
3.2.7	Computational System Requirements.....	19
3.2.7.1	Operational Computer System. ....	19
3.2.7.2	Operational System Software.....	19
3.2.7.3	Firmware.....	19
3.2.7.4	Built-In-Test (BIT). ....	19
3.2.7.4.1	Error Codes.....	20
3.3	Design and Construction.....	21
3.3.1	Materials, processes and parts.....	21
3.3.1.1	Hazardous Materials.....	21
3.3.1.2	Castings.....	21
3.3.2	Nameplate and Markings.....	21
3.3.2.1	Main Identification Plate.....	21
3.3.2.1.1	Fire Control Unit and Firing Unit.....	22
3.3.2.2	Warning and caution labels /markings.....	22
3.3.2.2.1	Fire Control Unit and Firing Unit.....	22
3.3.2.2.2	Hint Label on Firing Unit.....	22
3.3.2.3	Battery.....	22
3.3.3	System Safety.....	22
3.3.3.1	Electrical Safety.....	22
3.3.3.2	Personnel Safety.....	23

3.3.3.3	Mechanical Safety.....	23
3.3.3.4	Batteries.....	23
3.3.3.5	Fail-Safe.....	23
3.3.3.6	Loading/Unloading Pyrotechnics.....	23
3.3.3.7	Hangfire.....	24
3.3.4	Human Performance/Human Engineering.....	24
3.3.5	Interchangeability.....	24
3.3.6	Workmanship .....	24
4.	QUALITY ASSURANCE PROVISIONS.....	25
4.1	Responsibility for Inspection.....	25
4.1.1	Responsibility for Compliance.....	25
4.1.2	Contractor Furnished Inspection Equipment.....	25
4.1.2.1	Testing Facilities.....	25
4.1.2.2	Contractor Design.....	25
4.1.2.3	Test Log.....	25
4.2	Quality Conformance Inspections.....	25
4.2.1	Acceptance Test.....	25
4.2.2	Conformance Verification.....	25
4.3	Pre-Production Qualification Test (PPQT).....	26
4.4	Quality Conformance Inspections.....	26
5.	PREPARATION FOR DELIVERY.....	26
5.1	Preservation, Packaging, Packing and Marking.....	26
6.	NOTES.....	26
6.1	Intended Use.....	26
6.2	Definitions.....	26
6.2.1	Damage.....	26

## 1. SCOPE

1.1 Scope. This specification establishes the performance design, test, manufacture, and acceptance requirements for the Direct/Indirect Fire Cue prime item.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2 Government documents

2.2.1 Specifications, Standards and Handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein.

#### STANDARDS:

##### MILITARY

MIL-STD-130- Identification Marking of U.S. Military Property  
Rev. H, 11 Dec. 93

MIL-STD-454 Standard General Requirement For Electronic Equipment  
Rev. N, Notice 3, 22. Sep 94

MIL-STD-810- Environmental Test Methods and Engineering Guidelines  
Rev. E, Notice 2, 1 Sept. 93

MIL-STD-1472 - Human Engineering  
Rev. D, Notice 3, 10 Feb. 94

MIL-STD-1474 - Noise Limits for Military Material (METRIC)  
Rev. C, Notice 1, 30 Jul. 93

#### HANDBOOKS:

##### MILITARY

MIL-HDBK-759 - Human Factors Engineering Design for Army Material  
Rev. B, 30 Jul. 92

(Unless otherwise specified, copies of federal and military specifications, standards and handbooks are available through the DOD Single Stock Point: Standardization Document Order Desk, Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2.2 Other Government Documents, Drawings and Publications. The following Government documents, drawings and publications form a part of this document to the extent specified herein. In the event of conflict between this specification and the referenced Performance Specification for the Direct/Indirect Fire Cue (DIFCUE), the Performance Specification shall take place.

AMSTE Test Operations Procedure (TOP) 1-2-511 29 Dec. 89	-	Intersystem Electromagnetic Compatibility Requirements, System Testing
19200-DS-138 1 Apr. 94 and Mod P00013	-	Critical Item Development Specification for Audio/Visual Cue Pyrotechnic Simulator
AMSTI-93-S027 1 Apr. 94 and Mod P00013	-	Performance Specification For The Direct/Indirect Fire Cue (DIFCUE)
FED-STD-595 Rev 5, 15. May 89	-	Colors Used In Government Procurement
ANSI/IPC-D-275 Sep 91	-	Design Standard For Rigid Printed Boards And Rigid Printed Board Assemblies
ANSI/IPC-RB-276. Amendment 1 Nov 94	-	Qualification And Performance Specification For Rigid Printed Boards

## DRAWINGS

### U.S. ARMY SIMULATION, TRAINING AND INSTRUMENTATION COMMAND (STRICOM - Code 57039)

#### Product Drawings

148300-2	KIT, DIFCUE
148771-2	Interface Control Drawing, Firing Unit, DIFCUE
148732-2	Interface Control Drawing, Fire Control Unit, DIFCUE
148767-1	Interface Control Drawing Cable Assy FCU/FU, MGSS
148764-1	Interface Control Drawing Cable Assy DC Power

### U.S. ARMY ARMAMENT RESEARCH DEVELOPMENT AND ENGINEERING CENTER (ARDEC - Code 19200)

#### Product Drawings

12978535	AVCPS, DIFCUE, M31 (pyrotechnic cartridge)
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(Unless otherwise specified, copies of Government documents, drawings and publications are available through the Naval Air Warfare Center Training Systems Division, Code 27322, 12350 Research Parkway, Orlando, FL 32826-3276.)

2.3 Non-Government Publications. The following documents form a part of this document to the extent specified herein.

#### GERMAN MILITARY STANDARDS

VG95234 - Elektrische Steckverbinder mit Bajonettkupplung  
Issue Jan. 92 (Electrical Connectors with quarter-turn fastener)

(Application for copies should be addressed to Beuth Verlag GmbH, 10772 Berlin, Germany)

#### DIEHL LUFTFAHRT ELEKTRONIK DOCUMENTS

Doc.No.: 9721803 The Operating and Support Hazard Analysis (O&SHA) for the keyless Main Gun Signature Simulator (MGSS), Direct / Indirect Fire Cue (DIFCUE) and the Audio Visual Cue Pyrotechnic Simulator (MILES 2000 SDRL #A00F)

Doc.No.: 9719201 Acceptance Test Procedure for the MILES 2000 MGSS & DIFCUE

Doc.No.: 9718801 EMI Test Procedure for MILES 2000 MGSS/DIFCUE/AVCPS (MILES 2000 SDRL #A018)

(Application for copies should be addressed to DIEHL LUFTFAHRT ELEKTRONIK, Heinrich-Diehl-Str. 2; 90552 Roethenbach, Germany)

2.4 Order of Precedence. In the event of conflict between this document and the references cited herein, the AMSTI-93-S027 Performance Specification shall be first in precedence followed by this document. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 DIFCUE Definition. The DIFCUE is an electro-mechanical device that is installed on a vehicle and simulates both direct fire vehicle kill and incoming artillery during force-on-force training exercises. The DIFCUE can be loaded with up to 30 pyrotechnic cartridges (AVCPS-DIFCUE) and simulates flash, smoke and noise of a direct fire kill and incoming artillery explosion. The pyrotechnic cartridges are activated electrically by the DIFCUE in response to a trigger signal from the Multiple Laser Engagement System 2000 (MILES 2000) or the Simulated Area Weapons Effects / Multiple Integrated Laser Engagement System II - Vehicle Detection Device (SAWE/MILES II-VDD). When the cartridge is activated there is a short warning whistle, followed by a flash, a bang and a short duration production of green smoke. The DIFCUE has one trigger input for MILES 2000 or SAWE/MILES II-VDD and makes no differentiation between incoming triggers of direct fire kill or artillery.

3.1.1 DIFCUE Block Diagrams. The DIFCUE system is shown in block diagram Figure 1.

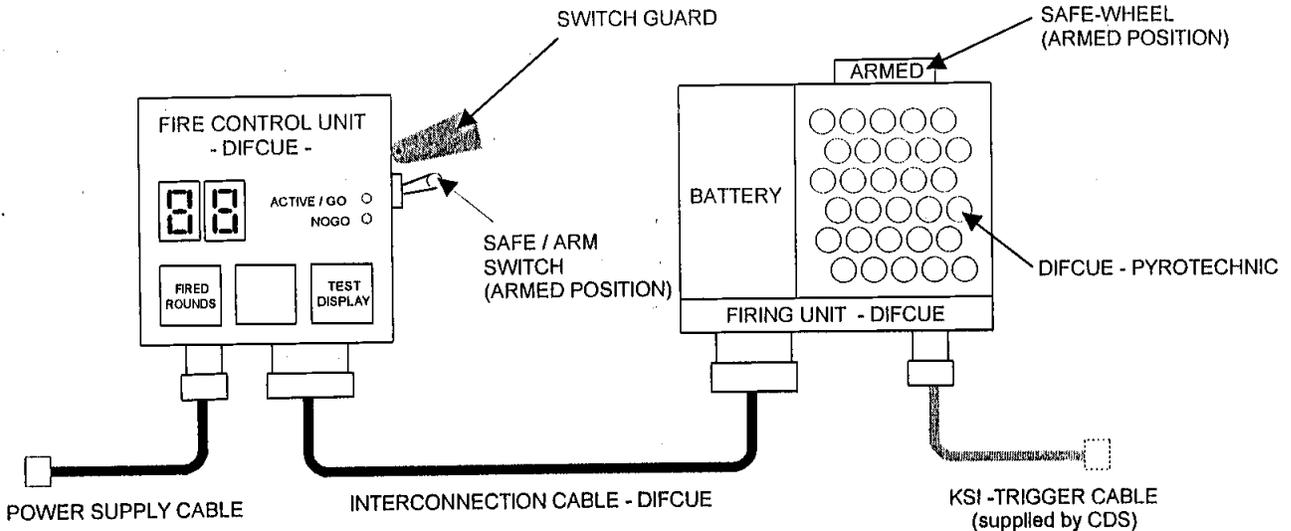


Figure 1: Block Diagram For The DIFCUE System

3.1.2 DIFCUE Pyrotechnic Definition. The DIFCUE pyrotechnic consists of the DIFCUE Audio/Visual Cue Pyrotechnic Simulator (AVCPS/DIFCUE). The DIFCUE pyrotechnic cartridge is not part of the DIFCUE Kit and is ordered, packed and shipped separately from the DIFCUE Kit(s). The DIFCUE must use only the special pyrotechnic cartridges M31 (AVCPS, DIFCUE per ARDEC Dwg. 12978535) that were designed for this device. The pyrotechnic cartridges are manually loaded/unloaded into the DIFCUE device. There is no spent cartridge ejection.

3.1.3 Major Component List. The DIFCUE consists of a Fire Control Unit (FCU), a Firing Unit (FU) for 30 shots, a Cable Assy DC Power, a Cable Assy FCU/FU and a Velcro Fastener Tape (for FCU). The DIFCUE Kit shall comply with all requirements specified on drawing 148300, and all associated drawings, and with all requirements specified in applicable specifications and standards.

3.2 Characteristics. The following subparagraphs describe the performance and physical characteristics of the DIFCUE.

3.2.1 Performance Characteristics. The major subassemblies of the DIFCUE system are shown in Figure 2, and a functional diagram is shown in Figure 3.

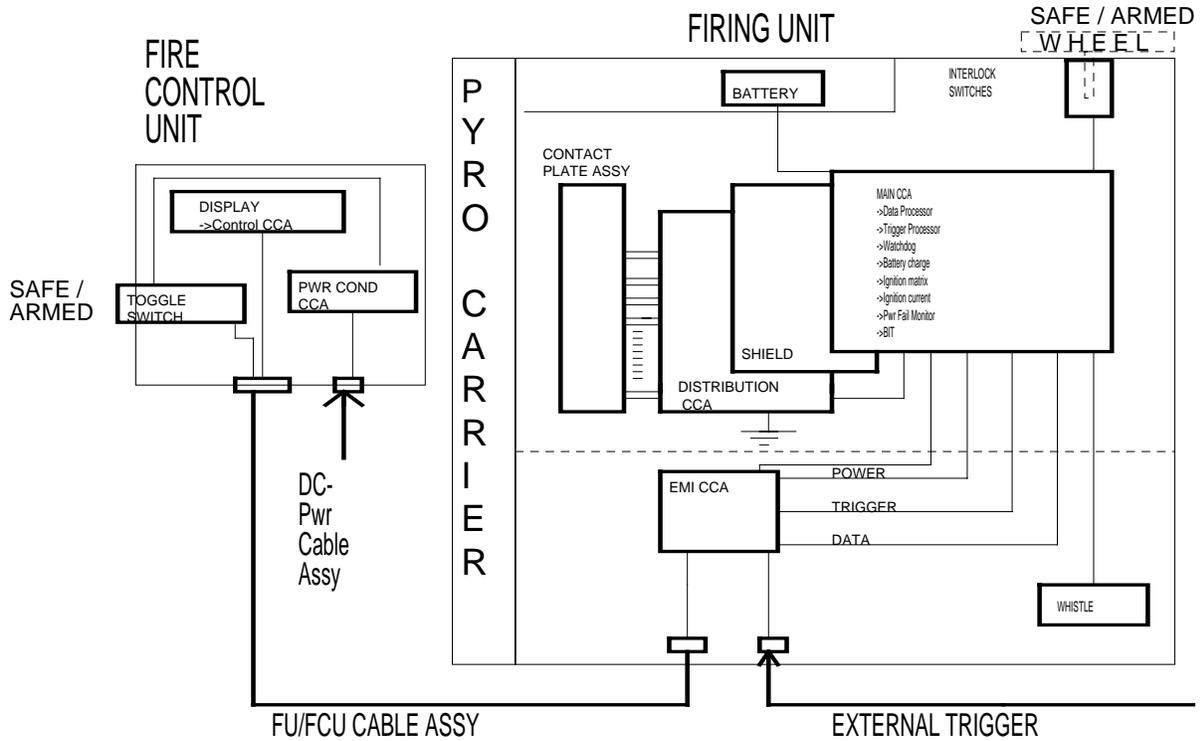
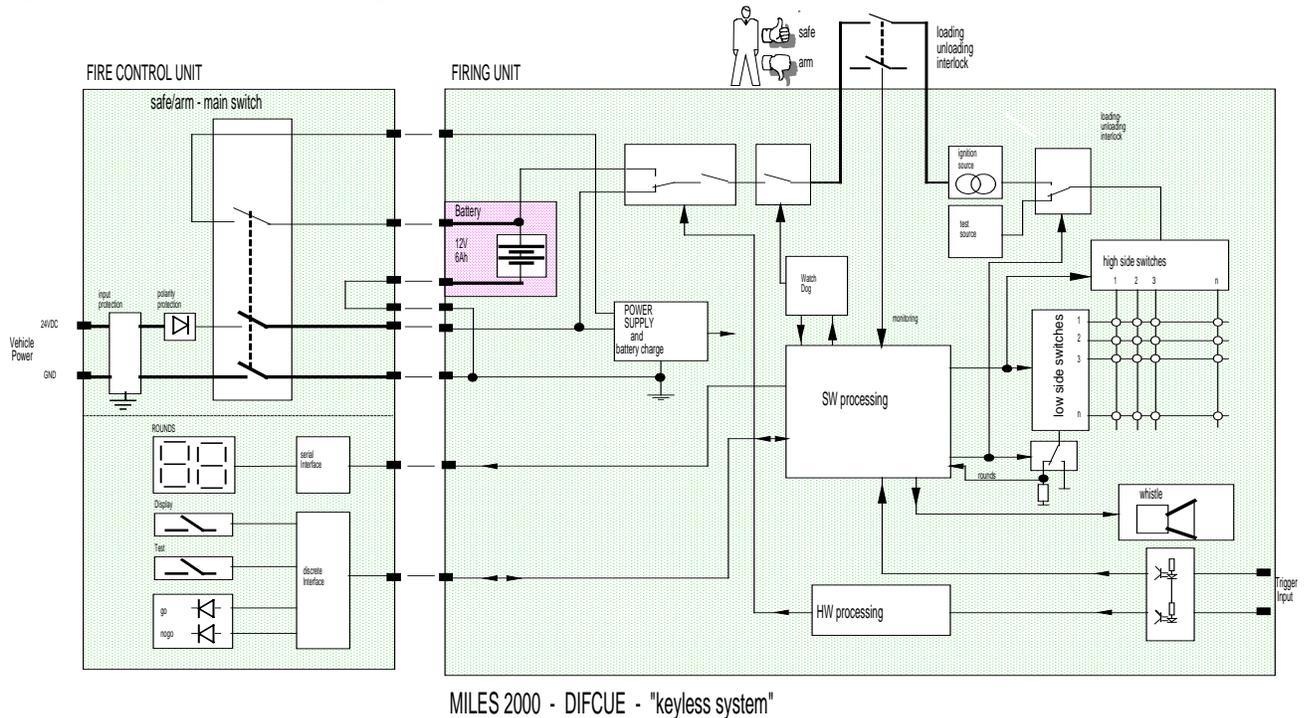


Figure 2: DIFCUE Block Diagram



MILES 2000 - DIFCUE - "keyless system"

Figure 3: DIFCUE Functional Block Diagram

Normal functional sequence of the DIFCUE system:

- 1) System is installed and ready for operation, that means pyrotechnics have been loaded, Safe Wheel of Firing Unit is turned to „ARMED“ position, and SAFE/ARM-Switch of Fire Control Unit is in „SAFE“ position (loading and unloading pyrotechnic see paragraph 3.3.3.6).
- 2) Put SAFE/ARM-Switch of the FCU to ARMED-position.
- 3) System starts with a short „beep“ of the whistle and runs an automatic power-on self-test (BIT). During the selftest all display segments are illuminated for a short time.
- 4) The ACTIVE GO indicator on the FCU will illuminate (green) if no BIT error was detected.
- 5) The NO GO indicator on the FCU will illuminate (red) if a BIT error was detected. The system will not operate and an error code will be displayed in the „Rounds“ window of the FCU.
- 6) After a successful self-test and GO indication, the system will count the actual number of rounds (pyros) loaded in the Firing Unit.
- 7) System will display the actual number of rounds
- 8) System is ready and waits for a valid trigger signal
- 9) If a valid trigger signal is detected, the activation sequence starts - the warning whistle sounds for approximately 2.5 seconds and then the first pyrotechnic is activated.
- 10) After activation, the rounds display at the FCU will be automatically updated (decreased by one).
- 11) Depressing and holding the FIRED ROUNDS button at the FCU will cause the display to change and indicate the number of rounds fired. Depressing the DISPLAY TEST button at the FCU will initiate a self-test (BIT).
- 12) An incoming trigger signal will interrupt the self-test and begin a normal activation sequence.
- 13) If vehicle power is interrupted or not available, the DIFCUE will automatically switch to it's internal battery and continue normal operation. After approximately 5 seconds on battery power (with no activity), the DIFCUE will go into a power-saver mode . The display will go blank, and the GO indicator will flash (green) at approximately one second intervals. The system is fully operational in the power-saver mode and will reactivate with any activity.
- 14) When/if vehicle power returns, or if a valid trigger signal is received, or if FCU buttons are depressed, the system returns to normal operation.
- 15) The system is normally shut down in a series of steps: putting the SAFE/ARM-Switch at the FCU to the SAFE-position, approach FU from opposite side of the firing direction and turn the SAFE-WHEEL of the FU to SAFE-position. Open the Firing Unit and removing all pyrotechnic cartridges. Close the cartridge carrier of the FU and lock it with the handles on each side. Leave the area of the Firing Unit according the safety distances (see 3.3.3.2).  
If the FU was opened without setting the FCU into SAFE-position, the microprocessor sets the FCU out of function. A reset of the FCU is necessary (see 3.2.1.4).

3.2.1.1 Fire Control Unit (FCU). The FCU is the human interface/control unit for the DIFCUE system (see Figures 4). The FCU contains the main SAFE/ARM-Switch as well as the display, indicators and pushbuttons for the user interaction with the system. The SAFE/ARM-Switch is the ON-OFF switch for all power to the DIFCUE, -including the battery.

There is one display, two indicators and two membrane pushbuttons on the Fire Control Unit.

They operate as follows:

ACTIVE/GO Indicator (LED):

Continuous green = ``GO``, system OK after passing BIT

Continuous green = ``ACTIVE``, system operational and supplied by vehicle power

Flashing green = ``ACTIVE``, system operational but on battery power and in power-save mode.

NO GO Indicator (LED):

Continuous red = ``NOGO`` after BIT with failure result (error code, see paragraph 3.2.7.4.1) or  
``NOGO`` after improper „safeing-procedure“, when loading pyrotechnics

Flashing red = ``NOGO`` after BIT with failure result (error code), equipment is supplied by  
internal battery (power down mode)

Rounds Display (2 character, 7-segment LED's):

Normal display = number of available pyrotechnic cartridges is displayed.

If "Fired Rounds" button is depressed and held = number of fired pyrotechnic cartridges is displayed.

If a continuous or flashing red NO GO indicator is illuminated = error code is displayed.

DISPLAY/TEST Button:

If depressed and held for greater than 1 second = BIT is initiated.

If depressed for less than 1 seconds when FCU is in battery power-save mode = reactivates all displays.

FIRED ROUNDS BUTTON:

If depressed and held = causes display to change and show the number of fired rounds, i.e., expended cartridges.

TEST/DISPLAY and FIRED ROUNDS (both buttons depressed > 5 seconds):

Override error code „09“ (Battery Low)

With the SAFE/ARM-Switch of the Fire Control Unit, the system can be from the „SAFE“ (OFF) into the „ARMED“ (ON) operation mode (see Figures 4). The SAFE/ARM-Switch has a switch guard. When in SAFE-position (engraved text „SAFE“ and „ARMED“ on FCU frame), the switch is down (see Figure 4-1), in ARMED-position the switch guard is opened and switch lever is pushed up (see figure 4-2). If the switch guard is closed the switch is forced to the down or SAFE position.

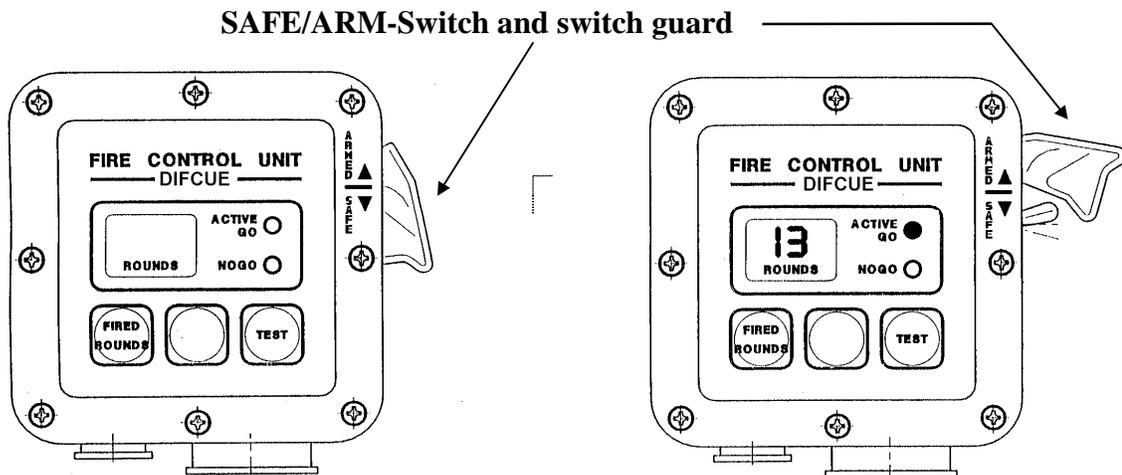


Figure 4-1: Fire Control Unit DIFCUE „SAFE“

Figure 4-2: Fire Control Unit DIFCUE „ARMED“

3.2.1.1.1 Indication of Rounds. The Fire Control Unit contains the 2 character (7-Segment-LED) display. The display normally shows the number of remaining live pyrotechnic cartridges. By depressing the "FIRED ROUNDS" button and holding it down, the display will change to show the number of fired or expended pyrotechnic cartridges. When the button is released the display returns to normal.

Upon power or reset, the DIFCUE system checks for the quantity and position of live pyrotechnic cartridges. This information is stored so that only those positions with live pyrotechnics will be activated (fired), and they will be activated in precise sequence, -see 3.2.1.3 Firing Sequence.

3.2.1.1.2 Fault Detection. The DIFCUE contains built-in-test (BIT) capabilities. The BIT is initiated by depressing the DISPLAY/TEST button. System failures of a "NO GO" nature are detected, an error code is displayed, and the system ceases to operate. A description of the BIT and list of error codes is provided in paragraph 3.2.7.4.

3.2.1.2 Firing Unit. The Firing Unit is shown in Figure 5 and 5-1. The Firing Unit is comprised of the main body and the upper hinged pyrotechnic carrier for 30 DIFCUE pyrotechnic cartridges. The status of fired rounds or available rounds is displayed on the Fire Control Unit (see paragraph 3.2.1.1). The connection of the system is described in paragraph 3.1.1 and 3.2.1.

The Firing Unit (see Figure 5) can be attached to the vehicle adapters via 4 captive screws (see paragraph 3.2.1.13.3). The cartridge carrier (see Figure 5-1) is designed for easy, safe and fast pyrotechnic reloading of up to 30 DIFCUE cartridges. The carrier can be locked by lever locking mechanism on two sides.

The aluminum main housing contains the integrated electronics, wiring, a warning whistle and after the carrier is in reload position (see Figure 5-1) a front accessible battery and front removable pyrotechnic contact assys.

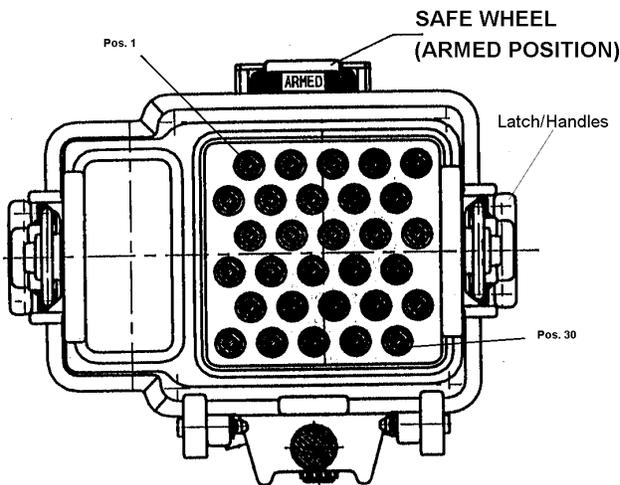


Figure 5: Firing Unit DIFCUE

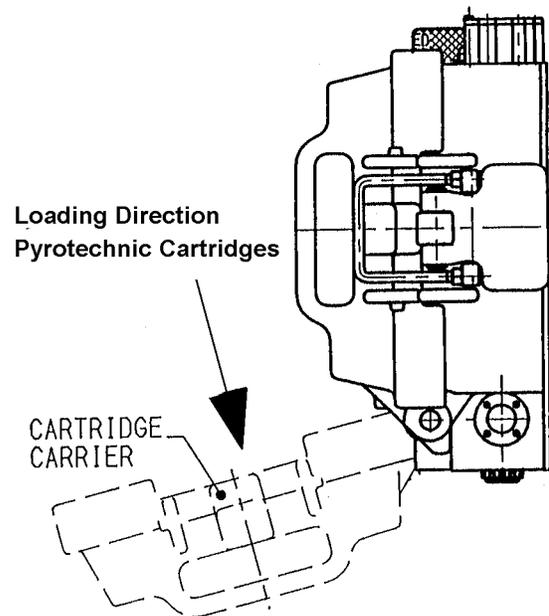


Figure 5-1: Open cartridge carrier

3.2.1.2.1 **SAFE-WHEEL.** With the SAFE-WHEEL of the DIFCUE Firing Unit, the Firing Unit can be switched from the „SAFE“ operation mode to the „ARMED“ operation mode (see Figures 5 to 7). The SAFE-WHEEL has a red (ARMED) and a green (SAFE) flag with engraved text „ARMED“ and „SAFE“. The loading/unloading procedure for the system is described in paragraph 3.3.3.6). The SAFE-WHEEL has the following functions (see Figures 6 and 7):

- Interruption of electrical power path via an internal ignition path switch (interlock switch #1).
- SAFE/ARMED detection by the microprocessor using an internal monitoring switch (interlock switch #2).
- Mechanical interlock of the cartridge carrier in the ARMED-position.
- The „interlock switches“ will be activated by a disc cam mechanism on the shaft of the SAFE-WHEEL.

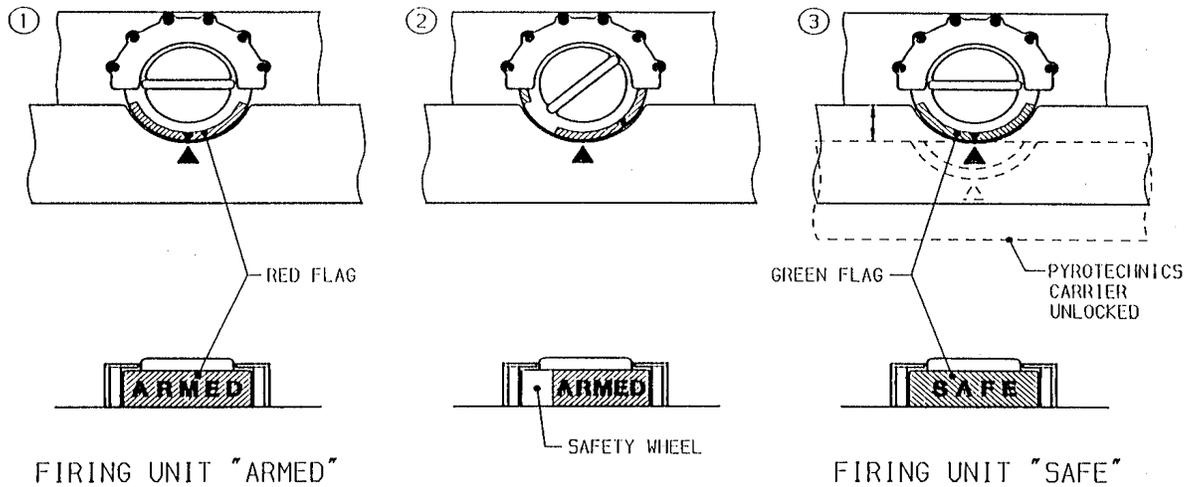


Figure 6: Side view on SAFE-WHEEL (Firing Unit)

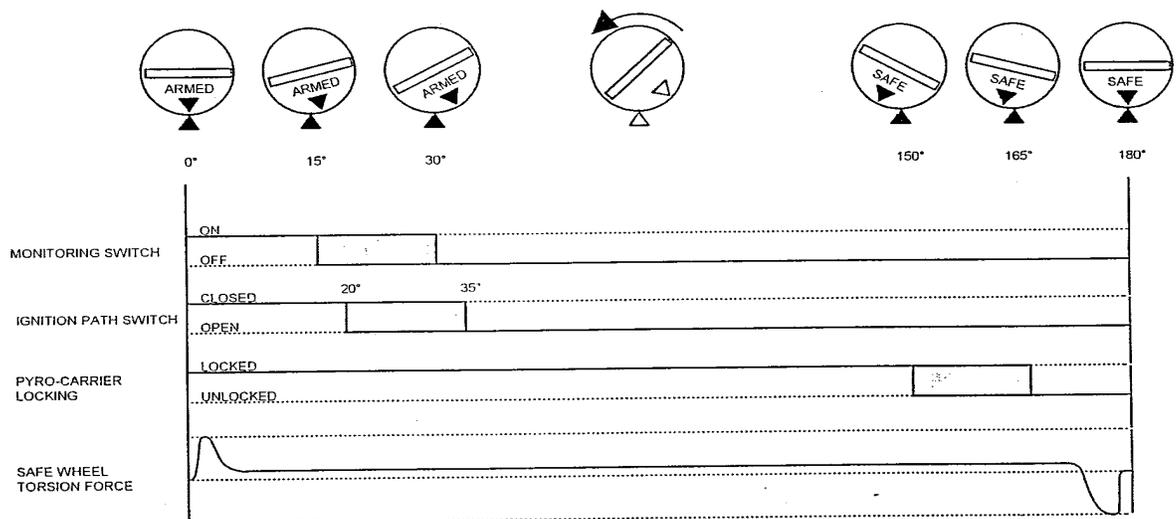


Figure 7: SAFE-WHEEL function diagram

3.2.1.3 Firing Sequence. The Firing Unit activates the pyrotechnics in a prescribed sequence from the first active loaded position to the last active loaded position. One pyrotechnic is activated with each valid trigger signal. The firing sequence stops when the last active loaded position has been fired and starts over at the first active loaded position after reloading. The priority of loaded positions starts at position 1 in Figure 5 and goes left to right, row by row to position 30. Each valid trigger signal causes the DIFCUE to immediately activate a warning whistle for 2.5 +/- .5 seconds and following the whistle one pyrotechnic cartridge will be activated (fired). The Firing Unit is capable of producing the activation's every 3.5 +/- 1 seconds for the entire 30 positions. The trigger processing is shown in Figure 8. The ignition path is shown in Figure 9.

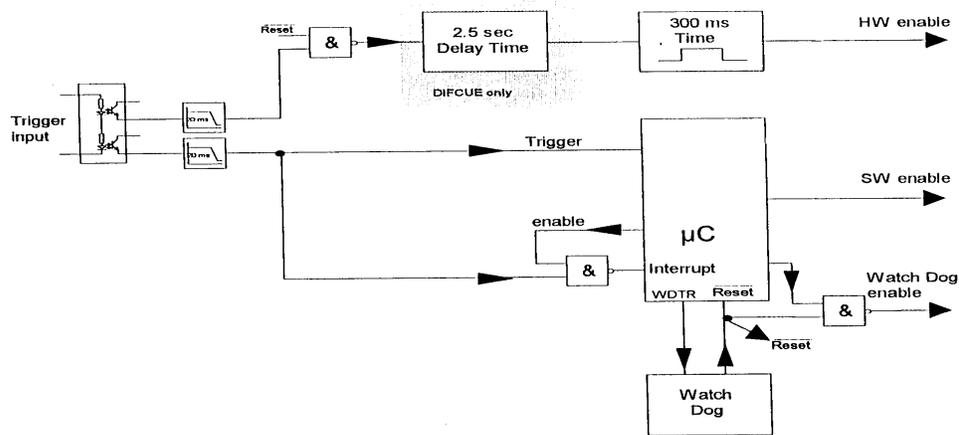


Figure 8: Trigger processing

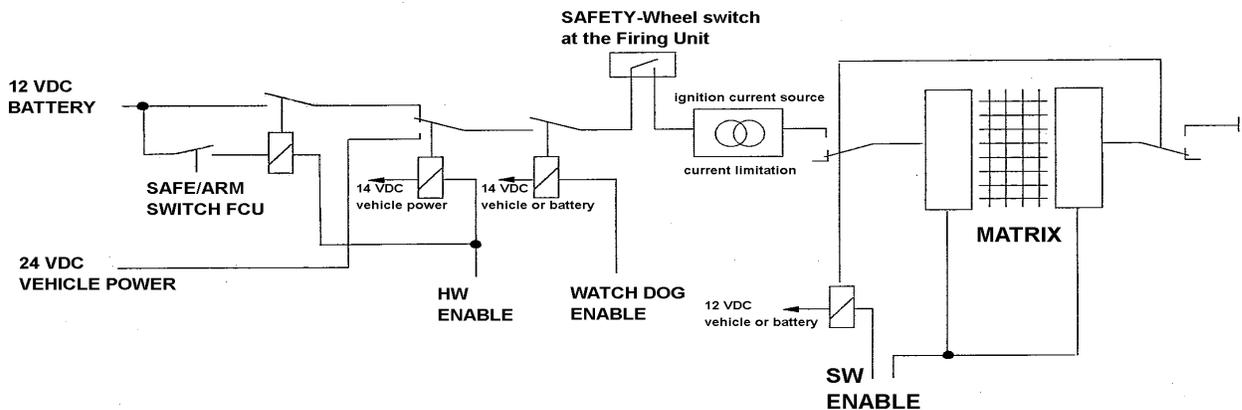


Figure 9: Ignition path

3.2.1.4 Firing Sequence Reset. The DIFCUE resets to the first active loaded position each time the system is powered up (ARMED), or any time that the system is intentionally reset by cycling the SAFE/ARM-Switch of the Fire Control Unit from "ARMED" to "SAFE" and back to "ARMED".

3.2.1.5 Firing Capacity. The Firing Unit is capable of firing 30 consecutive pyrotechnics without reloading. Any number of pyrotechnics can be safely loaded from 1 to 30.

3.2.1.6 Operating Voltages. The DIFCUE will normally operate from vehicle power (external) and also has an internal battery for backup operation.

3.2.1.6.1 Vehicle Power Source. The DIFCUE is designed for an operating voltage (external) of 16VDC to 32VDC and has surge protection of up to 250 volt spikes. Circuit protection and losses are included in the 16VDC minimum.

3.2.1.6.2 Internal Power Source. The DIFCUE system has its own internal power source (12VDC battery) and switches automatically when vehicle power is discontinued. The battery is protected with a shock absorbing enclosure and is installed in a separate housing in the Firing Unit. The system includes a battery recharging capability which operates when vehicle power is available and the DIFCUE is in an active state. The DIFCUE, with a fully charged battery, is capable of operating for a minimum of 30 activation's in a 4 day period without any vehicle power. Details on the battery are provided in paragraph 3.3.2.3.

3.2.1.7 Power On/Off Condition.

- If vehicle power is lost, the system automatically transfers to the internal battery and continues normal operation. After 5 seconds the system goes into power saver mode (``GO``-LED on Fire Control Unit flashes, the display of ``Rounds of available pyrotechnics`` goes down).
- If the vehicle power is restored again, the system reactivates from power saver mode. The Fire Control Unit display ``Rounds of available pyrotechnics`` appears and ``GO``-LED is continuously illuminated.
- If vehicle power is lost and battery is low, the system may or may not operate depending on the actual condition of the battery. The system should be reset to check for a low battery condition (an error code will be displayed as a result of BIT). If battery is low, it should be charged or replaced. The error code „09“ (Battery Low) can be overridden by depressing both buttons TEST/DISPLAY and FIRED ROUNDS for more than 5 seconds (see paragraph 3.2.7.4.1).
- There is no reset required in the case of switching back from power down mode (battery) to vehicle power, because the software works all the time. There is no software lockout.

3.2.1.8 Safety Interlock.

- a. The SAFE-WHEEL of the Firing Unit provides both a mechanical safety interlock and two electrical interlocks.
- b. The Firing Unit cannot be opened until the SAFE-WHEEL is turned into the SAFE position.
- c. There are two electrical interlocks (switches), activated by turning the SAFE-WHEEL. One switch interrupts the ignition path, the other provides a signal for the microprocessor to „safe“ the system via software control.
- d. If the Firing Unit is opened without setting the Fire Control Unit into SAFE position, the microprocessor maintains the „safe“ or disabled state. A reset of the FCU is necessary, see 3.2.1.4.

3.2.1.8.1 Loading/Unloading Interlock. The operator cannot open the Firing Unit to load the pyrotechnics unless the SAFE-WHEEL is turned to the SAFE-position. On the normal load/unload procedure the operator has to set the SAFE/ARM-Switch of the Fire Control Unit into SAFE-position and has to turn the SAFE-WHEEL on the Firing Unit into SAFE-position (approach FU from opposite side of the firing direction). Now the operator can open and load or unload the Firing Unit with pyrotechnics (see also paragraph 3.3.3.6).

3.2.1.8.2 Safety Interlock Status Indicators. The SAFE/ARM status of the system is indicated by the SAFE/ARM-Switch on the Fire Control Unit (see Figures 4) and the SAFE-WHEEL (with red (engraved text „ARMED“) and green flag (engraved text „SAFE“), see 3.2.1.2.1.

3.2.1.9 Warning Whistle. The warning whistle generates a noise that level cannot exceed 85 dB (A) at 2 meters. The warning whistle sounds a short beep when the system is powered up (ARMED) at the FCU and an approx. 2.5 seconds beep prior to every pyrotechnic activation.

3.2.1.10 Audio/Visual Cue. The DIFCUE uses a pyrotechnic to produce the audio/visual cue, consisting of a flash, bang and a short duration of green smoke.

3.2.1.10.1 Flash. The DIFCUE provides a flash visible at a distance of 1500 meters, on a „Standard clear day“ as defined in the AMSTI-93-S027 paragraph 3.2.1.9.2.1. For testing purposes, a minimum value of 330,000 candela (peak) at 20m was established by ARDEC.

3.2.1.10.2 Smoke. The DIFCUE produces a green smoke which is visible at a distance of 1500 meters on a „Standard clear day“ as defined in the AMSTI-93-S027 paragraph 3.2.1.9.2.2

3.2.1.10.3 Bang. The noise generated by the DIFCUE should be 135 +/- 15 dB peak at a distance of 2 meters.

3.2.1.11 Pyrotechnic. The DIFCUE Audio/Visual Cue Pyrotechnic Simulator (AVCPS/DIFCUE) is in accordance with the requirements of 19200-DS-138 and the following requirements. See also paragraph 3.1.2.

3.2.1.11.1 Replacement of Pyrotechnic. The operator is able to load or unload pyrotechnics from the Firing Unit by hand with no tools in three minutes or less. Any quantity from one to thirty can be loaded.

3.2.1.11.2 Pyrotechnic Interchangeability. The AVCPS/DIFCUE is designed such that the MGSS Audio/Visual Cue Pyrotechnic Simulator and other similar pyrotechnics common to the training environment in which the DIFCUE is used, cannot be used in or activated by the DIFCUE.

3.2.1.11.3 Fragmentation. Outside a safety distance of 2m the DIFCUE doesn't discharge hazardous fragments/debris or generate sufficient heat/radiation that could ignite nearby foliage, damage nearby equipment or cause skin breakage, burns, or eye injury to personnel.

3.2.1.11.4 Pyrotechnic Interface. The pyrotechnic is manually installed into the DIFCUE by inserting the cylindrical cartridge into the loading holes of the Firing Unit. To activate the pyrotechnic cartridge, the DIFCUE provides a nominal 5A signal (7 A max.) to the cartridge's electric match through two contact pins at the base of the cartridge.

3.2.1.12 Transit Case. A transit case is not part of the DIFCUE Kit as defined in this specification.

3.2.1.13 DIFCUE External Interface Requirements. The DIFCUE interfaces mechanically and electrically with the MILES 2000, the SAWE/MILES II-VDD and the vehicles.

3.2.1.13.1 Interface Description. The DIFCUE activates on a trigger signal from the MILES 2000 for the direct fire kill and the SAWE/MILES II-VDD for incoming artillery. The DIFCUE is only activated by a signal of +5 volts to +31 volts for more than/or equal 80 milliseconds (see Figure 10). Transients and spikes are in accordance with the EMI Test Procedure for MILES 2000 MGSS/DIFCUE/AVCPS (Doc.No.: 9606502) paragraph 2.6. On the DIFCUE Firing Unit there is a trigger cable receptacle J1 according MS3114E8-4P. All other connectors or receptacles on the DIFCUE system are in accordance with VG95234. No trigger cable is provided with the kit defined herein - the trigger cable is provided at the next system level. The system must sense the trigger signal drop-off to 4 VDC min before another trigger signal will be accepted.

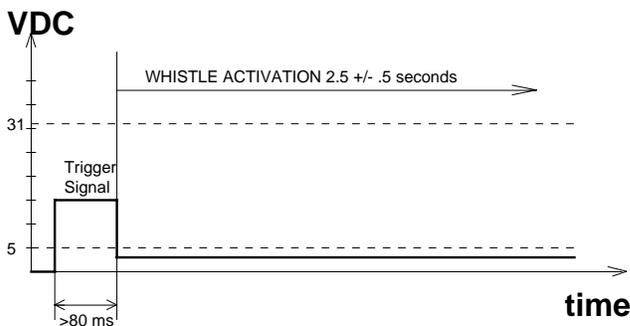


Figure 10: Timing diagram of a valid trigger signal

3.2.1.13.2 Vehicle Power Interface. The Fire Control Unit includes receptacle J1 in accordance with VG95234 B1-10SL-3P1N. A DC power cable is included in the kit to interface with the 24VDC vehicle power - see also the applicable installation instructions/manual.

3.2.1.13.3 Vehicle Interface Description. Special mounting adapters are required to install the DIFCUE Firing Unit on most vehicles. The Firing Unit has 4 captive screws, which provide mounting capability for adapters. The mounting adapters are not part of the DIFCUE Kit as defined in this specification. The Fire Control Unit is designed to be mounted inside the vehicle with a hook and loop (velcro) pad. The Firing Unit mounting hole pattern and the Fire Control Unit pad are shown on Interface Control Drawings 148771 and 148732 respectively.

3.2.2 Physical Characteristics. The following subparagraphs describe the minimum required physical characteristics of the DIFCUE.

3.2.2.1 Weight. The assemblies of the DIFCUE Kit have the following weights (Tolerance: +7.5%):

DIFCUE Firing Unit (incl. Battery):	48.4 lbs
DIFCUE Cable Assy FCU/FU:	4.9 lbs (8meters length)
DIFCUE Fire Control Unit:	1.5 lbs
DIFCUE Cable Assy DC-Power :	0.9 lbs (5 meters length)
Miscellaneous:	<u>0.7 lbs</u>
nominal weight:	56.4 lbs (maximum)

3.2.2.2 Size. The assemblies of the DIFCUE Kit have the following sizes (the sizes given in inches):

DIFCUE Firing Unit:	approx. 17.7" x 15.8" x 8.3" [width x height x depth]
DIFCUE Cable Assy FCU/FU:	spooled up: 17.7" in diameter, 2.0" in height
DIFCUE Fire Control Unit:	approx. 5.3" x 4.5" x 2.5" [width x height x depth]
DIFCUE Cable Assy DC-Power:	spooled up: 7.9" in diameter, 1.2" in height

3.2.2.3 Finish And Color. All aluminum parts are chemical film treated in accordance with MIL-C-5541 Class 3 or equivalent.

Paint for exterior surfaces: Primer in accordance with MIL-P-85582 Type 1 Class 2 or equivalent;  
Color Black: FED-STD-595 Color Number 37030

or

Powder Coated using „Tiger Drylac Series 19 No. 09/00241“ RAL 9005  
Matt, Vendor, Tigerwerk, A-4600 Wels, Austria or equivalent.

Stainless Steel Parts without surface treatment: Anodic Oxidation in accordance with DIN 17611.

3.2.2.4 Circuit Card Assemblies. The circuit card assys shall be designed and fabricated in accordance with ANSI/IPC-D-275 and ANSI/IPC-RB-276.

3.2.2.4.1 Coating/Protection of Circuit Card Assemblies. The type of coating is in accordance with MIL-I-46058. The process of coating is in accordance with the regular process specification of the used coating.

3.2.3 Reliability. The DIFCUE Kit shall meet the required Mean Time Between Failure (MTBF) quantitative reliability requirement of 530 activation's. Verification of the Reliability requirement shall be done using MIL-HDBK-781 and the approved Reliability Test Procedure.

3.2.4 Maintainability. The maximum Mean Time to Repair (MTTR) shall be 15 minutes. This represents an operational level of maintenance where the major assemblies (Firing Unit and Fire Control Unit) can be disconnected, removed from their mounting, and replaced. Additionally, the

DIFCUE shall be designed with easily replaceable subassemblies and shall have Built-in-test capabilities to diagnose failures.

3.2.5 Environmental Conditions. The DIFCUE shall meet the environmental requirements as specified in AMSTI-93-S027.

3.2.6 Transportability. The DIFCUE Kit, in the transport case, shall withstand without damage, the stresses incidental to movement, handling in transit, and tie-down aboard common carrying vehicles such as aircraft and trucks.

3.2.7 Computational System Requirements

3.2.7.1 Operational Computer System. The operational computer system shall use one or more Commercial Off the Shelf (COTS) processors, components and connectors. The processor(s) shall have a word size, operating speed, installed memory, and bus bandwidth to fulfil the performance requirements of this specification and have spare capacity. The following resources shall be provided as a minimum:

Spare memory = at least 50%.

Spare processing time = at least 50% of the highest averaged over a continuous operation period.

I/O capacity to accommodate all the required and designed-in functions.

3.2.7.2 Operational System Software. The operational system software shall consist of one or more of the following: developed software, reusable software, COTS software, and modified, previously developed software.

The software engineering methods are in accordance with AMSTI-93-S027 and RTCA/DO-178B. The program language is Assembler.

3.2.7.3 Firmware. Code and/or data which is stored in hardware devices (e.g., Programmable Read Only Memory) is considered software and shall be incorporated into the appropriate Computer Software Configuration Items (CSCI) with the same requirements as other software.

3.2.7.4 Built-in-Test (BIT). If the BIT recognizes a fault in the system, a error code is displayed on the 7-Segment-LED on the Fire Control Unit. The list of error codes is shown in paragraph 3.2.7.4.1. The following BIT-Functions are incorporated into the system (see Software Design Document MILES 2000 MGSS/DIFCUE; Doc.No.: MGSS/DIFCUE-202-1.3; paragraph 4):

- SBIT: Self-test after power-on (ARM)

SBIT controls the processing during start-up Built-in- Test. As long as the test is active all segments of the display and both LED's are switched on ('lamp test'). A set of test functions is activated sequentially. If any of those test functions indicates an error, the test sequence is aborted and the error is passed to the calling mode.

- IBIT: Initiated BIT by pressing the pushbutton > 1 second on the Fire Control Unit (see paragraph 3.2.1.1)

IBIT controls the processing during initiated Built-in-Test. As long as this test is active all segments of the display and both GO and NO GO indicators are switched on ('lamp test'). A set of test functions is activated sequentially. If any of those test functions indicates an error, the test sequence is aborted and the error is passed to the calling mode. The test sequence is also aborted if a valid trigger pulse has been recognized.

- **CBIT**: Continuous BIT as permanent software function.

CBIT controls the processing during continuous Built-in-Test. A set of test functions is activated sequentially. If any of those test functions indicates an error, the test sequence is aborted and the error number is passed to the calling mode. If a valid trigger pulse has been recognized, the test sequence is aborted.

3.2.7.4.1 **Error Codes**. If the NOGO-LED on the Fire Control Unit is continuous red or flashing red, an error code is displayed and is flashing. The error codes are listed in the following table:

<b>Error Number</b>	<b>Meaning</b>
01	<b>defect RAM memory of microcontroller</b> : read/write test failed for at least on memory cell, detected by SBIT/IBIT
02	<b>defect ROM memory</b> : microcontroller computed invalid checksum of ROM memory, detected by SBIT/IBIT
03	<b>defect timer system</b> : the microcontroller's timer is not running, detected by SBIT/IBIT
04	<b>failure at serial I/O's</b> : at least one of the shift registers that are used to control the matrix transistors has failed, detected by SBIT/IBIT
05	<b>failure of AD converter</b> : the microcontroller's internal AD converter has delivered at least one invalid value at its internal channels (i.e. reference, 1/2 reference or ground couldn't be measured correctly), detected by SBIT/IBIT/CBIT
06	<b>failure of whistle</b> : whistle could not be sensed during SBIT/IBIT
07	<b>failure of `watchdog relay`</b> : an unallowed high voltage has been detected at test point TP3 in the ignition path during SBIT/IBIT
08	<b>failure of `current source`</b> : an unallowed high voltage has been detected at test point TP4 in the ignition path during SBIT/IBIT
09	<b>failure of battery</b> : battery voltage too low (less than approx. 9V) or not connected at all. This failure can be overridden by depressing both buttons TEST/DISPLAY and FIRED ROUNDS for more than 3 seconds, detected by SBIT/IBIT
10	<b>failure of battery charger</b> : output voltage of battery charger too low (DIFCUE only), detected by SBIT/IBIT
11	<b>failure of FCU supply</b> : FCU supply voltage too low, detected by SBIT/IBIT/CBIT
12	<b>stack error</b> : RAM memory has been overwritten due to a stack overflow, malfunction of microcontroller, detected by CBIT

13	<b>failure of highside matrix FET:</b> detected a short circuit at one of the highside FETs which are used to switch on the selected matrix point for ignition, detected by SBIT/IBIT/CBIT
14	<b>failure of lowside matrix FET:</b> detected a short circuit at on of the lowside FETs which are used to switch on the selected matrix point for ignition, detected by SBIT/IBIT/CBIT
15	<b>SAFE-WHEEL open, or not closed properly,</b> detected by SBIT/CBIT/IBIT
24	<b>failure at serial I/O's:</b> at least one of the shift registers that are used to control the matrix transistors has failed, detected by CBIT
26	<b>failure of whistle:</b> whistle could not be sensed during ignition sequence (may be not connected, DIFCUE only); faulty whistle has been detected by CBIT, ignition sequence has been aborted, detected by CBIT
27	<b>failure of ignition current:</b> no ignition current was measured during ignition (this could be a failure in the DIFCUE firing circuitry or it could be a failed pyrotechnic in which the match is abnormal), detected by CBIT
F1	<b>pushbutton „TEST“ depressed or defective</b> during start-up, detected by SBIT
F2	<b>static trigger present:</b> this <b>no failure of DIFCUE</b> , but indicates an incorrect trigger input interface. A static trigger level is sensed at the trigger input during start-up. To avoid the self generation of a trigger pulse (i.e. rising edge) when enabling the trigger input, the system is deactivated until the trigger level is low, detected by SBIT
F3	<b>pushbutton „FIRED ROUNDS“ depressed or defective</b> during start-up, detected by SBIT

3.3 Design and Construction. The DIFCUE design and construction complies with the requirements stated in the following paragraphs.

3.3.1 Materials, processes and parts.

3.3.1.1 Hazardous Materials. The DIFCUE system without the Audio Visual Cue Pyrotechnic is free of hazardous material. The hazards from the Audio Visual Cue Pyrotechnic are limited by the 19200-DS-138 and specified in the military specification for the Audio Visual Cue Pyrotechnic. The DIFCUE shall not incorporate any asbestos or suspended glass fibre materials. The system shall preclude exposure of personnel or the environment to excessive levels of toxic, carcinogenic, or otherwise hazardous materials as defined by the Occupational Health and Safety Agency (OSHA), Environmental Protection Agency (EPA), or the Department of Transportation (DOT).

3.3.1.2 Castings. The casting material is aluminum.

3.3.2 Nameplate and Markings. The nameplates are mounted so that they may be seen and read easily. Assemblies, subassemblies and parts are marked in accordance with MIL-STD-130.

3.3.2.1 Main Identification Plate.

3.3.2.1.1 Fire Control Unit and Firing Unit: An aluminum plate with black background and natural text and text fields contains the nomenclature, contract-no., description, part-no., revision status, serial-no. and an application notice.

3.3.2.2 Warning and caution labels /markings.

3.3.2.2.1 Fire Control Unit and Firing Unit: The caution plate on FCU and FU, with black background and yellow text, has the following content: „CAUTION: THE SYSTEM MUST BE IN THE SAFE MODE BEFORE OPENING OR LOADING THE FIRING UNIT“

3.3.2.2.2 Hint Label on Firing Unit (visible after opening the cartridge carrier):  
The hint label on FU, with black background and white text, has the following content: „USE ONLY M31 (DIFCUE) CARTRIDGES IN THIS DEVICE“.

3.3.2.3 Battery. The 12 V, 2.5 Ah, sealed lead acid type battery is comprised of (6) 2 v cells in a package. The battery package is protected with a shock absorbing (silicone rubber) enclosure. The expected life under normal conditions is 2 years. The dimensions of the battery assembly are 176.5 mm x 118.6 mm x 90.5 mm.

The replacement of the battery should be done in accordance with the following procedure after opening the cartridge carrier:

- Open the cover (see marking of the cover) of the battery assembly (remove 7 screws),
- Remove cover and disconnect faston-contacts of interwiring
- Replace battery and connect faston-contacts (CAUTION: RED WIRE TO PLUS POLE, BLACK WIRE TO MINUS POLE!)
- Close the cover of the battery (ensure that O-ring seal is in place and insert 7 screws)
- See also 3.3.3.4, Battery Safety.

3.3.3 System Safety. The DIFCUE provides fail-safe features for safety of personnel during installation, operation, maintenance, loading/unloading, and testing. The Operating and Support Hazard Analysis (O&SHA) for the keyless Main Gun Signature Simulator (MGSS), Direct / Indirect Fire Cue (DIFCUE) and the Audio Visual Cue Pyrotechnic Simulator (Doc.No.: 9721803) deals with the evaluation of hazards or risks and the control of hazards or risks. The O&SHA makes notes for operational and support procedures. For operational safety see also 3.2.1 herein.

3.3.3.1 Electrical Safety. The electrical circuitry complies with the requirements of the National Electrical Code and the Occupational Safety and Health Act. The equipment is adequately grounded to protect equipment and personnel. The DIFCUE has a SAFE/ARM-Switch with a switch guard at the Fire Control Unit (see 3.2.1.1) and a SAFE-WHEEL on the Firing Unit (see 3.2.1.2.1). If the SAFE/ARM-Switch is pushed into SAFE-position, all power of the complete equipment is interrupted. If the Firing Unit was opened without setting the Fire Control Unit into SAFE-position, the microprocessor sets the FCU out of function. A reset of the Fire Control Unit is necessary (push SAFE/ARM-Switch from ARMED-position into SAFE-position and back into ARMED-position). A

Built-in test function provides fault detection and failures of a ``GO`` (green indicator lamp on Fire Control Unit) or „NOGO`` (red indicator lamp on Fire Control Unit) nature. The maximum voltage in the device is 31 VDC, the maximum current is 7 A.

3.3.3.2 Personnel Safety. The safety distance for the DIFCUE in operation (firing pyrotechnics) is 2m. Outside of this area there will be no influence of heat flux or fragmentation to personnel. Each activation by either MILES 2000 or MILES II causes the DIFCUE to immediately activate a warning whistle for 2,5 +/- 0,5 seconds and then immediately following the warning whistle the audio/visual cue shall fire only once.

3.3.3.3 Mechanical Safety. The DIFCUE is designed under consideration of personnel safety. The design incorporates handles on two opposite sides of the firing unit and a SAFE-WHEEL as a mechanical interlock (when the cartridge carrier is closed in the ARMED-position). The Firing Unit is configured to open or close in a clam shell manner. There are positive latching handles that lock the main body of the firing unit to the cartridge carrier portion of the firing unit. When the device is opened, after the SAFE-WHEEL is turned into SAFE-position, there is no contact of the pyro cartridges with the firing plate. Electrical contact occurs only when the two portions of the firing unit are positioned, locked and the SAFE-WHEEL is turned into ARMED-position. Proper procedures must be followed to assure that the device is „safe`` and that personnel avoid being in very close direct line of fire of loaded cartridges. Edges and corners, which be rounded and free from burrs. When the cartridge carrier is loaded with pyrotechnics and the handles are not latched, turning the SAFE-WHEEL into ARMED-position is not possible.

3.3.3.4 Battery. The DIFCUE contains a 12V, 2.5Ah, sealed lead acid type battery as backup power source. The battery is located in a dedicated and segregated part of the Firing Unit housing with a pressure relief valve. The battery charging system is a constant voltage (13.7 VDC nom.) trickle current (approx. 200 mA) type.

The battery assembly includes a silicone rubber enclosure which has the following raised or indented marking on the top and bottom sides;

- Identification Marking with nomenclature, description and part number .
- Caution Marking: „CAUTION: AVOID SHORT CIRCUIT; DO NOT THROW INTO FLAME. IF EXPOSED TO ELECTROLYTE, WASH IMMEDIATELY WITH WATER“.

The replacement of the battery should be done in accordance with the description in paragraph 3.3.2.3.

3.3.3.5 Fail-Safe. The DIFCUE has a fail-safe shut-off which removes power from the DIFCUE when in safe mode and contains two separate status indicators of different colors which indicate when the unit is armed and when in SAFE-position (see 3.3.3.1). The DIFCUE is not capable of receiving or generating false or uncontrolled signals which would cause it to generate a pyrotechnic activation inadvertently.

3.3.3.6 Loading/Unloading Pyrotechnics. The pyrotechnics are designed to be safe for normal handling, transport and storage. Nevertheless, care should always be taken when working with pyrotechnic devices. The normal loading/unloading procedure is as follows:

- a. The SAFE/ARM-Switch of the Fire Control Unit is pushed down into the SAFE-position (closing the red switch guard will force the switch to the SAFE-position). In the SAFE-position all power is switched off and there should be no system activity.
- b. Approach the Firing Unit from a direction away from or to the side of the pyrotechnic firing direction.
- c. Grip the SAFE-WHEEL of the Firing Unit and rotate into the SAFE-position (operator sees green portion of wheel with engraved text „SAFE“). Now the SAFE-WHEEL locking between the cartridge carrier and the main housing is released.
- d. Release the two side latches by pulling up on the side handles, then clear the latches so the cartridge carrier can be swing open.
- e. Load/unload with the proper pyrotechnic cartridges.
- f. If loading is complete, close the cartridge carrier, position the two latches and press down on side handles until latches are fully secured. Then rotate SAFE-WHEEL to the ARMED-position.  
Note: when the cartridge carrier is loaded with pyrotechnics and the latches are not fully secured, the SAFE-WHEEL cannot be engaged and cannot be rotated into the ARMED-position.
- g. If unloading is complete (and reloading is not desired) then close the cartridge carrier, position the two latches and secure them. The SAFE-WHEEL can remain in the SAFE-position.
- h. After loading the Firing Unit, and with the SAFE-WHEEL in ARMED-position, the SAFE/ARM-Switch at the Fire Control Unit should remain in the SAFE-position until the system is ready to be used.

3.3.3.7 Hangfire. There may be a situation in which the DIFCUE sends the appropriate activation signal and the pyrotechnic does not fire. The DIFCUE provides no indication of this type of pyrotechnic failure. As long as the electric match of the pyrotechnic is detected, the system recognizes this position as loaded position. There is no identification of hangfire pyrotechnics incorporated in the system. The DIFCUE moves on to the next available position when it receives the next trigger signal. Upon reset of the DIFCUE, BIT will run and the system may or may not produce an error code 27 depending on the integrity of the electric match inside the pyrotechnic. The suspect pyrotechnic should be removed and disposed of properly. The DIFCUE should be reloaded and checked via BIT.

3.3.4 Human Performance/Human Engineering. The DIFCUE permits rapid, error free performance of critical operational and maintenance tasks by 5th through 95th percentile soldiers working in the anticipated environments. The DIFCUE meets the criteria stated in MIL-STD-1472 (excluding paragraphs 5.7, 5.10, 5.11, 5.12, 5.14, and 5.15), MIL-STD-1474, MIL-HDBK-759, and the requirements of this specification.

3.3.5 Interchangeability. Items, subassemblies and parts with the same identification/part number shall be interchangeable in any DIFCUE device.

3.3.6 Workmanship. Workmanship shall be in accordance with MIL-STD-454 Rqt. 5 and 9.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. The contractor is responsible for the performance of all inspection requirements as specified herein. The contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspection set forth in the Specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance. All components of the DIFCUE must meet all requirements of Sections 3 and 5. The inspection set forth in this Specification becomes a part of the Contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Contractor Furnished Inspection Equipment.

4.1.2.1 Testing Facilities. Room conditions for test facilities are as specified in MIL-STD-810, Paragraph 5.1, subparagraph a., standard ambient.

4.1.2.2 Contractor Design. Concept, construction, materials, dimensions, and tolerances used in design of test equipment is selected and controlled to ensure that the test equipment indicates reliable acceptance of a product that does not exceed 90 percent of the prescribed tolerance limit and permit positive rejection when non-conforming.

4.1.2.3 Test Log. The log contains information by date as to those equipment activated, maintenance performed including adjustments and alignments, equipment failure, redesign, and replacement. The Contractor presents the information in the log to help the Government technical representative determine that the maintenance, alignment, or replacement has not invalidated previously completed tests.

4.2 Quality Conformance Inspections.

4.2.1 Acceptance Test. The DIFCUE should be tested in accordance with the „Acceptance Test Procedure for the MILES 2000 MGSS & DIFCUE“ Doc.No.: 9719201.

4.2.2 Conformance Verification. The results of the Acceptance Tests will be recorded in the Acceptance Test Report for Group A, B and C Inspection (see Acceptance Test Procedure for the MILES 2000 MGSS & DIFCUE“ Doc.No.: 9719201).

4.3 Pre-Production Qualification Test (PPQT). Prior to start of production and following any change in regular production methods, a production qualification lot of DIFCUE Kits shall be produced and tested in accordance with AMSTI-93-S027 paragraph 4.4.

4.4 Quality Conformance Inspections. Quality conformance inspection/tests shall be performed on all production lots in accordance with AMSTI-93-S027 paragraph 4.5.

## 5. PREPARATION FOR DELIVERY

5.1 Preservation, Packaging, Packing and Marking. Preservation, Packaging, Packing and Marking of the DIFCUE shall be in accordance with MIL-STD-2073-1, to assure arrival of each DIFCUE at its destination in an undamaged condition. Marking shall be in accordance with MIL-STD-129.

## 6. NOTES

6.1 Intended Use. The DIFCUE will be used to enhance the realism of training exercises. The DIFCUE is intended to simulate the flash, smoke, and noise of direct and indirect fire in order to help soldiers recognize when a vehicle is killed by MILES 2000 TES, or indirect fire is present and to assist forward observers in adjusting indirect fire. The major role of the DIFCUE shall be to operate with the MILES 2000 TES direct fire kill and the SAWE/MILES II for indirect fire indications in tactical (force on force) training exercises in accordance with Army Training and Evaluation Programs. The DIFCUE shall be capable of operating while mounted on vehicles that can be mobile or stationary. The DIFCUE will be deployed wherever the SAWE/MILES II - VDD is deployed and will be deployed with most MILES 2000 TES equipment.

### 6.2 Definitions

6.2.1 Damage. Damage is defined as the degradation in specified performance evidenced by one or any combination of the following conditions: breakage, loosening, shift, failure of any finish; failure of any hardware connection; failure of any component; condensation or moisture within the system packages; or deterioration in quality or complete failure of system performance as specified in this Specification.