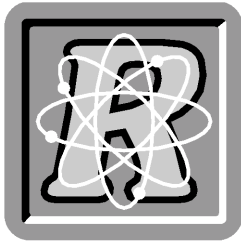


**Exhibit H: User Manual**

**FCC ID: CW21668-2-1W**



**ROTHENBUHLER  
ENGINEERING**

***REMOTE FIRING DEVICE***

***OPERATOR'S MANUAL***

***(DRAFT 10/25/99)***

The information contained in this document is subject to change without notice. In no event shall Rothenbuhler Engineering Company be liable for errors contained herein or for special, indirect, or consequential damages or injuries of any nature resulting from use of information in this document.

ROTHENBUHLER ENGINEERING  
P.O. BOX 708  
2191 RHODES ROAD  
SEDRO WOOLLEY, WA 98284

1668-A16  
10/25/99

©1999 Rothenbuhler Engineering  
All Rights reserved

# **SPECIAL NOTICE**

## **WARNING TO USERS AND AFFECTED PERSONS**

The Remote Firing Device (RFD) is designed to be used in blasting operations. Explosives used in connection with the RFD may be extremely powerful. Improper use of explosives with or without the RFD or improper safety precautions taken with respect to personnel or property may result in death, serious personal injury, or property damage. Other manufacturers' equipment that may not be in compliance with frequency coordination may inadvertently interfere with the operation of the RFD. Be aware of other operations within the receiving range of the RFD.

The literature accompanying this warning contains information of a general nature for users of the RFD based upon the Manufacturer's experience in the design and manufacture of remote radio frequency devices. In addition, the Manufacturer provides product literature and technical data sheets periodically which should be consulted for detailed information on the characteristics, specifications and recommendations for the RFD. The Manufacturer does not purport to give information or advice on explosives or their use.

The RFD and related explosive devices are intended for use only by trained professionals having comprehensive knowledge of the RFD, the explosives being used, and the application together with all related safety precautions. The Manufacturer of the RFD is responsible only for the proper performance of the RFD itself and is not responsible for the performance, safety, or specifications of the explosive used, nor the suitability of the RFD for any particular purpose other than that expressly described in the Manufacturer's literature.

## **LIMITED WARRANTY**

Manufacturer warrants the Model 1668 Remote Firing Device (RFD) to be free of defects in workmanship or materials for the period of one year from the date of purchase. In the event any RFD or component thereof is shown to be defective in workmanship or materials within one year, the system or component will be repaired or replaced without charge by Manufacturer at Manufacturer's place of business.

This warranty does not cover damage or injury to equipment resulting from abuse, neglect, or use in applications other than expressly described by Manufacturer as fit purposes for the RFD.

This Limited Warranty is given in lieu of all other legal warranties express or implied and neither Manufacturer nor its representatives shall be liable for any direct, incidental or consequential loss or damages arising out of any occurrence or accident involving the use of this product.

## **FCC NOTICE**

This device complies with Part 15 of the FCC regulations. Operation is subject to the following two conditions: (1) That this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

# TABLE OF CONTENTS

| Chapter                                         | Page |
|-------------------------------------------------|------|
| Special Notice .....                            | ii   |
| Warning to Users and Affected Persons .....     | ii   |
| Limited Warranty .....                          | ii   |
| FCC Notice .....                                | iii  |
| Table of Contents.....                          | iv   |
| List of Illustrations .....                     | vii  |
| Safety Summary .....                            | viii |
| 1. Introduction.....                            | 1-1  |
| 1.1. Purpose. ....                              | 1-1  |
| 1.2. Explosives Handling Practices.....         | 1-1  |
| 1.3. Storage and Environmental Conditions. .... | 1-1  |
| 1.4. Packaging.....                             | 1-2  |
| 1.5. Maintenance. ....                          | 1-4  |
| 2. Introduction to RFD System Components.....   | 2-5  |
| 2.1. System.....                                | 2-5  |
| 2.2. Controller Unit.....                       | 2-7  |
| 2.3. Controller Unit Switch Operation.....      | 2-8  |
| 2.4. Controller Unit Display Operation. ....    | 2-10 |
| 2.5. Detonator Unit.....                        | 2-12 |
| 2.6. Battery Charger Assembly.....              | 2-13 |
| 2.7. Antenna Assembly.....                      | 2-14 |
| 2.8. Carrying Case.....                         | 2-15 |
| 2.9. Vent operation. ....                       | 2-16 |
| 2.10. Antenna / Battery Charger Connector. .... | 2-17 |
| 2.11. Connector Dust Cover Operation. ....      | 2-19 |

|                                                                                                                                  |      |
|----------------------------------------------------------------------------------------------------------------------------------|------|
| 3. System Specifications. ....                                                                                                   | 3-20 |
| 3.1. Radio. ....                                                                                                                 | 3-20 |
| 3.2. Physical. ....                                                                                                              | 3-21 |
| 3.3. Battery. ....                                                                                                               | 3-21 |
| 3.4. Timing. ....                                                                                                                | 3-22 |
| 3.5. Detonate Output. ....                                                                                                       | 3-22 |
| 3.6. System Identification.....                                                                                                  | 3-23 |
| 4. Pre-Operational Procedures. ....                                                                                              | 4-24 |
| 4.1. Physical Inspection. ....                                                                                                   | 4-24 |
| 4.2. Battery Charging. ....                                                                                                      | 4-24 |
| 4.3. Battery Discharging.....                                                                                                    | 4-25 |
| 4.4. Bench Testing The System.....                                                                                               | 4-26 |
| 5. Operational Procedures.....                                                                                                   | 5-29 |
| 5.1. Ready the System at Site. ....                                                                                              | 5-29 |
| 5.2. Placement of Detonator Units. ....                                                                                          | 5-30 |
| 5.3. System Operation – Detonator Units Within 1,000 Feet of Controller Unit. ....                                               | 5-31 |
| 5.4. System Operation – Detonator Units More Than 1,000 Feet And Less Than 5 Miles From Controller Unit.....                     | 5-32 |
| 5.5. System Operation – Detonator Units Both Within and In Excess of 1,000 Feet and Less Than 5 Miles from Controller Unit. .... | 5-34 |
| 6. Post Operational Procedures.....                                                                                              | 6-36 |
| 6.1. Securing the System.....                                                                                                    | 6-36 |
| 6.2. Physical Inspection. ....                                                                                                   | 6-36 |
| 6.3. Packaging. ....                                                                                                             | 6-36 |
| 6.4. Maintenance & Equipment Storage. ....                                                                                       | 6-36 |
| 7. Basic Troubleshooting in the Field.....                                                                                       | 7-37 |
| 7.1. Detonator Units.....                                                                                                        | 7-37 |
| 7.2. Controller Unit.....                                                                                                        | 7-37 |
| 8. Optimizing Range.....                                                                                                         | 8-38 |



# LIST OF ILLUSTRATIONS

|                                                                  |      |
|------------------------------------------------------------------|------|
| Figure 1-1 RFD System.....                                       | 1-3  |
| Figure 2-1 RFD System.....                                       | 2-6  |
| Figure 2-2 Controller Unit. ....                                 | 2-7  |
| Figure 2-3 Detonator Unit. ....                                  | 2-12 |
| Figure 2-4 Battery Charger Assembly. ....                        | 2-13 |
| Figure 2-5 Antenna Assembly. ....                                | 2-14 |
| Figure 2-6 Carrying Case. ....                                   | 2-15 |
| Figure 2-7 Vent Operation. ....                                  | 2-16 |
| Figure 2-8 Controller Antenna / Battery Charger Connection. .... | 2-17 |
| Figure 2-9 Detonator Antenna / Battery Charger Connection.....   | 2-18 |
| Figure 2-10 Connector Dust Cover Operation. ....                 | 2-19 |
| Figure 3-1 Identification Label. ....                            | 3-23 |
| Figure 8-1 Unit Normal Transmission Location.....                | 8-39 |
| Figure 8-2 Detonator Unit Elevated. ....                         | 8-39 |
| Figure 8-3 Detonator Unit Tilted. ....                           | 8-40 |
| Figure 8-4 Antenna Radiation Pattern .....                       | 8-41 |

# SAFETY SUMMARY

The following are WARNINGS and CAUTIONS, contained throughout this manual and are repeated here for emphasis. All personnel engaged in the handling, firing, and storage of the system covered in this manual must fully understand these WARNINGS and CAUTIONS, and procedures by which hazardous conditions are to be reduced or eliminated. Also listed are general safety precautions that are not related to any specific procedures and therefore don't appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

**WARNING** Never rely on the equipment for your safety.

**WARNING** Use of this system and its components must be restricted to personnel qualified and experienced in the field of explosives and detonating devices. Under no circumstances shall untrained personnel attempt to use this manual as a text for self-teaching.

**WARNING** This system and its components should be stored in a secure area with no access to unauthorized personnel. This system can be used in conjunction with explosives as a deadly weapon.

**WARNING** These radios contain batteries. The potential for activation is always present whether or not antennas are attached to the units.

**WARNING** Employ standard blasting system safety standards when using this equipment with explosives.

**WARNING** Lightning induced energy, caused by electrical storms, can detonate explosives. In the interest of safety, blasting on land, water and underground should be suspended and all personnel should be evacuated to a safe distance from the blast area whenever lightning storms are in the vicinity. Dangerous levels of static electricity can build up in the atmosphere. These levels can be sufficient to detonate explosives.

**WARNING** Radio frequency energy of sufficient magnitude can cause blasting caps to detonate.

**WARNING** To eliminate long wire runs, and to make the "shoot" from a safe distance, the Remote Firing Device uses low energy level radio frequency transmissions.

**WARNING** The Controller Unit has a 5 watt output power level (5 mile transmit range). The Controller Unit should be considered DANGEROUS and NEVER be operated within 100 feet (minimum) of blasting caps, wires connected to blasting caps, or other electrically initiated explosives devices. Do NOT apply power to the Controller Unit unless the operator is at least 100 feet from blasting caps, wires connected to blasting caps, or explosives.

**WARNING** Do not connect a blasting cap to a Detonator Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electrically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

**WARNING** Ensure that blasting caps are not connected to any of the Detonator Units during bench test.

**WARNING** This is a sensitive electronic radio system and it may be damaged.

**WARNING** Detonator Units have been tested and are safe to use near explosives and blasting caps. The low level of transmit power (less than 100 milliwatts) used by the Detonator Unit will NOT detonate blasting caps, even if they are directly connected to the Detonator Unit's antenna terminals. The Detonator Unit transmission range is limited - approximately 1,000 feet. The Detonator Units will receive and will act upon commands from the Controller Unit which may be located in the line of site up to 5 miles away. The controller Unit need not and may not receive verification from a Detonator Unit which is more than 1,000 feet away.

**CAUTION** Do not assume the Disarm command has been received by the Detonator Unit unless DISARMED status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. If distance appears to be the problem, move closer to the Detonator Unit following standard procedures for this type of situation. The "STATUS" and/or "DISARM" switches may be pressed repeatedly as the Detonator Unit is approached. Maintain a safe distance from the Detonator Unit. Do not approach the Detonator Unit until Disarmed status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. Under no conditions should the "FIRE" switch be pressed as the Detonator Unit is approached. Do not bring the Controller Unit closer than 100 feet to blasting caps, wires connected to blasting caps, or other explosives.

**CAUTION** All units must be thoroughly tested and the batteries fully charged prior to operational use.

**CAUTION** Unequal air pressure inside the Controller Unit may affect the operation of membrane switch keypad. Extreme pressure differentials may irreversibly damage the keypad and/or cases.

**CAUTION** Vents in all units should be momentarily opened and closed immediately before use.

**CAUTION** Do not open a vent if there is water on or near the vent. Take necessary precautions to ensure water does not enter the vent.

**CAUTION** Do not use any component that is damaged, suspected of being damaged, or is not able to operate as designed. The safety of the operation could be compromised.

# **1. INTRODUCTION.**

## **1.1. PURPOSE.**

1.1.1. The primary purpose of this manual is to provide descriptive information, operational information, instructions in assembly, and instructions in testing and preparation for operational or training use of the Remote Firing Device (RFD).

1.1.2. The Remote Firing Device (RFD) is used to activate electric detonator devices. The System is strictly an electronic device, containing no explosive. The Controller Unit shall be operated from 100 feet to five miles from the explosive. The Detonator Unit shall be placed at the explosive site, with a two-conductor firing line running to the explosive. The Controller Unit communicates to the Detonator Unit through a two-way RF transmitter data link, for a line of site distance of 5 miles. The Detonator Unit can return communication for a distance of 1,000 feet.

## **1.2. EXPLOSIVES HANDLING PRACTICES.**

1.2.1. The transmitting output power of a Detonator Unit is limited to less than 100 milliwatts. The Detonator Unit's radio frequency power output level is well below the safe energy limits cited by the IME (Institute for Manufacturers of Explosives) to detonate a single blasting cap via radio frequency energy. This safe power level has been established by IME in Pamphlet 20, titled "Safety Guide for the Prevention of Radio Frequency Radiation Hazards In the Use of Commercial Electric Detonators (Blasting Caps)."

## **1.3. STORAGE AND ENVIRONMENTAL CONDITIONS.**

1.3.1. The Controller Unit and Detonator Unit have manual operated vents. The vents should always be CLOSED during air transport, underwater transport, storage and operational use to prevent moisture intake. The operator should momentarily open and close the vent after the unit has been subjected to changes in elevation or depth. This equalizes pressure within the case to the outside environment. DO NOT open the vent if there is water on or near the vent. Towel dry prior to opening vents. The vents should be OPEN, when stored in a dry hot environment.

1.3.2. The Controller Unit and Detonator Unit (with vents closed) are airtight to an altitude of 30,000 feet and watertight to a depth of 100 feet.

1.3.3. The Controller Unit and Detonator Units are shock resistant, drop tested from 5 feet onto concrete.

1.3.4. The battery pack and unit electronics are electrically isolated from the unit case.

1.3.5. The Controller Unit and Detonator Unit have a temperature operation from -22 °F to +140 °F.

#### 1.4. PACKAGING.

1.4.1. The RFD Systems are packaged in a hard-shell carrying case. The Controller Unit and all Detonator Units have an individual cut-out location in the internal packing. There is a cut-out location in the internal packing for all the Antenna Assemblies. Provided in Carrying Case Assembly is a cut-out location in the internal packing with the Battery Charger Assembly. Do not damage or throw away the Carrying case Assembly, this is used to store and ship the RFD System.

Table 1-1 RFD System

| Figure     | Index No. | Description              | Units Per System |
|------------|-----------|--------------------------|------------------|
| Figure 1-1 | 1         | Controller Unit          | 1                |
| Figure 1-1 | 2         | Detonator Unit           | 8                |
| Figure 1-1 | 3         | Battery Charger Assembly | 1                |
| Figure 1-1 | 4         | Antenna Assembly         | 9                |
| Figure 1-1 | 5         | Carrying Case Assembly   | 1                |

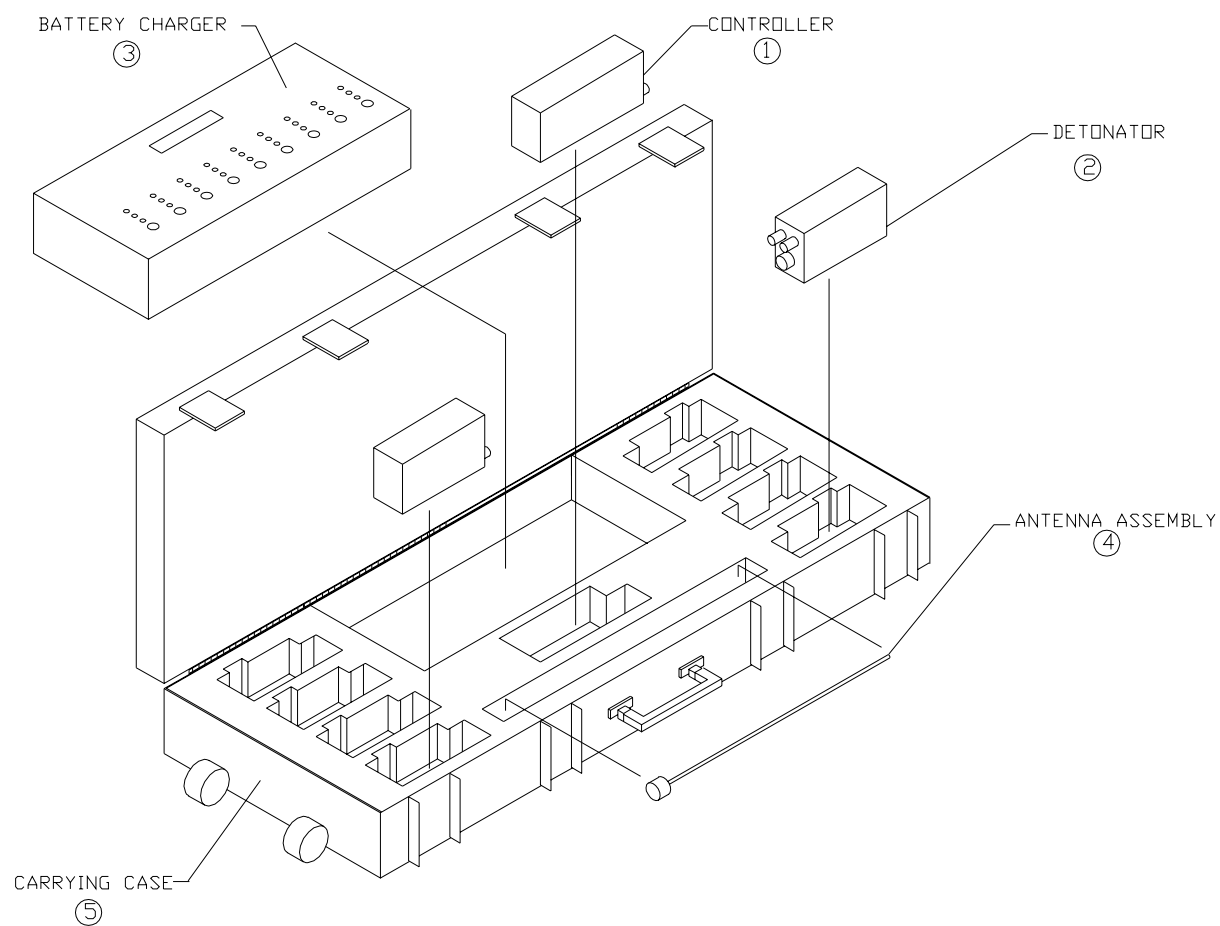


Figure 1-1 RFD System.

## 1.5. MAINTENANCE.

1.5.1. Periodic maintenance is limited to discharging and charging the battery packs.

1.5.2. Corrective maintenance shall be accomplished at the Manufacturer or Repair Depot. Replacement of parts or repair at the user level and field disassembly is not authorized.

1.5.3. In case of failure of a component of the RFD System, ship the System to the Repair Depot.

## 2. INTRODUCTION TO RFD SYSTEM COMPONENTS.

### 2.1. SYSTEM.

2.1.1. The RFD is a battery powered, hand held, radio remote controlled system to be used on land as a primary firing mechanism to detonate explosive charges. The RFD system consists of a Controller Unit and 8 Detonator Units.

2.1.2. The Controller Unit and Detonator Units in one System will not operate with Units from another System.

2.1.3. The RFD is transportable over land, underwater to a depth of 100 feet, and in the air to an altitude of 30,000 feet. The units are shock resistant (5 feet to concrete) and impervious to static discharge.

2.1.4. The RFD will operate in a temperature range of -22 °F to + 140 °F.

2.1.5. The system has two modes of operation; the one-way (out of range) and the two-way (in range) mode.

2.1.5.1. Range for one-way mode is up to 5 miles in the line of site.

2.1.5.2. Range for two-way mode is up to 1,000 feet in the line of site.

2.1.6. The RFD System consists of the component parts in Table 2-1. The total system is shown and identified in Figure 2-1.

Table 2-1 RFD System.

| Figure     | Index No. | Description              | Units Per System |
|------------|-----------|--------------------------|------------------|
| Figure 2-1 | 1         | Controller Unit          | 1                |
| Figure 2-1 | 2         | Detonator Unit           | 8                |
| Figure 2-1 | 3         | Battery Charger Assembly | 1                |
| Figure 2-1 | 4         | Antenna Assembly         | 9                |
| Figure 2-1 | 5         | Carrying Case Assembly   | 1                |

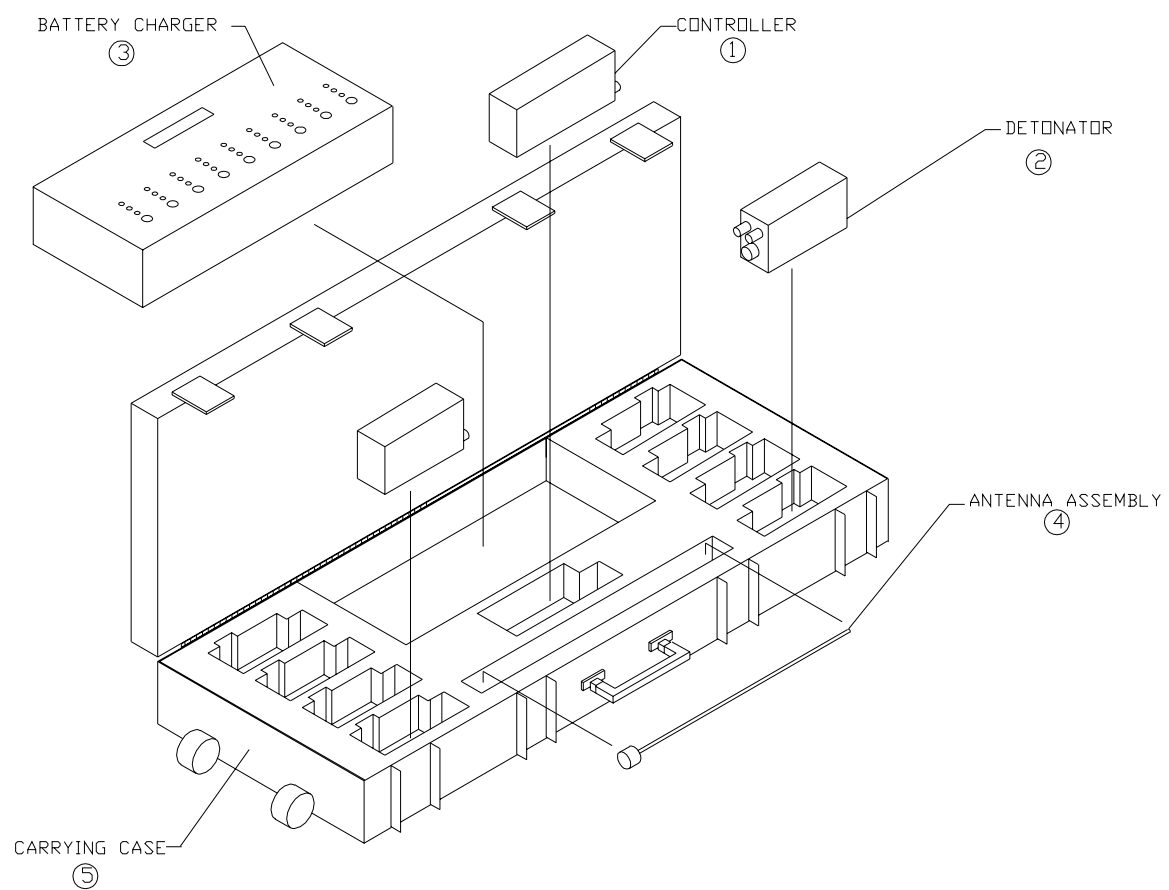


Figure 2-1 RFD System.

## 2.2. CONTROLLER UNIT.

2.2.1. Figure 2-2. Provides the physical size, weight, front panel light, and switch locations on the Controller Unit. The unit is sealed at the Manufacturer or repair depot and should not be opened during field activity.

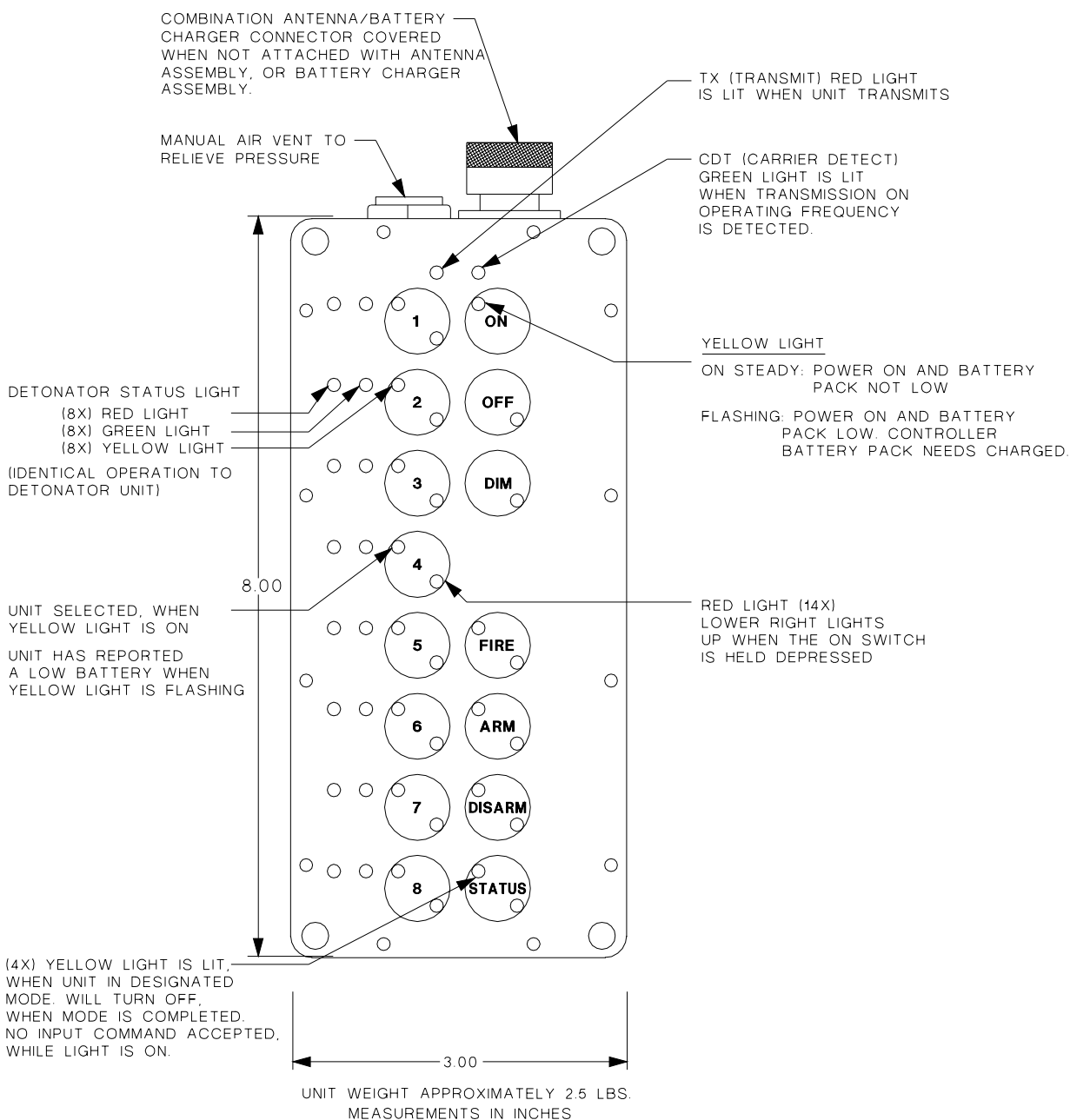


Figure 2-2 Controller Unit.

## 2.3. CONTROLLER UNIT SWITCH OPERATION.

2.3.1. **Unit Power Control.** Depress the “ON” switch to turn the power on to the Controller Unit when the Antenna Assembly is attached. Depress the “OFF” switch to turn the power off to the Controller Unit. The power is off when the Antenna Assembly is removed.

2.3.2. **Display Panel Light Dimmer Circuit.** Depress the “DIM” switch to toggle the display panel lights dim or bright.

2.3.3. **Select Detonator Units.** Depress “1” through “8” switches to select independently the Detonator Units that will communicate with the Controller Unit. Any combination of the eight Detonator Units may be selected. The yellow SELECT light on the switch indicates if the Detonator Unit programmed for that switch is selected. Press the switch again and the yellow SELECT light for that Detonator Unit will be turned off indicating the Detonator Unit is not selected.

2.3.4. **Request Detonator Unit Status.** Depress “STATUS” switch to transmit a status request signal to the selected Detonator Units. The selected Detonator Units will transmit their current status to the Controller Unit. If none of the Detonator Units are selected, the Controller Unit will request status from all eight Detonator Units. If the Controller Unit is within range of the Detonator Unit transmitter, the status of the selected Detonator Unit will be presented on the display panel with a steady light. If the Controller Unit is out of range of the Detonator Unit transmitter, the status will be assumed from the last command sent to that Detonator Unit. In that case the assumed status of the Detonator Unit will flash on the display panel.

2.3.5. **Arm the Detonator Unit.** Depress the “ARM” switch for 1/2 second and the Controller Unit will transmit the Arm command to the selected Detonator Units. The red ARMED light at the selected Detonator Units will flash on the Controller Unit display panel until the firing capacitor charging time is completed. The Controller Unit then requests status of the selected Detonator Units. If the Controller Unit is within range of the selected Detonator Unit transmitter, the ARMED red light for that Detonator Unit will be on steady on the Controller Unit display panel. If the Controller Unit is out of range of the selected Detonator Unit transmitter, the red ARMED light for that Detonator Unit will continue to flash on the Controller Unit display panel. If the Fire command is not sent within 60 seconds, the system will disarm automatically.

**2.3.6. Disarm the Detonator Unit.** Depress the “DISARM” switch, the Controller Unit will transmit the Disarm command to selected Detonator Units. Selected Detonator Units will internally discharge their firing capacitor. Selected Detonator Units that receive the Disarm command will become Disarmed within 3 seconds of receiving the command. The green DISARMED light for selected Detonator Units will begin to flash on the Controller Unit display panel. The Controller Unit will then request status of selected Detonator Units. If the Controller Unit is within range of the selected Detonator Unit transmitter, the green DISARMED light for that Detonator Unit will turn to steady on the Controller Unit display panel. If the Controller Unit is out of range of the selected Detonator Unit transmitter, the green DISARMED light for that Detonator Unit will continue to flash on the Controller Unit display panel. If the Fire command is not sent within 60 seconds of Arming, the system will Disarm automatically.

**CAUTION** Do not assume the Disarm command has been received by the Detonator Unit unless DISARMED status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. If distance appears to be the problem, move closer to the Detonator Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Detonator Unit is approached. Maintain a safe distance from the Detonator Unit. Do not approach the Detonator Unit until Disarmed status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Detonator Unit is approached. Do not bring the Controller Unit closer than 100 feet to blasting caps, wires connected to blasting caps, or other explosives.

**2.3.7. Activate the Detonator Unit Firing Circuit.** Depress the “FIRE” switch for 1/2 second and the Controller Unit will transmit the Fire command to selected Detonator Units. If the “FIRE” switch is pressed during the firing capacitor charge time, the Controller Unit will wait until the Detonator Units have had time to fully Arm, and then it will send the Fire command automatically. The Controller Unit will only transmit the Fire command to selected Detonator Units whose status is Armed. The selected Detonator Units will be placed in Fire Mode and discharge the firing capacitor across the binding posts. The red ARMED light will turn off and the green DISARMED light for each selected Detonator Unit will begin to flash on the Controller Unit display panel. The Controller Unit will then request status from the selected Detonator Units. If the Controller Unit is within range of the selected Detonator Unit transmitter, the DISARMED green light for that Detonator Unit will turn to steady on the Controller Unit display panel. If the Controller Unit is out of range of the selected Detonator Unit transmitter, the green DISARMED light for that Detonator Unit will continue to flash on the Controller Unit display panel.

**2.3.8. Multistage Firing of Detonator Units.** Multistage firing provides the ability to Arm all eight Detonator Units at one time, and select any combination of the Detonator Units to Fire at different intervals within the 60 second Arm period. The procedure for multistage firing is :

- Depress “1” through “8” switches.

- Depress “ARM” switch – all eight Detonator Units will Arm.
- Depress the switches for the Detonator Units that will not be fired initially.
- Depress the “FIRE” switch. Only Detonator Units still selected will Fire.
- Depress the switches for the Detonator Units that were just Fired.
- Depress the switches for Detonator Units to be Fired next.
- Depress the “FIRE” switch. Only Detonator Units still selected will Fire.
- Repeat as necessary. Detonator Units will automatically Disarm if not Fired within 60 seconds of Arming.

2.3.9. **Misfires.** If a Detonator Unit does not Fire when the Fire command is sent, repeat Fire sequence up to 3 times. If the Detonator Unit continues not to Fire, then a thirty-minute wait prior to approaching is mandatory. Follow your standard operating procedures for misfires.

## 2.4. CONTROLLER UNIT DISPLAY OPERATION.

2.4.1. **Nighttime Panel Switch Locator.** There are fourteen red lights used for backlighting the Controller Unit switches. When the “ON” switch is pressed, the lights turn on to locate the switch positions.

2.4.2. **Display Panel Dimmer Circuit.** Pressing “DIM” switch reduces the intensity of all of the panel display lights except the ON light.

2.4.3. **Controller Unit Battery Status.** The yellow light at the “ON” switch displays the Controller Unit battery status. If the Controller Unit Battery is low, the yellow light at the “ON” switch will flash. Otherwise this light will be on steady.

2.4.4. **Detonator Unit Battery Status.** The yellow select light at each of the “1” through “8” switches will indicate the selected Detonator Units’ battery status after a status request command is issued. If the selected Detonator Unit transmitter is within range of the Controller Unit and Detonator Unit’s battery is low, the yellow select light for that Detonator Unit will flash. Else, the select light will be on steady.

2.4.5. **Detonator Unit Disarmed.** A green light next to each of the “1” through “8” switches is used to indicate when the corresponding Detonator Unit is Disarmed. The light will be on steady when the Detonator Unit transmitter is within range of the Controller Unit and it is Disarmed. If the Detonator Unit transmitter is out of range of the Controller Unit, the light will flash after a Disarm command has been sent.

2.4.6. **Detonator Unit Armed.** A red light next to each of the “1” through “8” switches is used to indicate when the corresponding Detonator Unit is Armed. The ARMED light for selected Detonator Units will flash after the Arm command is sent to the selected Detonator Units. The ARMED light will go to steady after the firing capacitor charge time if the Controller Unit is within range of the selected Detonator Unit's transmitter. If the Detonator Unit transmitter is out of range of the Controller Unit, the ARMED light will continue to flash.

2.4.7. **Status.** A yellow light at the “STATUS” switch lights when the “STATUS” switch is pressed. The light remains on until the display panel has been updated with results of the status request. All new commands are blocked while this light is on.

2.4.8. **Arm.** A yellow light at the “ARM” switch lights when the “ARM” switch is pressed. This light will stay on for the firing capacitor charge time. Other commands will not be sent until this light is turned off.

2.4.9. **Disarm.** A yellow light at the “DISARM” switch lights when the “DISARM” switch is pressed. This light will stay on until the display panel is updated for the Disarm command. Other commands will not be sent until this light is turned off.

2.4.10. **Fire.** A yellow light at the “FIRE” switch lights when the “FIRE” switch is pressed. This light will stay on until the display panel is updated for the Fire command. Other commands will not be sent until this light is turned off.

2.4.11. **“TX” (Transmit).** A red light at the “TX” position lights while Controller Unit is transmitting.

2.4.12. **“CDT” (Receiver).** A green light at the “CDT” position lights when the Controller Unit is receiving status from the Detonator Units. The light will be on whenever the Controller Unit detects transmissions on its operating frequency.

## 2.5. DETONATOR UNIT.

2.5.1. Figure 2-3. Provides the physical size, weight, and front panel lights on the Detonator Unit. The unit is sealed at the Manufacturer or repair depot and should not be opened during field activity.

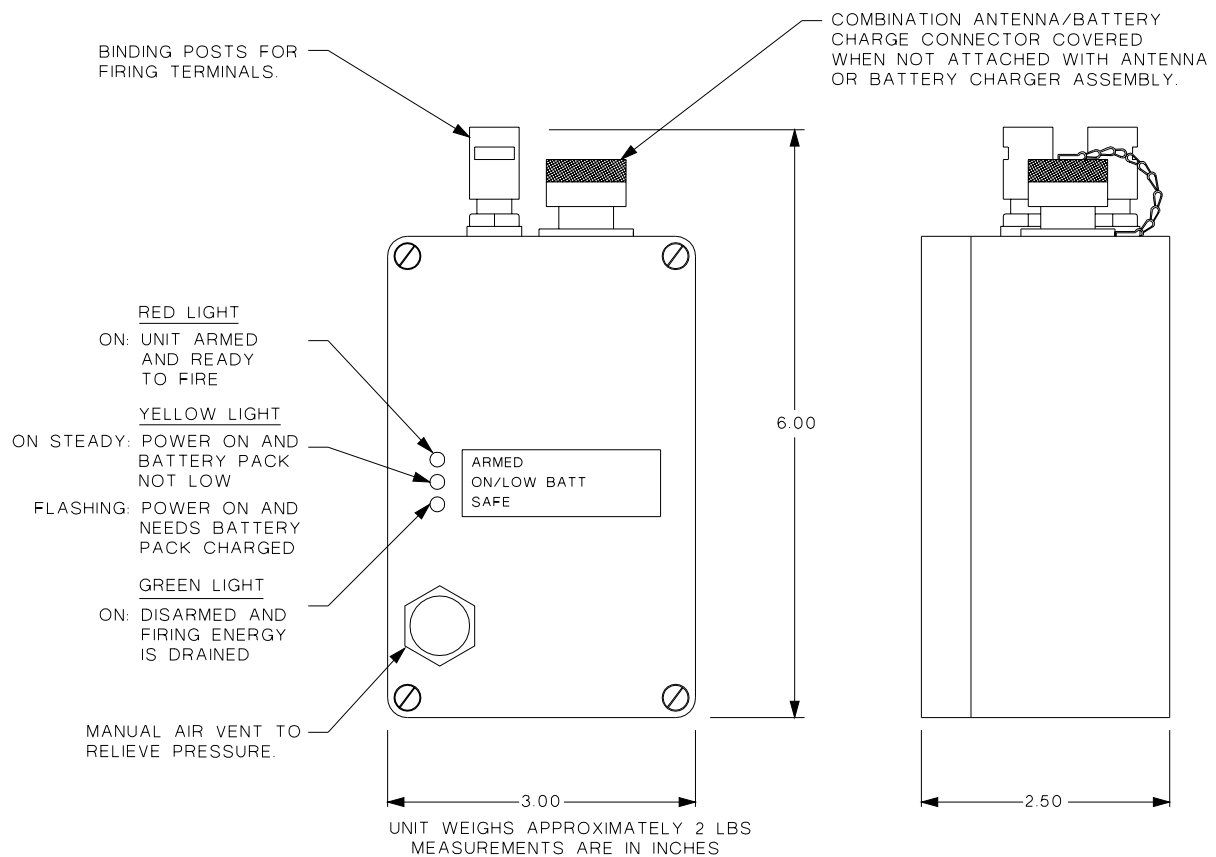


Figure 2-3 Detonator Unit.

## 2.6. BATTERY CHARGER ASSEMBLY.

2.6.1. Figure 2-4. Provides the front panel lights, and switch position on the Battery Charger Assembly. The unit is sealed at the Manufacturer or repair depot and should not be opened during field activity.

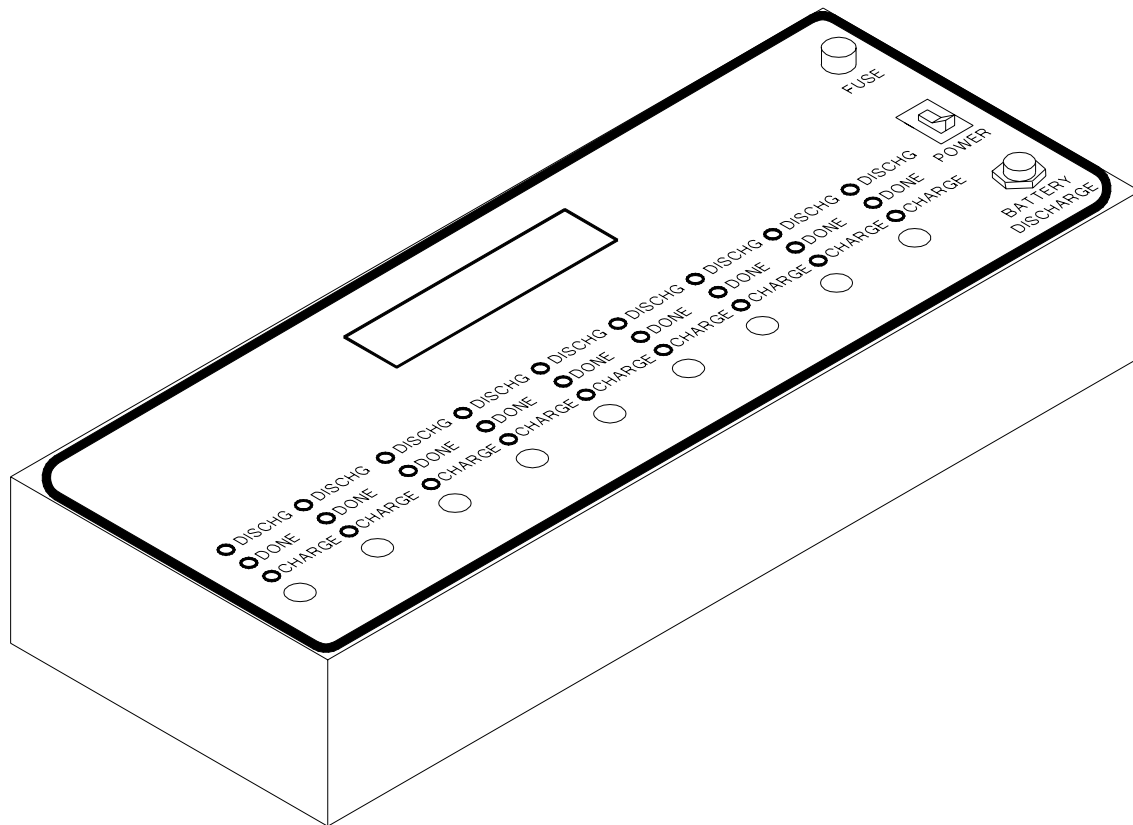


Figure 2-4 Battery Charger Assembly.

## 2.7. ANTENNA ASSEMBLY.

2.7.1. Figure 2-5. Provides the physical size, technical requirements and view of the Antenna Assembly. The power to the Controller Unit and Detonator Unit is interrupted when the Antenna Assembly is not connected.

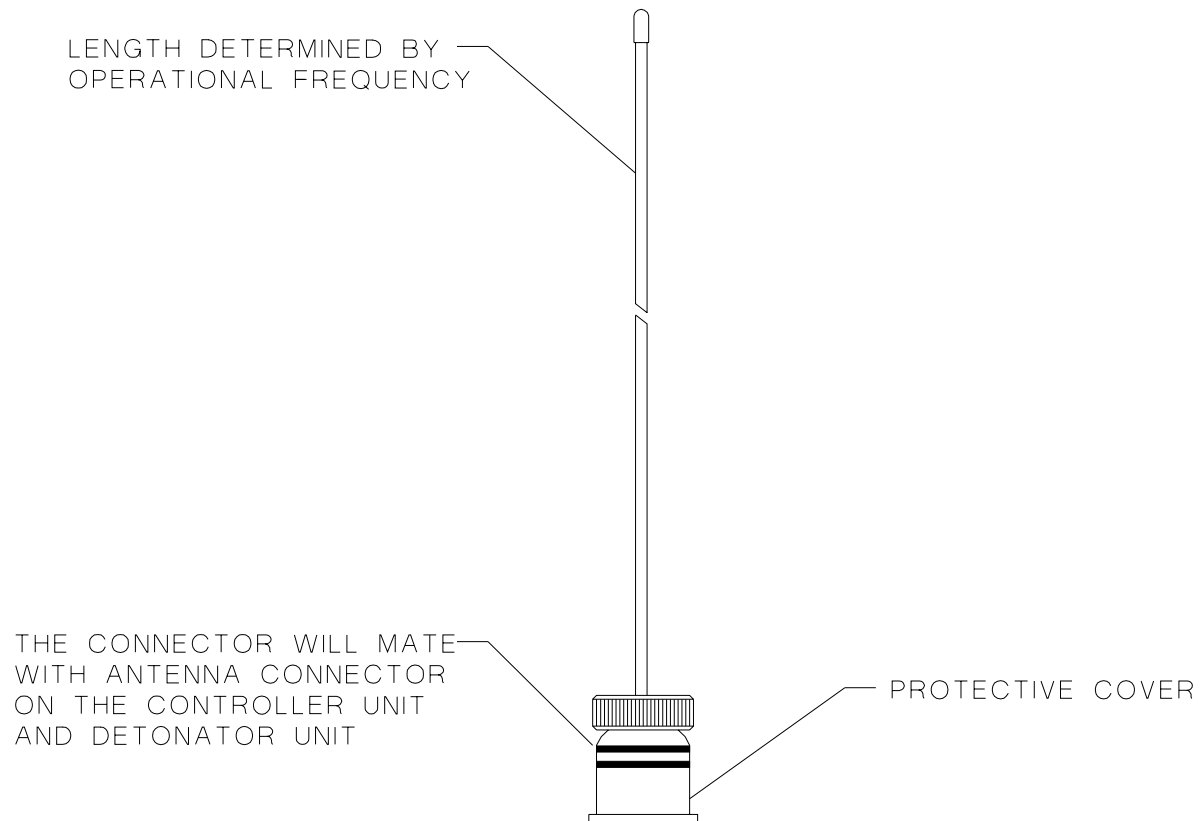


Figure 2-5 Antenna Assembly.

## 2.8. CARRYING CASE.

2.8.1. Figure 2-6. Provides the physical size of the Carrying Case and a view of the storage location for System assemblies in the Carrying Case. The Carrying Case has a pressure equalization vent near the handle. The vent should be opened prior to opening the Carrying Case. The vent should be kept closed during storage and shipment.

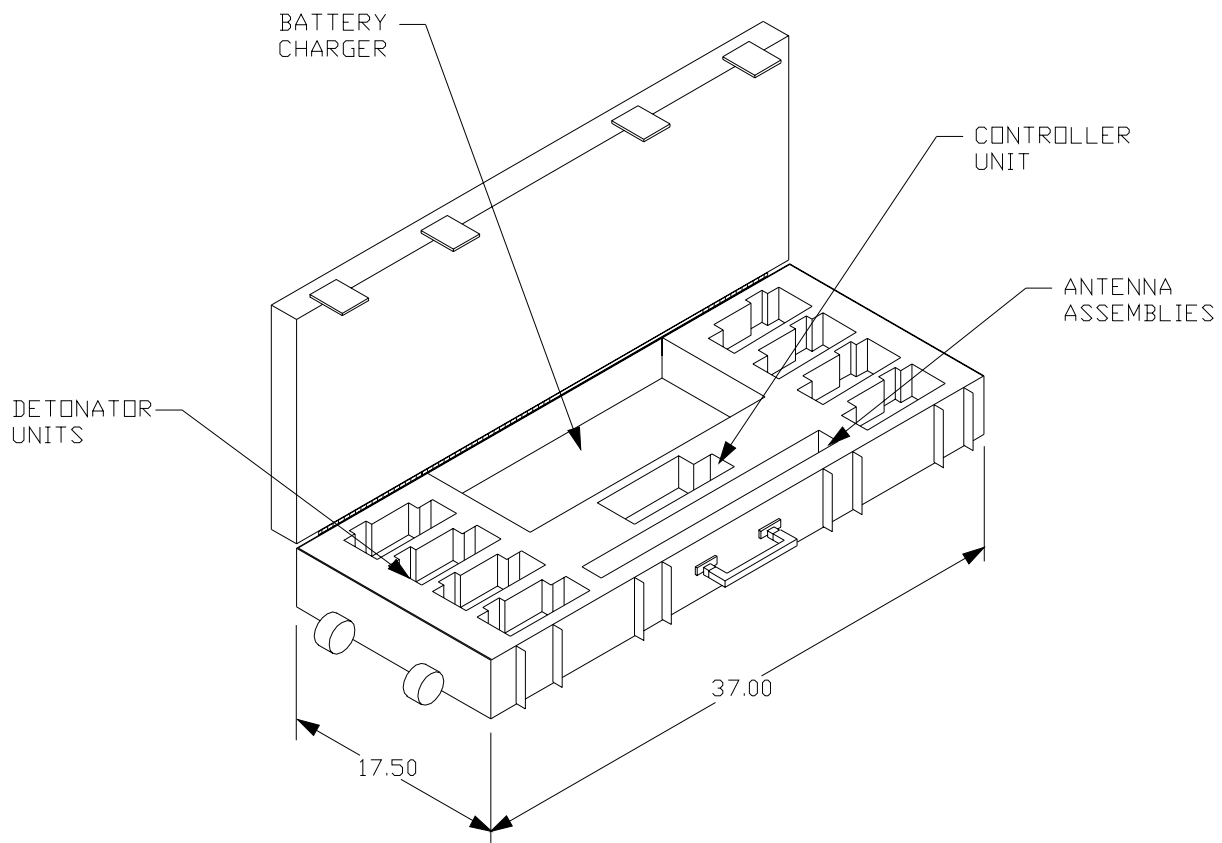


Figure 2-6 Carrying Case.

## 2.9. VENT OPERATION.

2.9.1. Figure 2-7. The Controller Unit and Detonator Unit vents are manual and relieve internal pressure due to heat and altitude. When the vent is closed, it will not leak in 100 feet of water or up to 30,000 feet in altitude.

**CAUTION** Unequal air pressure inside the Controller Unit may affect the operation of membrane switch keypad. Extreme pressure differentials may irreversibly damage the keypad and/or cases.

**CAUTION** Vents in all units should be momentarily opened and closed immediately before use.

**CAUTION** Do not open a vent if there is water on or near the vent. Take necessary precautions to ensure water does not enter the vent.

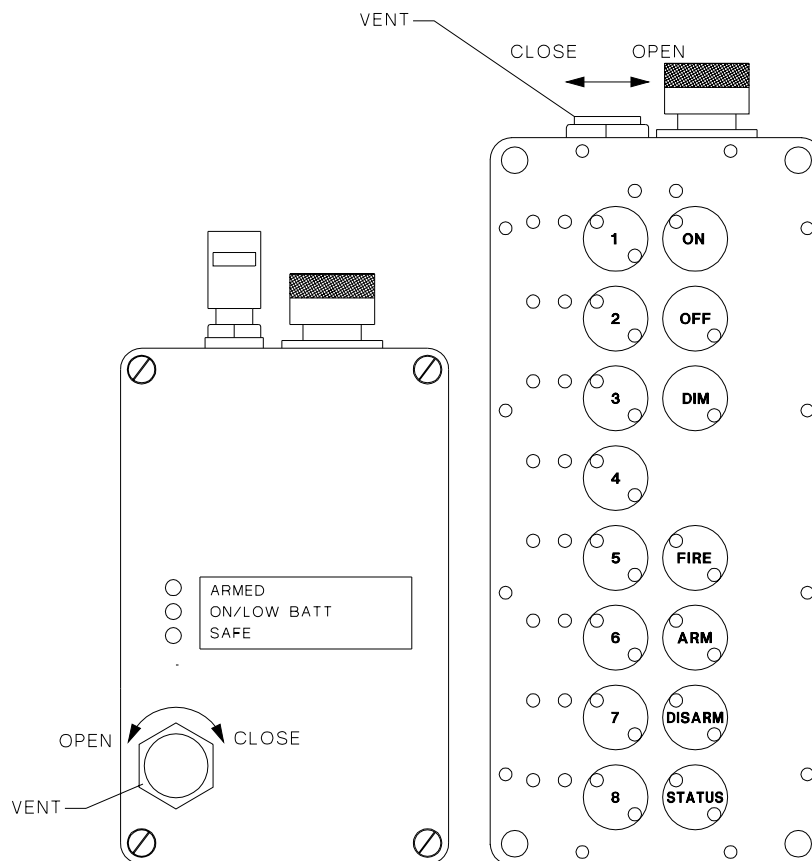


Figure 2-7 Vent Operation.

## 2.10. ANTENNA / BATTERY CHARGER CONNECTOR.

2.10.1. Figure 2-8. & Figure 2-9. The Controller Unit and Detonator Unit antenna / battery charger connector accommodates the input requirements for both the Antenna Assembly and the Battery Charger Assembly. The unit electronics and battery pack are only connected together when the Antenna Assembly is connected to the antenna / battery charger Connector.

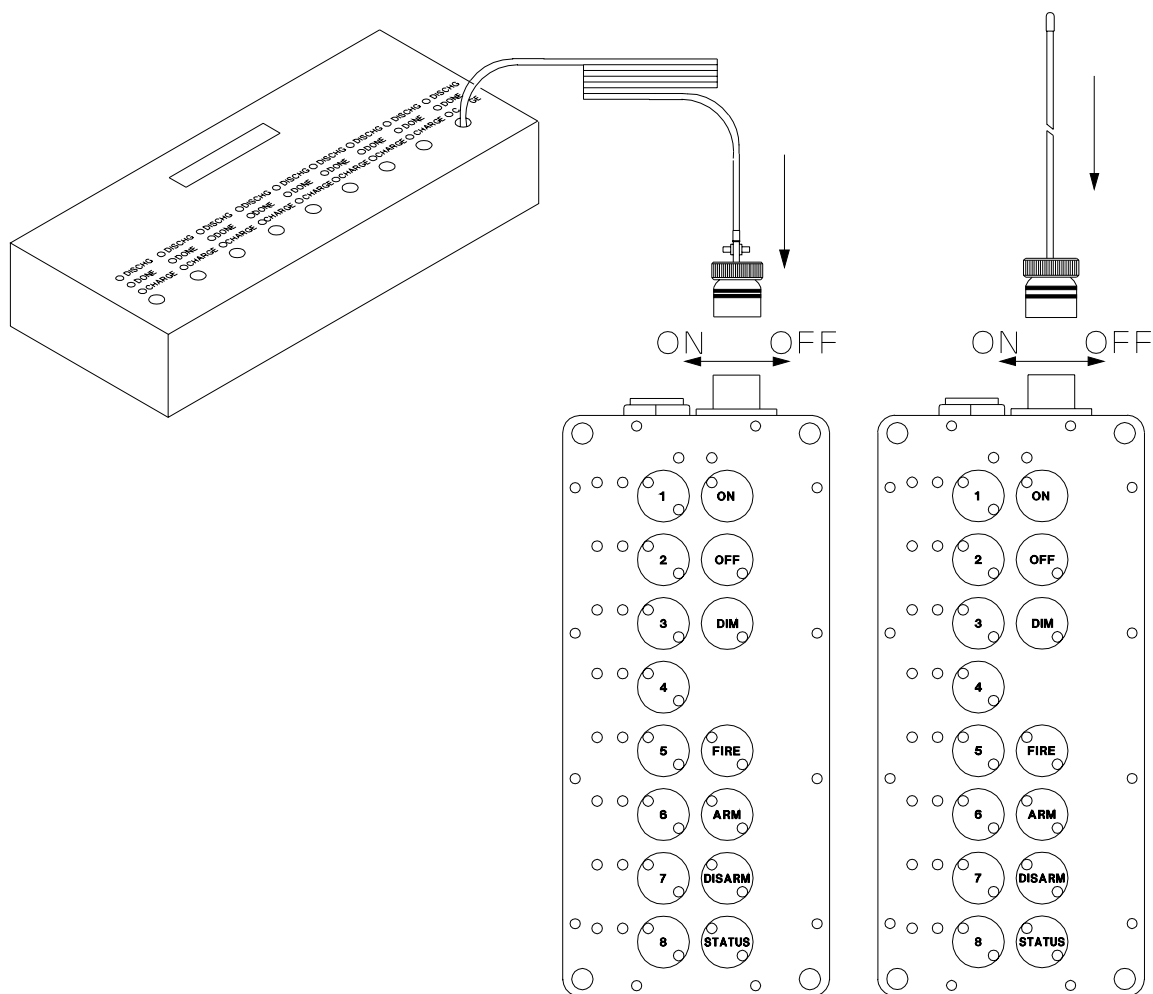


Figure 2-8 Controller Antenna / Battery Charger Connection.

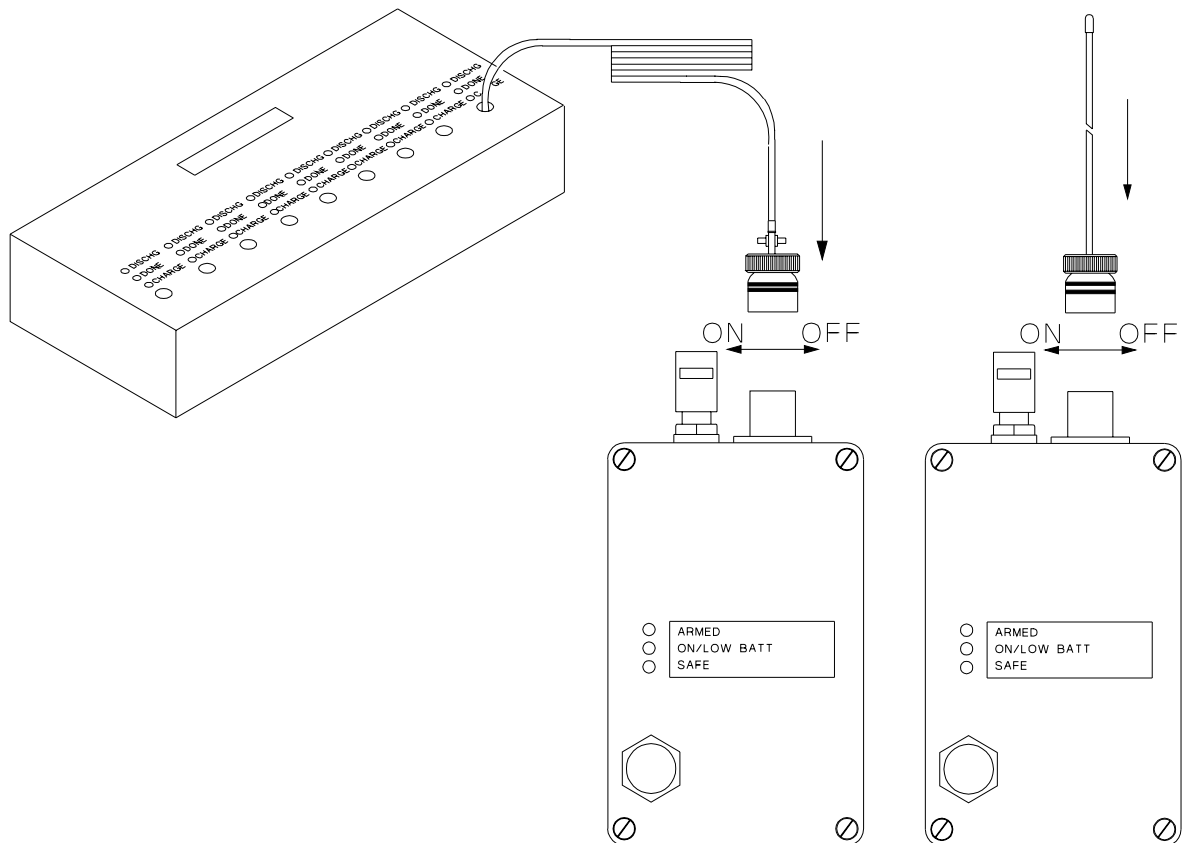


Figure 2-9 Detonator Antenna / Battery Charger Connection.

## 2.11. CONNECTOR DUST COVER OPERATION.

2.11.1. Figure 2-10. The Controller Unit and Detonator Unit antenna / battery charger connector dust cover protects the connector pins from shorting out and damage when the Antenna Assembly or Battery Charger Assembly is not connected. The connector dust cover should be connected to the connector when the connector is not in use.

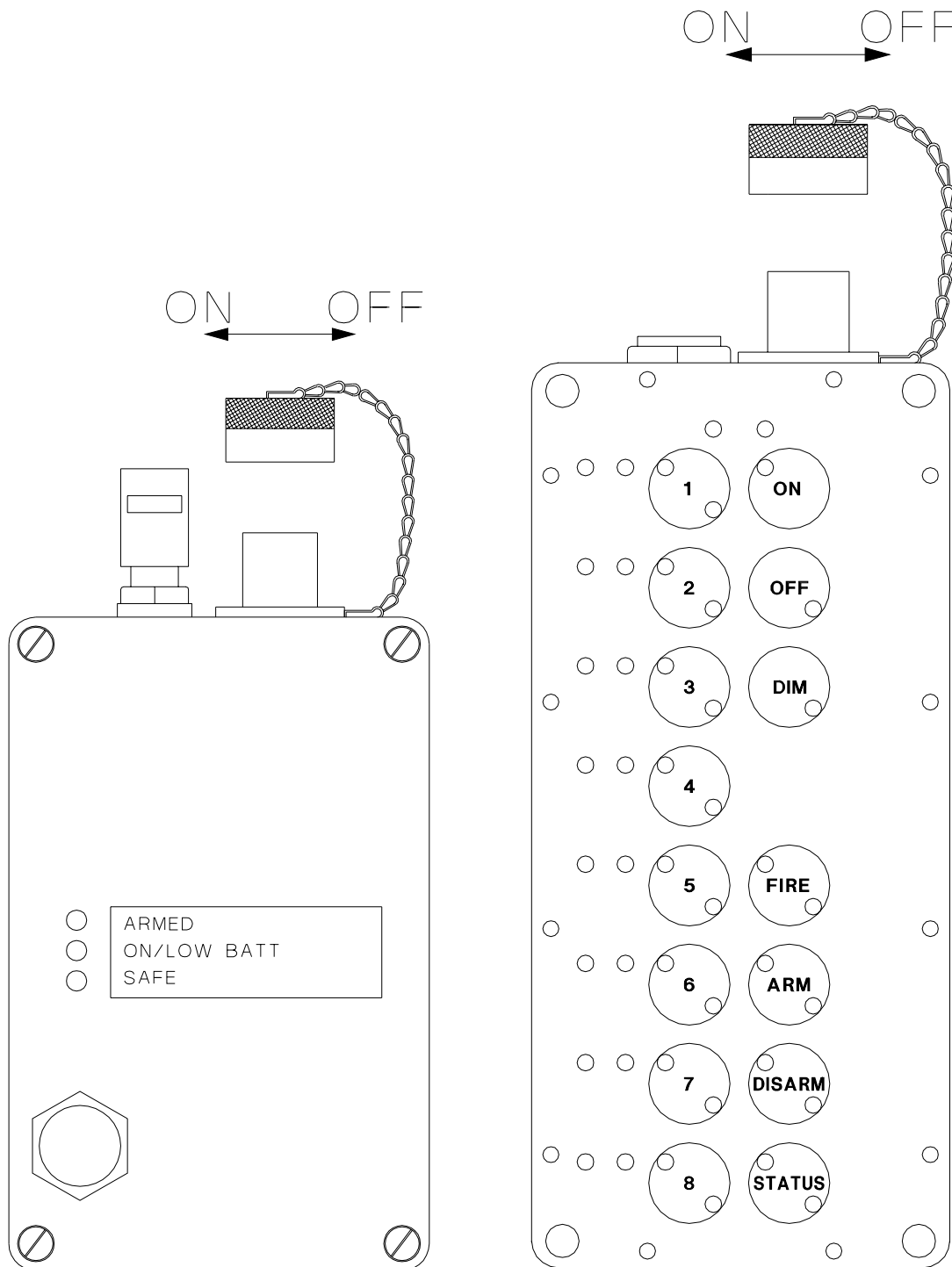


Figure 2-10 Connector Dust Cover Operation.

### 3. SYSTEM SPECIFICATIONS.

#### 3.1. RADIO.

|                             |                            |                                   |                                     |
|-----------------------------|----------------------------|-----------------------------------|-------------------------------------|
| CARRIER<br>FREQUENCY        | 135 - 174 MHz *            | OPERATING<br>TEMPERATURE<br>RANGE | -30°C to 60°C<br><br>-22°F to 140°F |
| FCC ID:                     | CW21668-1                  | CW21668-2                         | CW21668-2-1W***                     |
|                             | <u>CONTROLLER<br/>UNIT</u> | <u>REMOTE UNIT</u>                | <u>REMOTE UNIT</u>                  |
|                             |                            | <u>100 mW</u>                     | <u>1W</u>                           |
| FREQUENCY<br>STABILITY      | ±5PPM OR<br>(0.00005%)     | ±5PPM OR<br>(0.00005%)            | ±5PPM OR<br>(0.00005%)              |
| MODULATION                  | 10K6F2D (AFSK)             | 9K56F2D (AFSK)                    | 9K56F2D (AFSK)                      |
| TRANSMIT<br>POWER           | 5 Watts                    | 0.1 Watt                          | 1 Watt                              |
| OPERATING<br>POWER          | 12 VDC                     | 7.2 VDC                           | 7.2 VDC                             |
| TRANSMISSION<br>RANGE (LOS) | Greater than 5<br>miles    | 1000 Feet                         | 1 mile                              |
| RECEIVER<br>SENSITIVITY     | 12 dB Sinad at<br>0.28uV   | 12 dB Sinad at<br>0.28uV          | 12 dB Sinad at<br>0.28uV            |

(\*) The Production Unit Frequency Designation will be provided in the contract.

(\*\*) Typical transmission range, based on frequency used and terrain. Frequencies under 150 MHz typically have a range of at least 4 miles.

(\*\*\*) 1 Watt units are only certified for use on 150 – 174 MHz

### 3.2. PHYSICAL.

| <u>Controller Unit</u>   |                        | <u>Detonator Unit</u>   |                        |
|--------------------------|------------------------|-------------------------|------------------------|
| SIZE(w/out antenna) (in) | 8H x 3W x 2.5D         | SIZE(w/out antenna)(in) | 6H x 3W x 2.5D         |
| SIZE(w/out antenna) (cm) | 20.32H x 7.62W x 6.35D | SIZE(w/out antenna)(cm) | 15.24H x 7.62W x 6.35D |
| WEIGHT (w/battery)       | 2.5 lbs., 1.14 kg      | WEIGHT (w/battery)      | 2 lbs., 0.91 kg        |
| CASE                     | Die cast aluminum      | CASE                    | Die cast aluminum      |
| COLOR                    | Black                  | COLOR                   | Black                  |

### 3.3. BATTERY.

| <u>Controller Unit</u> |                    | <u>Detonator Unit</u> |                    |
|------------------------|--------------------|-----------------------|--------------------|
| BATTERY PACK           | Rechargeable NiCad | BATTERY PACK          | Rechargeable NiCad |
| BATTERY LIFE           | 6 Hours            | BATTERY LIFE          | 24 Hours*          |
| BATTERY RECHARGE       | 90 Minutes         | BATTERY RECHARGE      | 90 Minutes         |
| STANDBY CURRENT        | 60 milliamps       | STANDBY CURRENT       | 30 milliamps       |
| TRANSMIT CURRENT       | 1 Amp              | TRANSMIT CURRENT      | 800 milliamps      |

(\*) At the end of the standby time, the Detonator unit can detonate 5 (2-Ohm) blasting caps connected in series and attached to 100 feet of wire.

### 3.4. TIMING.

|                                   |                   |
|-----------------------------------|-------------------|
| Controller Unit ARM time:         | 1/2 ± 0.1 Seconds |
| Detonator Unit ARM time:          | 10 ± 0.1 Seconds  |
| Controller Unit Auto DISARM time: | 60 ± 0.1 Seconds  |
| Detonator Unit Auto DISARM time:  | 60 ± 0.1 Seconds  |
| Controller Unit DISARM time:      | 3 ± 0.1 Seconds   |
| Detonator Unit DISARM time:       | 3 ± 0.1 Seconds   |
| Controller Unit FIRE time:        | 1 ± 0.1 Seconds   |
| Detonator Unit FIRE time:*        | 20 Milliseconds   |

\*This is the delay after the Detonator Unit receives the command signal from the Controller Unit to Fire.

### 3.5. DETONATE OUTPUT.

3.5.1. The Detonator Unit detonation output pulse is from a 3300 microfarad capacitor charged to 27 volts.

|                         |                    |
|-------------------------|--------------------|
| Stored Energy Level:    | 1 Joule (minimum)  |
| Pulse Voltage Level:    | 27 VDC (minimum)   |
| Circuit Current Limit:* | 0.1 Ohm (maximum)* |

\*This is the maximum resistance between the firing capacitor and the output terminals.

### 3.6. SYSTEM IDENTIFICATION.

3.6.1. Each Controller Unit and Detonator Unit is marked with an identification label. Figure 3-1. Shows how the identification label should be interpreted. The Controller Unit will only communicate with Detonator Units from the same System.

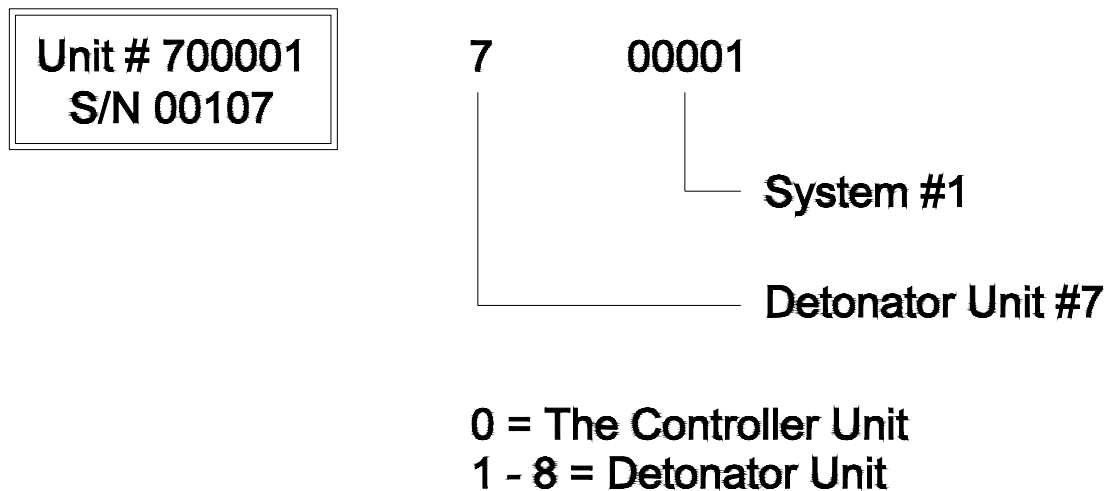


Figure 3-1 Identification Label.

## 4. PRE-OPERATIONAL PROCEDURES.

### 4.1. PHYSICAL INSPECTION.

4.1.1. Inspect all components for physical damage.

**CAUTION** Do not use any component that is damaged, suspected of being damaged, or is not able to operate as designed. The safety of the operation could be compromised.

4.1.2. Ensure the antenna / battery charger connector on the Controller Unit and Detonator Unit is not Damaged.

4.1.3. Remove the antenna / battery charger connector dust cover and ensure the electrical pin area is clean and free of foreign material. Replace the dust cover.

4.1.4. Ensure the Antenna Assembly whip is not broken and that the whip has not separated from the sealing compound at the top of the connector.

4.1.5. Ensure that the spring-loaded binding posts on the Detonator Units are not damaged.

4.1.6. Remove the red dust cover from the Antenna Assembly and ensure that there is no foreign material in the electrical contact area. Replace the red dust cover.

### 4.2. BATTERY CHARGING.

4.2.1. The battery packs in the Controller Unit and Detonator Units contain rechargeable NiCad batteries. The battery packs are recharged through the antenna / battery charger connector on each unit. Battery packs are not to be removed (case opened) in the field.

4.2.2. The battery pack in the Controller Unit and Detonator Units should be charged before the System is used each time. The Battery Charger Assembly will charge the Controller Unit and Detonator Units in 90 minutes. Each Battery Charger Assembly has nine independent rapid chargers. Each rapid charger has a CHARGE, DONE, and DISCHG light. The Battery Charger Assembly has a single "BATTERY DISCHARGE" switch. The Battery Charger Assembly will discharge all battery packs connected, when the "BATTERY DISCHARGE" switch is pressed. Complete discharge of battery packs occurs in approximately 2 hours. Battery capacity will be maintained if the battery packs are discharged prior to charging.

4.2.3. Turn off the power switch on the Battery Charger Assembly.

- 4.2.4. Plug the AC cord into a 110 VAC 60 Hz outlet. The Battery Charger Assembly will operate from 90-135/180-270 VAC, 47-63 Hz.
- 4.2.5. Connect each Detonator Unit and the Controller Unit to the Battery Charger Assembly. The Controller Unit can be connected to any of the nine cables.
- 4.2.6. Open the vent on each Detonator Unit and the Controller Unit.
- 4.2.7. Turn on the power switch on the Battery Charger Assembly.
- 4.2.8. The CHARGE light for each connected unit will flash for approximately 5 seconds. The flashing CHARGE light indicates that rapid charging is pending.
- 4.2.9. In normal operation, the CHARGE light will be on solid after 5 seconds has passed. The solid CHARGE light indicates that the battery is being rapid charged.
- 4.2.10. The battery must be within the temperature range 32 °F and 104 °F for rapid charging to occur. If the battery pack is not within temperature range for rapid charging, the CHARGE light will continue to flash beyond 5 seconds. While the CHARGE light is flashing, the battery pack is being slow charged.
- 4.2.11. If the detected battery voltage is less than 6 volts for Detonator Units and 10 volts for Controller Units, the battery will be slow charged until the voltage is high enough for rapid charge. If the battery pack is defective and the voltage does not rise to the correct level, for rapid charge, the Battery Charger Assembly remains in slow charge mode. In that case the CHARGE light will continue to flash.
- 4.2.12. When rapid charging terminates, the DONE light will be on steady, and the CHARGE light will be turned off.
- 4.2.13. Rapid charging terminates when the charger detects the battery pack is charged. Rapid charging will also terminate after 90 minutes, or if the battery pack temperature is out of range.
- 4.2.14. If a Controller Unit or Detonator Unit is left turned on beyond the low battery point, the battery pack may not fully charge before the 90 minute rapid charge time limit expires. In that case, charge the battery pack again.
- 4.2.15. Close the vent on each Detonator Unit and the Controller Unit

#### 4.3. BATTERY DISCHARGING.

- 4.3.1. Turn off the power switch on the Battery Charger Assembly.
- 4.3.2. Plug the AC cord into a 110VAC 60Hz outlet. The Battery Charger Assembly will operate from 90-135/180-270 VAC, 47-63 Hz.

- 4.3.3. Connect each Detonator Unit and the Controller Unit to the Battery Charger Assembly. The Controller Unit can be connected to any of the nine cables.
- 4.3.4. Open the vent on each Detonator Unit and the Controller Unit.
- 4.3.5. Turn on the power switch on the Battery Charger Assembly.
- 4.3.6. The CHARGE light for each connected unit will flash for approximately 5 seconds. The flashing CHARGE light indicates that rapid charging is pending.
- 4.3.7. Press the BATTERY DISCHARGE switch. The DISCHG light will be on solid and the CHARGE light will flash.
- 4.3.8. After the battery pack has been discharged, the DISCHG light will turn off and the CHARGE light will be on solid indicating rapid charge mode.
- 4.3.9. When the battery pack is charged, the DONE light will be on steady, and the CHARGE light will be turned off.
- 4.3.10. Close the vent on each Detonator Unit and the Controller Unit.
- 4.4. BENCH TESTING THE SYSTEM.

**WARNING** Radio frequency energy of sufficient magnitude can cause blasting caps to detonate.

- 4.4.1. The System test must be conducted in an area that is at least 100 feet from the nearest blasting caps, wires connected to blasting caps, or other explosives.
- 4.4.2. All RFD System controls are described in detail in section 2.

**CAUTION** All units must be thoroughly tested and the batteries fully charged prior to operational use.

**WARNING** The Controller Unit has a 5 watt output power level (5 mile transmit range). The Controller Unit should be considered DANGEROUS and NEVER be operated within 100 feet (minimum) of blasting caps, wires connected to blasting caps, or other electrically initiated explosives devices. Do NOT apply power to the Controller Unit unless the operator is at least 100 feet from blasting caps, wires connected to blasting caps, or explosives.

- 4.4.3. Install the Antenna Assembly on the antenna / battery charger connector of the Controller Unit. Ensure the Controller Unit is off.

4.4.4. Install the Antenna Assemblies on the antenna / battery charger connectors of the Detonator Units. The ON/LOW BATT and SAFE lights will come on steady. If the ON/LOW BATT light is flashing, the Detonator Unit has a low battery. Recharge the battery in accordance with section 4.2.

4.4.5. Turn the Controller Unit on by pressing the “ON” switch for 1 second. A yellow light located in the upper left quadrant of the “ON” switch will come on steady. If the yellow light does not come on steady, but flashes, this indicates a low battery for the Controller Unit. Recharge the battery in accordance with section 4.2.

4.4.6. Press the “STATUS” switch for 1 second. The red TX light on the Controller Unit will start blinking for approximately 15 seconds. During that time the Controller Unit is requesting status from the Detonator Units.

4.4.7. When the TX light stops flashing, the green DISARMED light will come on steady adjacent to the switches numbered “1” through “8”. A steady DISARMED light indicates that Detonator Unit answered back with its status and it is disarmed. A flashing DISARMED light indicates the Controller Unit did not receive the Detonator Unit’s status transmission.

**WARNING** Ensure that blasting caps are not connected to any of the Detonator Units during bench test.

4.4.8. Select all of the Detonator Units by pressing switches “1” through “8”. A yellow light will be lit in each switch to indicate the corresponding Detonator Unit is selected.

4.4.9. Press the “ARM” switch for ½ second. The red ARMED light for each selected Detonator Unit will flash on the Controller Unit display panel for approximately 10 seconds and then come on steady. The ARMED light for each selected Detonator Unit will grow brighter and then stay on steady. The Detonator Units are now Armed.

4.4.10. Observe the Controller Unit and Detonator Units. In approximately 60 seconds the Detonator Units will automatically Disarm. The ARMED lights at the Controller Unit and Detonator Units should turn off. The DISARMED lights at the Controller Unit and SAFE lights at the Detonator Units should turn on.

4.4.11. Re-Arm the Detonator Units. Before the 60 second time-out takes place, press the “DISARM” switch on the Controller Unit. The Controller Unit’s ARMED light will be turned off. The DISARMED lights at the Controller Unit should blink for approximately 3 seconds and then turn on steady. The ARMED lights at the Detonator Units will turn off and the Detonator Units’ SAFE lights will turn on.

4.4.12. Connect a test bulb assembly to the binding posts of each Detonator Unit. Arm the Detonator Units. Press the “FIRE” switch on the Controller Unit. The test bulb should flash brightly. The ARMED light will turn off and the SAFE light will turn on at each Detonator Unit. The displayed status at the Controller Unit will change from Armed to Disarmed.

4.4.13. Turn off the Controller Unit by pressing the “OFF” switch. Turn off the Detonator Units by removing their Antenna Assemblies.

4.4.14. The RFD system is now ready to use operationally.

## 5. OPERATIONAL PROCEDURES.

**WARNING** Use of this system and its components must be restricted to personnel qualified and experienced in the field of explosives and detonating devices. Under no circumstances shall untrained personnel attempt to use this manual as a text for self-teaching.

**WARNING** Employ standard blasting system safety standards when using this equipment with explosives.

**CAUTION** All units must be thoroughly tested and the batteries fully charged prior to operational use.

### 5.1. READY THE SYSTEM AT SITE.

5.1.1. Detonator Units. Select the number of Detonator Units required for the operation. Remove the dust cover from the antenna / battery charger connector. Install the Antenna Assembly on to the antenna / battery charger connector. This will turn on the Detonator Unit. The yellow ON/LOW BATT light and green SAFE light will be turned on. The green SAFE light will be on whenever the Detonator Unit is turned on and it is Disarmed. In the Disarmed state, the firing capacitor charge circuit is disabled, the binding posts are electrically isolated from the firing capacitor, and the binding posts are shunted to each other. If the yellow ON/LOW BATT light is flashing, the Detonator Unit battery is low and should be recharged before use.

**WARNING** Do not connect a blasting cap to a Detonator Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electrically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

5.1.2. Open and close the vent on each Detonator Unit and the Controller Unit to equalize the case pressure. Unscrew the vent one revolution to open.

5.1.3. Remove the dust cover from the antenna / battery charger connector of the Controller Unit. Install the Antenna Assembly on to the antenna / battery charger connector. This will enable the keypad on the Controller Unit.

**WARNING** The Controller Unit has a 5 watt output power level (5 mile transmit range). The Controller Unit should be considered DANGEROUS and NEVER be operated within 100 feet (minimum) of blasting caps, wires connected to blasting caps, or other electrically initiated explosives devices. Do NOT apply power to the Controller Unit unless the operator is at least 100 feet from blasting caps, wires connected to blasting caps, or explosives.

5.1.4. Press the Controller Unit “ON” switch for one second. The yellow light in the upper left quadrant of the “ON” switch will come on steady. If the yellow light flashes, the Controller Unit battery is low and needs charging. Refer to Battery charging section 4.2.

5.1.5. Press the “STATUS” switch on the Controller Unit. The red TX light will flash for approximately 15 seconds. The green DISARMED light corresponding to each Detonator Unit will come on steady if the Controller Unit receives a status message from that Detonator Unit. If the Controller Unit does not receive a status message from a Detonator Unit, the green DISARMED light for that Detonator Unit will flash on the Controller Unit display panel.

**Note:** The Controller Unit battery life is approximately 6 hours when in the “ON” condition. To conserve battery life, the Controller Unit should be turned off when not being used.

5.1.6. Turn the Controller Unit “OFF” until Detonator Units are in place and wired to shoot.

## 5.2. PLACEMENT OF DETONATOR UNITS.

**WARNING** Do not connect a blasting cap to a Detonator Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electrically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

5.2.1. The range of the RFD is typically 5 miles under most conditions.

5.2.2. Place the Detonator Units with the antenna in a vertical position and free from obstruction within 100 feet of the shot. Use sandbags or other suitable materials to protect the Detonator Units from the shot.

5.2.3. Ensure that all Detonator Units indicate a SAFE condition (green light on steady).

5.2.4. After performing standard demolition circuit checks and before placing initiator into main charge, depress the two spring-loaded binding posts on the Detonator Unit.

5.2.5. Insert one leg of the demolition wire in each binding post and allow the binding posts to close on the wire ends.

5.2.6. Ensure the wire is held securely by the binding posts and that the wire ends are not touching the Detonator Case or each other.

5.2.7. Prepare the shot and return to the safe firing area.

5.2.8. If all Detonator Units are located within 1,000 feet of the Controller Unit, refer to section 5.3.

5.2.9. If all Detonator Units are located more than 1,000 feet and less than 5 miles from the Controller Unit, refer to section 5.4.

5.2.10. If some Detonator Units are located within 1,000 feet of the Controller Unit, and other Detonator Units are between 1,000 feet and 5 miles from the Controller Unit, refer to section 5.5.

### 5.3. SYSTEM OPERATION – DETONATOR UNITS WITHIN 1,000 FEET OF CONTROLLER UNIT.

**Note:** If the distance between the Controller Unit and the Detonator Units is in excess of 1,000 feet, the Detonator Units status transmissions may not be received by the Controller Unit. The Controller Unit will command the Detonators from a distance up to 5 miles, but the Detonator Status may not be confirmed. The Controller Unit performs just as it would when it is within 1,000 feet of the Detonator Units. The only difference is the method the status indications are displayed on the Controller Unit display panel. The ARMED and DISARMED status lights for out of range Detonator Units will flash on the Controller Unit display panel to indicate the Controller Unit did not receive a status message from the Detonator Unit. Once the Detonator Units are set up for the shot, the operator must assume the Detonator Units have received the command.

5.3.1. Ensure the area is clear.

5.3.2. Turn the Controller Unit on.

5.3.3. Press the “STATUS” switch. The Controller Unit will request status from all Detonator Units. The red TX light will flash for approximately 15 seconds. The green DISARMED light on the Controller Unit display panel will come on steady for the Detonator Units that the Controller Unit receives a Disarmed status message from.

5.3.4. Select the Detonator Units that are to be used in the shot by pressing the corresponding numbered switches “1” through “8”. Press the numbered switches one at a time.

**System Safety Feature** Once Armed, the Detonator Units must be sent a Fire command within 60 seconds. If the Detonator Units do not receive a Fire command within 60 seconds of being armed, they will automatically Disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.3.5. To Arm the selected Detonator Units, press the “ARM” switch. The red ARMED light next to each selected Detonator Unit switch will flash for 10 seconds and then come on steady. The selected Detonator Units are now ARMED!

5.3.6. To Fire the Detonator Units, press the “FIRE” switch. The operator should get an indication of shot initiation. The ARMED light will go out and the green DISARMED light for each selected Detonator Unit will come on solid on the Controller Unit display panel.

5.3.7. If not all the Detonator Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.3.8. To Disarm any Detonator Units that have been Armed, select the Detonator Units and press the “DISARM” switch. All selected Detonator Units will return to the DISARMED mode in approximately 3 seconds.

**CAUTION** Do not assume the Disarm command has been received by the Detonator Unit unless DISARMED status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. If distance appears to be the problem, move closer to the Detonator Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Detonator Unit is approached. Maintain a safe distance from the Detonator Unit. Do not approach the Detonator Unit until Disarmed status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Detonator Unit is approached. Do not bring the Controller Unit closer than 100 feet to blasting caps, wires connected to blasting caps, or other explosives.

5.3.9. Turn off the Controller Unit.

5.3.10. Recover the fielded Detonator Units.

5.3.11. Refer to Post Operational Procedures in chapter 6.

#### 5.4. SYSTEM OPERATION – DETONATOR UNITS MORE THAN 1,000 FEET AND LESS THAN 5 MILES FROM CONTROLLER UNIT.

**Note:** If the distance between the Controller Unit and the Detonator Units is in excess of 1,000 feet, the Detonator Units status transmissions may not be received by the Controller Unit. The Controller Unit will command the Detonators from a distance up to 5 miles, but the Detonator Status may not be confirmed. The Controller Unit performs just as it would when it is within 1,000 feet of the Detonator Units. The only difference is the method the status indications are displayed on the Controller Unit display panel. The ARMED and DISARMED status lights for out of range Detonator Units will flash on the Controller Unit display panel to indicate the Controller Unit did not receive a status message from the Detonator Unit. Once the Detonator Units are set up for the shot, the operator must assume the Detonator Units have received the command.

5.4.1. Ensure the area is clear.

5.4.2. Turn the Controller Unit on.

5.4.3. Press the “STATUS” switch. The Controller Unit will request status from all Detonator Units. The red TX light will flash for approximately 15 seconds. The green DISARMED light on the Controller Unit display panel will flash for all Detonator Units that the Controller Unit does not receive a status message from.

5.4.4. Select the Detonator Units that are to be used in the shot by pressing the corresponding numbered switches “1” through “8”. Press the numbered switches one at a time.

**System Safety Feature** Once Armed, the Detonator Units must be sent a Fire command within 60 seconds. If the Detonator Units do not receive a Fire command within 60 seconds of being armed, they will automatically Disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.4.5. To Arm the selected Detonator Units, press the “ARM” switch. The red ARMED light next to each selected Detonator Unit switch will flash for 10 seconds, then come on steady for two seconds, and then continue to flash. The selected Detonator Units are now assumed to be ARMED!

5.4.6. To Fire the Detonator Units, press the “FIRE” switch. The operator should get an indication of shot initiation. The ARMED light will go out and the green DISARMED light for each selected Detonator Unit will flash on the Controller Unit display panel.

5.4.7. If not all the Detonator Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.4.8. To Disarm any Detonator Units that have been Armed, select the Detonator Units and press the “DISARM” switch. All selected Detonator Units will return to the DISARMED mode in approximately 3 seconds.

**CAUTION** Do not assume the Disarm command has been received by the Detonator Unit unless DISARMED status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. If distance appears to be the problem, move closer to the Detonator Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Detonator Unit is approached. Maintain a safe distance from the Detonator Unit. Do not approach the Detonator Unit until Disarmed status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Detonator Unit is approached. Do not bring the Controller Unit closer than 100 feet to blasting caps, wires connected to blasting caps, or other explosives.

5.4.9. Turn off the Controller Unit.

5.4.10. Recover the fielded Detonator Units.

5.4.11. Refer to Post Operational Procedures in chapter 6.

**5.5. SYSTEM OPERATION – DETONATOR UNITS BOTH WITHIN AND IN EXCESS OF 1,000 FEET AND LESS THAN 5 MILES FROM CONTROLLER UNIT.**

**Note:** If the distance between the Controller Unit and the Detonator Units is in excess of 1,000 feet, the Detonator Units status transmissions may not be received by the Controller Unit. The Controller Unit will command the Detonators from a distance up to 5 miles, but the Detonator Status may not be confirmed. The Controller Unit performs just as it would when it is within 1,000 feet of the Detonator Units. The only difference is the method the status indications are displayed on the Controller Unit display panel. The ARMED and DISARMED status lights for out of range Detonator Units will flash on the Controller Unit display panel to indicate the Controller Unit did not receive a status message from the Detonator Unit. Once the Detonator Units are set up for the shot, the operator must assume the Detonator Units have received the command.

5.5.1. The RFD will operate in a two-way mode (confirmed communications – range to 1,000 feet) and one-way mode (unconfirmed communications – range up to 5 miles).

5.5.2. If the Detonators are within 1,000 feet of the Controller Unit, the status of the Detonator Units (ON/LOW BATT, ARMED, and SAFE) will be displayed with solid lights on the display panel of the Controller Unit.

5.5.3. If one or more Detonator Units are out of range of the Controller Unit, the status of these Detonator Units will be assumed and their status lights will flash on the Controller Unit display panel to indicate unconfirmed status. Accordingly the operator must assume the following:

- Commands have been received by the Detonator Units.
- The Detonator Unit battery is sufficiently charged to activate the firing circuit.
- A “DISARM” command should not be assumed.

5.5.4. Ensure the area is clear.

5.5.5. Turn the Controller Unit on.

5.5.6. Press the “STATUS” switch. The Controller Unit will request status from all Detonator Units. The red TX light will flash for approximately 15 seconds. The green DISARMED light on the Controller Unit display panel will flash for all the Detonator Units that the Controller Unit does not receive a status message from.

5.5.7. Select the Detonator Units that are to be used in the shot by pressing the corresponding numbered switches “1” through “8”. Press the numbered switches one at a time.

**System Safety Feature** Once Armed, the Detonator Units must be sent a Fire command within 60 seconds. If the Detonator Units do not receive a Fire command within 60 seconds of being armed, they will automatically Disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.5.8. To Arm the selected Detonator Units, press the “ARM” switch. The red ARMED light next to each selected Detonator Unit switch will flash for 10 seconds, and then come on steady for two seconds. ARMED lights for selected Detonator Units that the Controller Unit did not receive a status message from will begin to flash again. The selected Detonator Units are now assumed to be ARMED! For unconfirmed communications, count to 10 from when the “ARM” switch is pressed and assume the Detonator Units are Armed.

5.5.9. To Fire the Detonator Units, press the “FIRE” switch. The operator should get an indication of shot initiation. The ARMED light will go out and the green DISARMED light for each selected Detonator Unit will flash on the Controller Unit display panel.

5.5.10. If not all the Detonator Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.5.11. To Disarm any Detonator Units that have been Armed, select Detonator Units and press the “DISARM” switch. All selected Detonator Units will return to the DISARMED mode in approximately 3 seconds.

**CAUTION** Do not assume the Disarm command has been received by the Detonator Unit unless DISARMED status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. If distance appears to be the problem, move closer to the Detonator Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Detonator Unit is approached. Maintain a safe distance from the Detonator Unit. Do not approach the Detonator Unit until Disarmed status is confirmed with a steady DISARMED light for that Detonator Unit on the Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Detonator Unit is approached. Do not bring the Controller Unit closer than 100 feet to blasting caps, wires connected to blasting caps, or other explosives.

5.5.12. Turn off the Controller Unit.

5.5.13. Recover the fielded Detonator Units.

5.5.14. Refer to Post Operational Procedures in chapter 6.

## **6. POST OPERATIONAL PROCEDURES.**

### **6.1. SECURING THE SYSTEM.**

6.1.1. Turn the Controller Unit off and remove the Antenna Assembly. This action disables the Controller Unit.

6.1.2. Replace the dust cover on the antenna / battery charger connector on the Controller Unit and replace the red plastic cap on the Antenna Assembly.

6.1.3. Remove the Antenna Assemblies from the Detonator Units. This action turns off the Detonator Units.

6.1.4. Replace the dust cover on the antenna / battery charger connector on the Detonator Units and replace the red plastic cap on the Antenna Assembly.

### **6.2. PHYSICAL INSPECTION.**

6.2.1. Inspect the Controller Unit and Detonator Units for physical damage.

6.2.2. Inspect the units for dirt or corrosion around/on connector pins and vent.

6.2.3. Replace any unit found to have damage. Return unit to Manufacturer.

6.2.4. Clean units using a soft bristle brush.

6.2.5. If a unit cannot be cleaned by brushing, make sure the vent is closed securely and wash units in warm soapy water.

6.2.6. Rinse units with clean water and dry thoroughly.

6.2.7. Inspect units for damage. Replace as necessary.

### **6.3. PACKAGING.**

6.3.1. Re-package all components in carrying case.

### **6.4. MAINTENANCE & EQUIPMENT STORAGE.**

6.4.1. Periodic battery charging.

6.4.2. Check for signs of corrosion around and on connector pins.

## 7. BASIC TROUBLESHOOTING IN THE FIELD.

### 7.1. DETONATOR UNITS.

7.1.1. “ON” and “SAFE” lights do not illuminate when the Antenna Assembly is installed.

- a) Check Antenna Assembly and make sure it is seated, “clicks” on to the connector.
- b) Recharge the battery.
- c) Try a different Antenna Assembly.

### 7.2. CONTROLLER UNIT.

7.2.1. “ON” Light does not stay on.

- a) Check Antenna Assembly and make sure it is seated, “clicks” on to the connector.
- b) Press and hold the “ON” switch for 5 seconds.
- c) Controller Unit battery needs to be recharged.

7.2.2. Command receipt is not confirmed by Detonator Unit.

- a) Detonator Unit is more than 1,000 feet from Controller Unit.
- b) If the Detonator Unit is less than 1,000 feet away from the Controller Unit.

Check for damage to Controller Unit Antenna Assembly.

Try a different Antenna Assembly on the Controller Unit.

Move at least 25 feet in any direction and try again.

Reposition the Detonator Unit if:

- The antenna is not positioned vertically.
  - The antenna is next to another radio antenna.
  - The antenna is surrounded by metallic objects.
  - Use optional magnetic mount antenna for improved gain.
- c) Check carrier detect light to see if there is interference from another source.

## 8. OPTIMIZING RANGE.

8.1.1. When power lines are in the area, the radio transmission distance is reduced. The System can operate at the following distance, when the Controller Unit is elevated to a maximum transmission location angle to the Detonator Unit location (see Figure 8-1).

| <u>Over</u>                            | <u>Minimum Distance</u> |
|----------------------------------------|-------------------------|
| Open Land or Water with Power Lines    | 1 Mile                  |
| Dense Vegetation without Power Lines   | 1 Mile                  |
| Open Land or Water without Power Lines | 5 Miles                 |

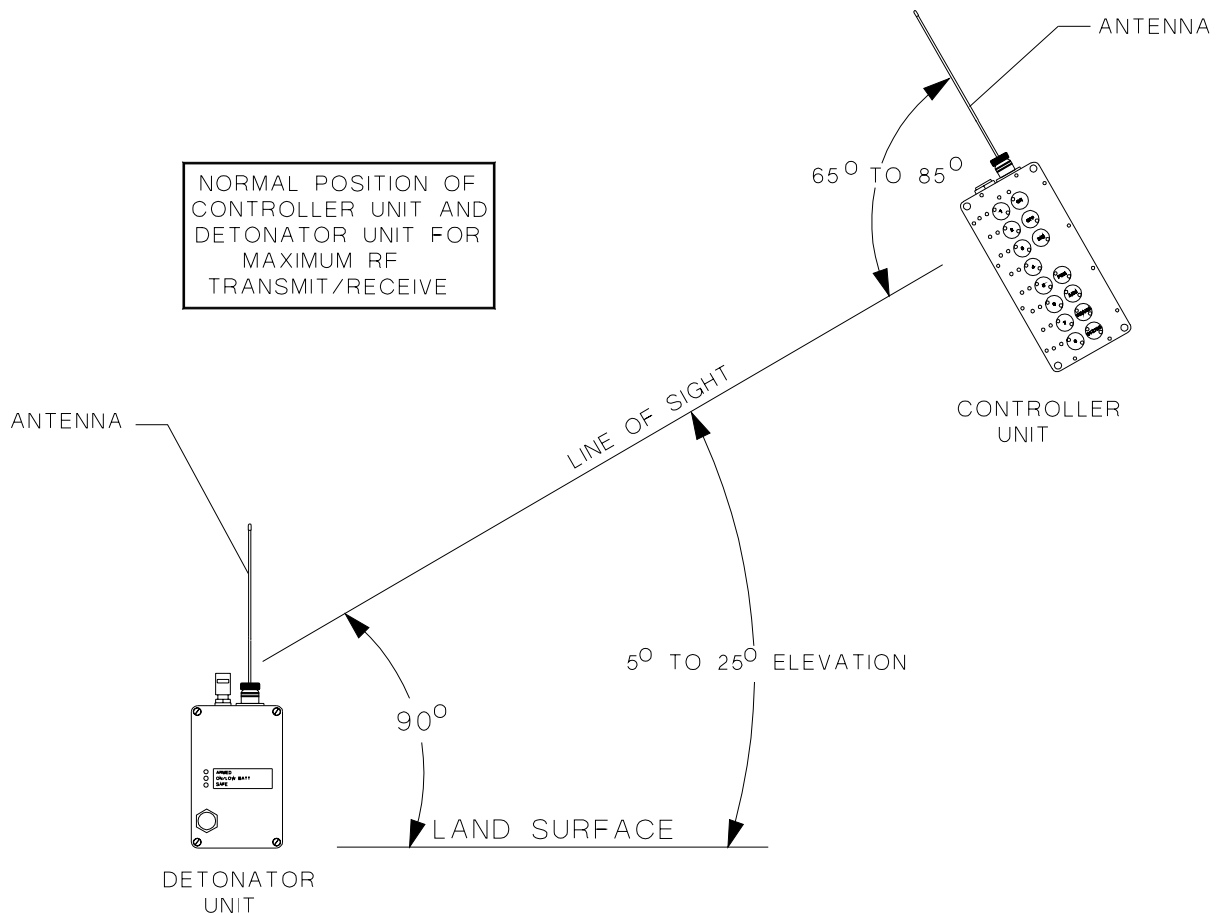


Figure 8-1 Unit Normal Transmission Location.

8.1.2. If the Controller unit and Detonator Unit must be placed in a position other than location in Figure 8-1, use Figure 8-2 or Figure 8-3. The minimum transmission will occur when the Controller Unit antenna and the Detonator Unit antenna are placed in the line of site. The maximum transmission occurs when the line of site lays in a path of 5 to 25 degrees above Unit top plane perpendicular to the antenna. Both the Controller Unit antenna and the Detonator Unit Antenna have the same radiant energy pattern as shown in Figure 8-4.

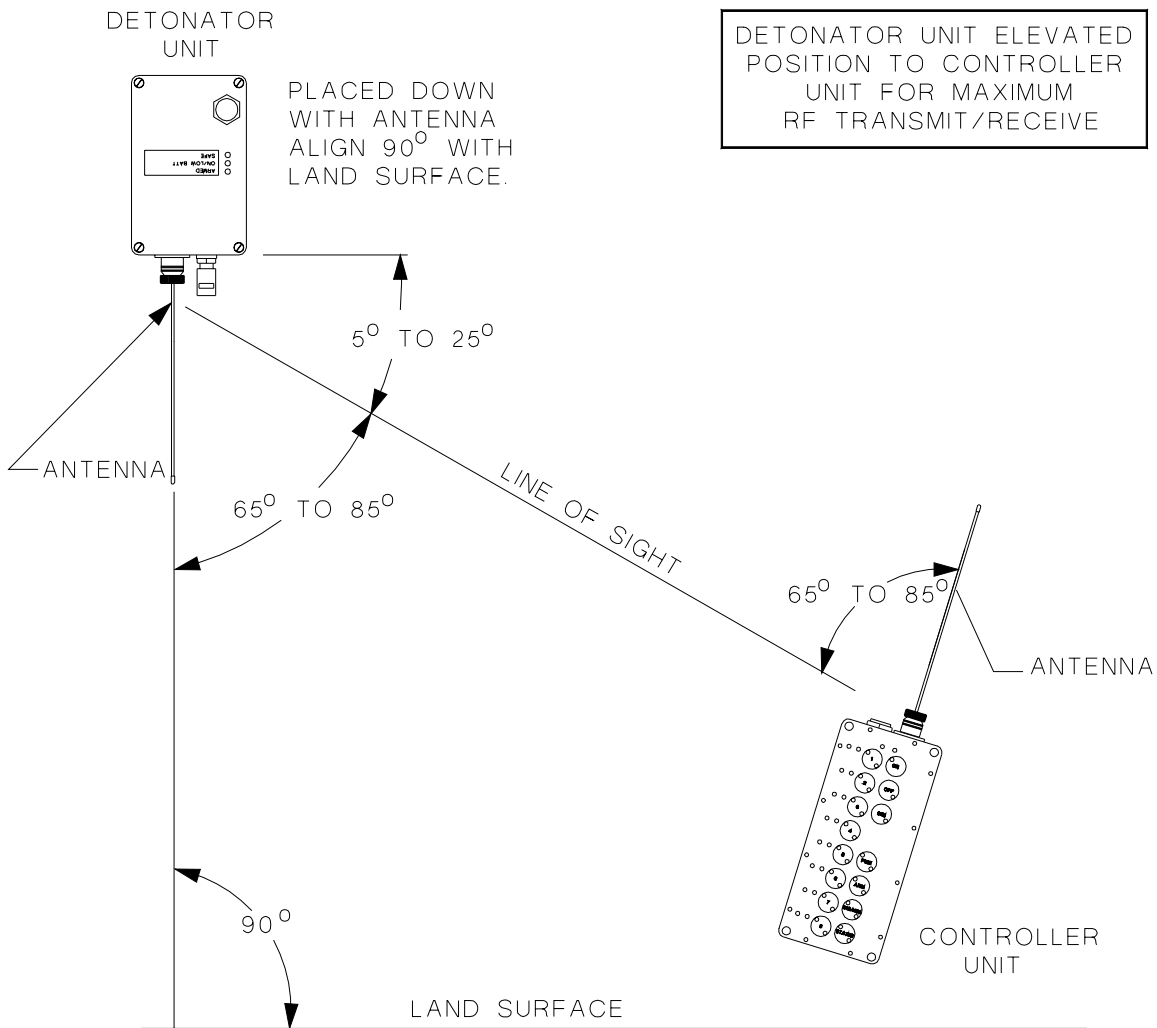


Figure 8-2 Detonator Unit Elevated.

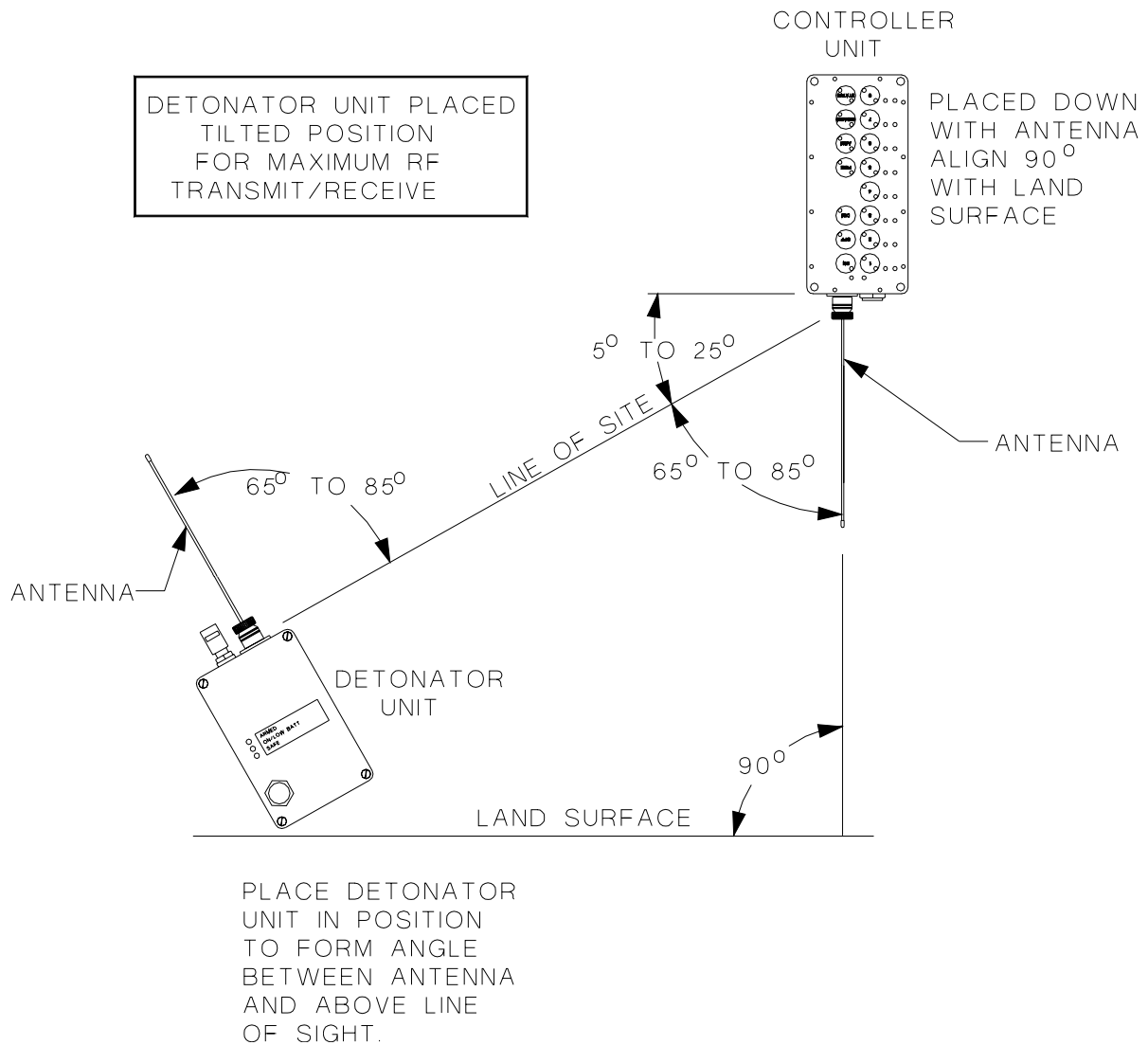


Figure 8-3 Detonator Unit Tilted.

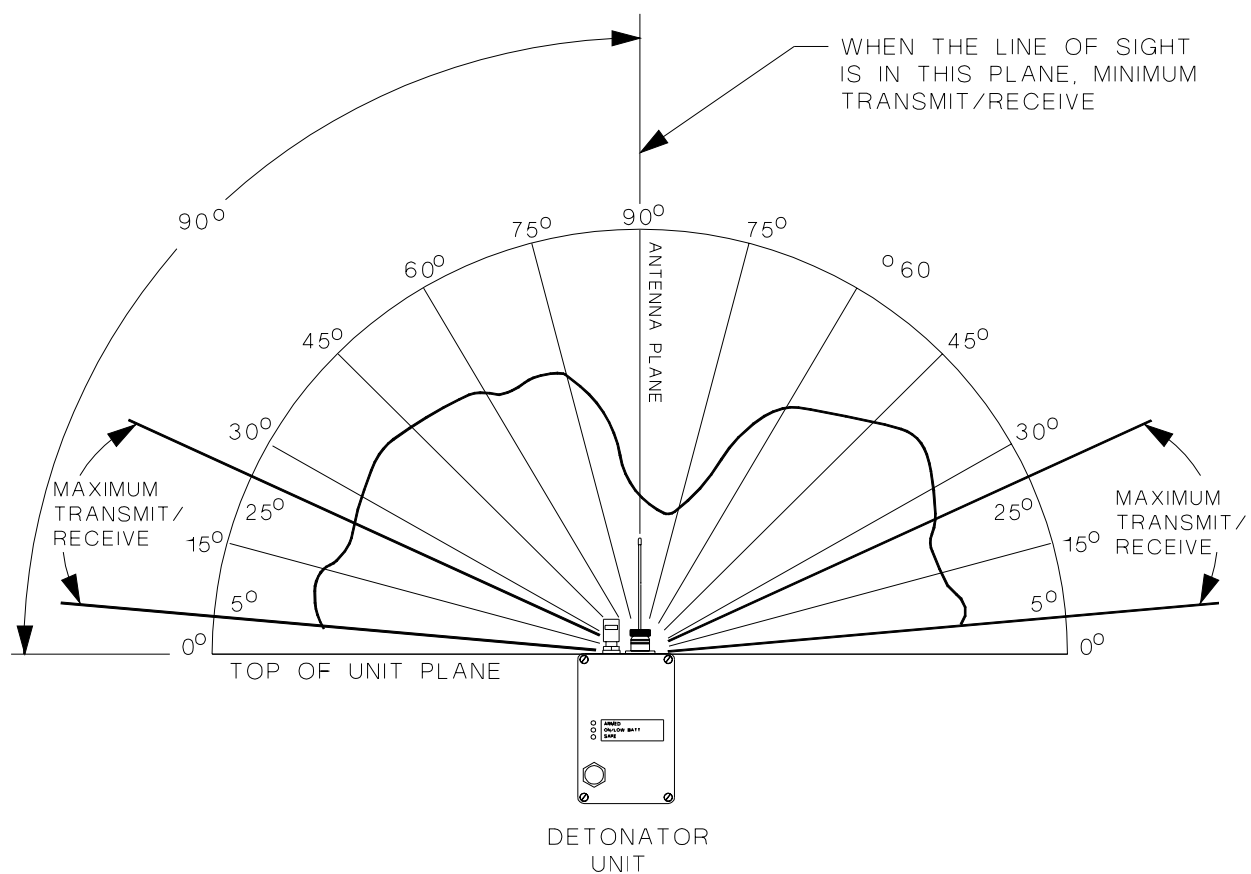


Figure 8-4 Antenna Radiation Pattern