



# Stationary Armor Target



(SAT)



RANGE AND TRAINING LAND PROGRAM – MANDATORY CENTER OF EXPERTISE

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## General

The Stationary Armor Target (SAT) emplacement is for the installation of a SAT target. There are two sizes of standard emplacements, 14' (4.27m) wide for frontal silhouettes and 28' (8.53m) wide for flank targets. By installing different silhouettes on the SAT lifter, the SAT emplacement can represent different threat scenarios to the trainees. Silhouettes include friendly and foe targets; heavy, medium, and light armor vehicles; technical trucks, etc., as well as several types of bunkers. A SAT emplacement can also simulate a breach wall. Most SAT emplacements have a Battle Effects Simulator (BES) installed. The BES is a self-contained unit provided and installed by the target provider; no special design is required. Electrical power centers can be collocated in a SAT.

Range designers should refer to the Inspection Checklists provided in the RDG to ensure that all required items are included in the design.

## Civil/Siting

This section covers the Civil Engineering and Siting issues unique to this type of emplacement. Refer to the separate range sections of the RDG for additional siting issues specific to a particular range. See the special sections below for additional information particular to a specific target type.

## Emplacement

The standard SAT emplacement uses either a treated timber or concrete gravity block retaining wall on three sides, with a protective earthen berm. Installations may prefer to use other materials, which is acceptable as long as it is durable, provides protection, and is compatible with the electrical and target equipment. The compacted earth berm provides the protection for the wall and installed equipment from all anticipated directions of fire. The concrete emplacement does not provide significant protection. The floor of the emplacement consists of gravel and a concrete slab. Orient the emplacement toward the anticipated direction of fire.

Mount all permanent electrical and communication boxes on the walls of the emplacement or to a metal slotted channel (Unistrut) structure directly behind the front wall. The target provider anchors the lifter to the concrete slab. SATs can be placed above or below-grade. See the standard Civil and Electrical detail drawings for additional specific dimensions and details.

### Above-Grade Emplacement:

Above-grade emplacements are the most common in range construction due to their ease of drainage, ease of obtaining line-of-sight, and small disturbance to the existing grade.

### Below-Grade Emplacement:

Below grade emplacements blend with the natural terrain and do not present the target position profile to the soldier/firer. Unfortunately, below-grade emplacements present several design issues as follows:

### **Drainage:**

Positive drainage is harder to achieve on a below grade emplacement. Floor drains are problematic in that they require a lower elevation nearby for a daylight drain and tend to clog. Drainage swales increase excavation requirements.

### **Unexploded Ordnance (UXO):**

UXO disturbance potential increases with the depth of excavation. While an above-grade emplacement might only require disturbing the surface to 150mm (6in) below natural grade, below-grade emplacements often require excavation of 1m (3ft) or more. For medium and high-risk areas, normally a subsurface clearance to a depth of one foot below the construction footprint is required.

### **Line-of-Sight:**

Line-of-sight between the firing position and the target emplacement may not be possible using the natural terrain.

### **Other debris:**

Below-grade emplacements also tend to gather more sand, snow, dirt, trash, and any windblown objects, which can cause maintenance problems.

The designer should discuss with the installation whether they desire above or below-grade SAT emplacements, while ensuring that the installation understands the design issues and costs associated with either choice.

## **Drainage**

Ensuring proper drainage is critical in the design and construction of target emplacements. Even though the electrical and target equipment is designed for outdoor installation, many of the issues with range targetry can be avoided with proper emplacement drainage. The ground should slope away from the emplacement whenever possible; add swales as necessary to ensure positive drainage. The floor of the emplacement must slope to the rear. Special care is required in the use of floor and trench drains, as they tend to clog easily and freeze in some climates. Ensure proper compaction under the emplacement to avoid differential settlement. Drainage is especially critical on newly constructed ranges before vegetation is fully established.

## **Target Clearance**

Provide a clear unobstructed area behind the emplacement to allow space for the target in the down position; a minimum of 6.4m (21ft) measured from the face of the emplacement wall.

## **Configuration**

The Civil Details and Electrical Details in the Appendix of this document show the standard SAT emplacement configuration. The emplacement design supports the ballistic characteristics of armor, low-hover helicopters and anti-armor systems. The emplacement does not provide protection from helicopter running and diving fire.

## Wall Height

The front wall and berm must be high enough to protect the targetry equipment while still allowing target visibility from the firing position. The minimum front wall height is 1067mm (3ft 6in), 1372mm (4ft 6in) for aerial gunnery. The height has been coordinated within the program as the minimum that hides both the electrical equipment and the targetry based on a relatively flat angle of fire from the shooter to the target, generally +/- 2 degrees.

## Angle of Fire

The angle of fire (AOF) from the gun barrel to the target is a critical parameter on a range that affects the functionality in a number of ways. Certain range and weapon types have a limit on the allowable angle of fire, e.g. a Known Distance range limits the AOF to +/- 2 degrees. Refer to the installation trainers, applicable training manuals, and the RDG section for specific range types for additional information and guidance. In addition, the amount of the target that is visible to shooters can affect the ability to qualify, i.e. it is harder to hit the target when only half of it is visible. Finally, rounds can hit and damage targetry and electrical equipment on higher angles of fire.

The standard SAT emplacement with a 42-inch front wall and a 2-percent slope on the berm provides adequate protection for AOF of +/- 2 degrees. Greater angles require special design consideration. Higher negative angles may require increasing the front wall height, adjusting the slope of the berm to match the AOF, or some other method. Theoretically, the minimum wall height hides the electrical equipment, including the target arms and clamps, up to a -10° AOF, higher with the aviation wall height. In situations with a positive AOF, greater than 2 degrees, the berm itself begins to hide the target. Adjustments to the berm slope may be necessary.

On ranges where target engagement is from multiple points, the designer must coordinate closely with the installation and the targetry provider to determine the correct front wall height. The emplacement protection is also critical for aviation gunnery.

## Wall Design

Typical retaining walls are designed using concrete gravity block or wood timbers and steel piles. Design the walls so that the top section is replaceable in case of damage. Filter fabric is normally required. The design of the SAT walls must take in consideration the stability of the wall, including site-specific geotechnical conditions. The design must include overturning, sliding, and settling.

## Berm Criteria

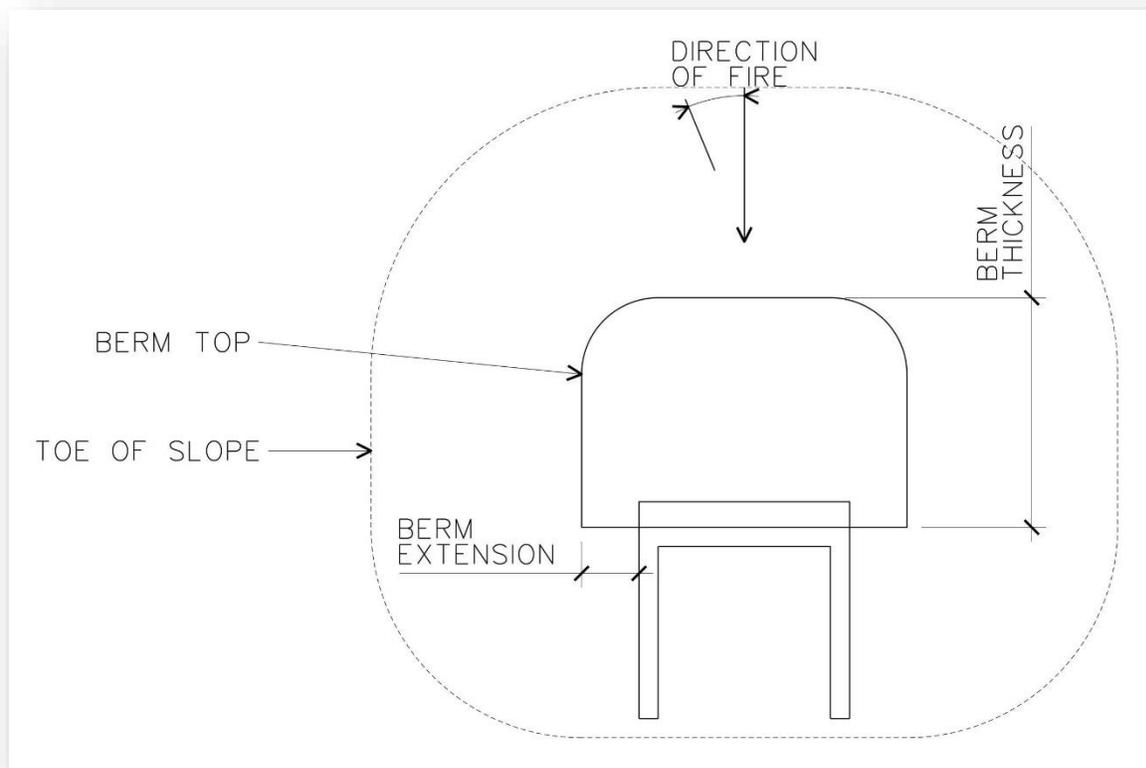
The Target Protection Design Curves, in the Target Protection Section of the RDG, provide the recommended thickness for emplacement protective berms. The curve thicknesses provide protection from many bullet impacts; the amount of soil needed to stop a single round is significantly less. The berm must protect the emplacement from all anticipated directions of fire, but is thickest in the expected direction of fire. Use thinner berms to protect the emplacement from occasional directions of fire and ricochets. The standard berm extensions are ¼ of the berm thickness; see figure below.

Determine the berm thicknesses based on projectile type, soil compaction, and the in-place soil density. In addition, the designer must coordinate with the range trainer or user to determine the appropriate berm thickness for each target, since individual target siting may dictate added target protection. Design the berm to withstand the largest weapon system that will engage that group of targets. At a minimum, berm widths will be at least 4 feet to facilitate ease of maintenance.

Historical experience shows that, under normal usage, well-compacted berms, designed with the recommended widths require maintenance cycles of 6-months on most range types. Ranges without fixed firing positions and those with lower usage can go much longer between maintenance cycles.

## Direction of Fire

The direction of fire (DOF) is the horizontal angle from perpendicular to the target. The standard berm provides full thickness protection for DOF of +/- 20 degrees and adequate protection to +/- 30 degrees or more. Due to SDZ and range safety considerations, it is uncommon to engage targets regularly at larger DOF; coordinate with the RTLP MCX in those cases. The standard berm will protect the electronics and mechanism from errant rounds and ricochets to much higher DOF, up 90 degrees.



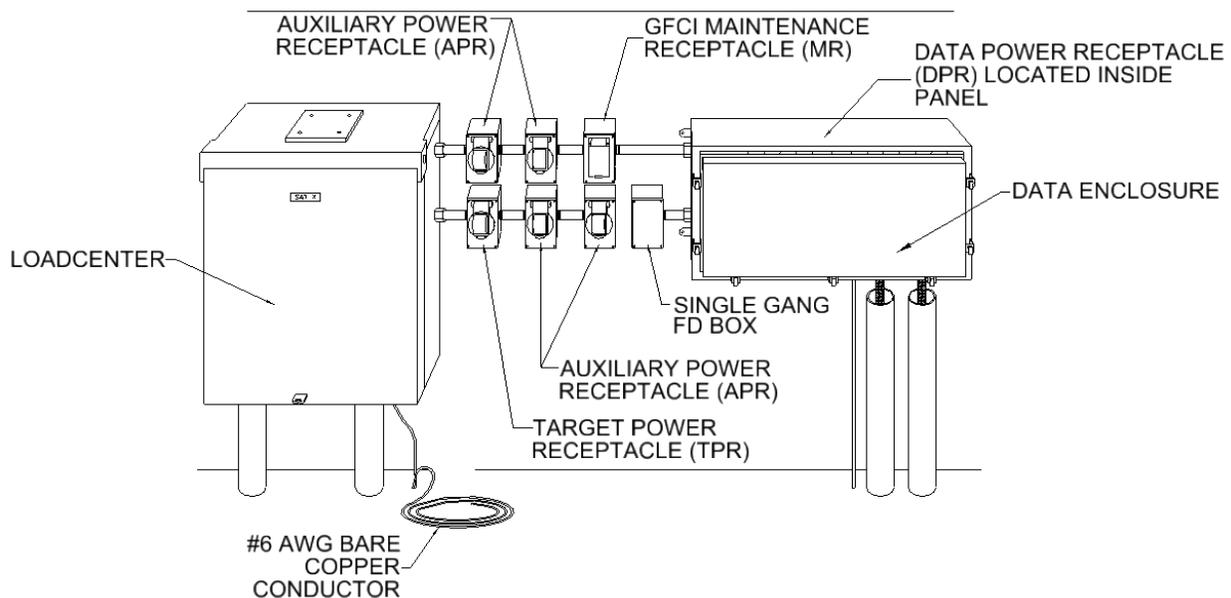
## Electrical/Communications

This section documents the electrical/communication requirements and equipment installed in a SIT emplacement. It primarily focuses on standard targets with hardwired power and data; a

paragraph below has information on battery-operated targets. The Downrange Power & Data Distribution Sections of the RDG describe requirements for downrange power distribution, data networks, transformers, trenching, etc. Use those sections in addition to this document to design a complete range. In addition, since some range types have power and data requirements that differ from the standard, refer to the specific range section for details.

## Target Emplacement Wall Configuration

Refer to the emplacement elevation figures below and the electrical detail drawings for typical wall configurations. The electrical equipment required in each SAT emplacement are the 1) Load Center (LC), 2) Target Power Receptacle (TPR), 3) Auxiliary Power Receptacle, 4) GFCI Maintenance Receptacle (MR), 5) and the data enclosure, along with the associated wiring and conduits which are not detailed in this document. The load center contains the secondary branch circuits and provides feed-through capability to the load center in the next adjoining target emplacement. Mount all boxes and receptacles on the front wall of the emplacement no higher than two inches below the top of the emplacement wall; this protects the boxes and receptacles from low rounds that might skim the top of the emplacement wall. The standard electrical detail drawings in the RDG include detailed drawings of the electrical equipment requirements for SAT emplacements.



*REPRESENTATIVE SAT ELEVATION DRAWING (NOT TO SCALE)*

## Routing

All conduits and/or cables should enter and exit from the side or rear of the emplacement. This cable routing helps to minimize damage to the cables from range operations and maintenance crews performing berm repair.

## Grounding

Grounding is required for safety at each downrange emplacement or equipment location. A 19mm (3/4in) by 3,050mm (10ft) copper-clad steel ground rod will be driven to a depth of 305mm (1ft) below finished grade at each emplacement or equipment location. The MTDP/TDP and load center equipment will be connected to the emplacement's single ground rod with a #6 AWG bare copper conductor and exothermically welded connections. All data cable armor or shields must be bonded to the ground bar in the TDP. The design will leave a 3048mm (10ft) coil of #6 AWG bare copper that will be used to ground the target mechanism.

## Surge Suppression

Provide surge protective devices (SPD) in the load center of all target emplacements. The surge suppression for the data communication cables will be provided by the target vendor during the installation of targets.

## Conduit and Cable Fittings

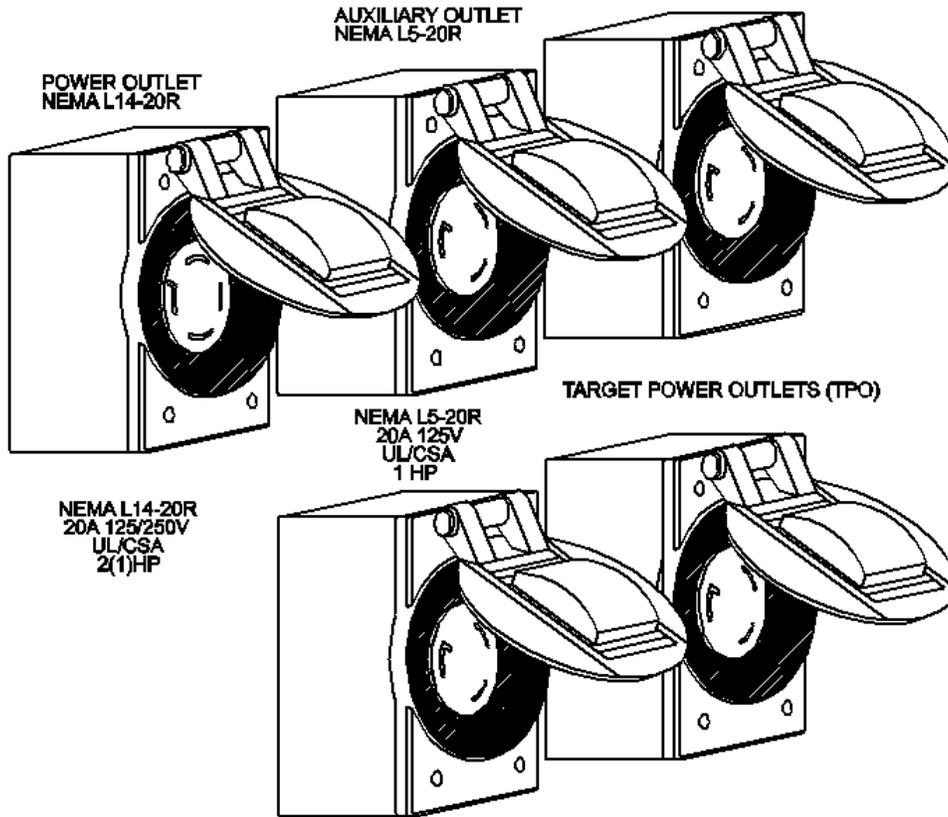
**All penetrations into the MTDP or TDP must be made with fittings approved for use with a NEMA 4, 4X or 6P enclosure. Non-compliance with this requirement will result in equipment failure.** The standard electrical detail drawings in the RDG illustrate the preferred sealing method. **Foam filled conduits are not acceptable.** The SIT load center only requires a NEMA 3R rated enclosure. Provide fittings approved for use with a NEMA 3R enclosure for connection to the load center.

## Target Outlets

Target Power Receptacles and Auxiliary Power Receptacles must be equipped with a waterproof enclosure approved for use with the power plug inserted and unattended, according to NEC 406.8(B) (2). The emplacement outlet configurations are shown in the Table below:

TARGET POWER RECEPTACLE	AUXILIARY POWER RECEPTACLE	FIBER OPTIC CABLE CONNECTORS	CATEGORY 5e OR BETTER CABLE CONNECTORS
NEMA L14-20R	NEMA L5-20R	Type "SC"	MALE, RJ45

*SAT EMPLACEMENT TARGET INTERFACE SPECIFICS*



*TARGET POWER RECEPTACLE (TPR) – AUXILIARY POWER RECEPTACLE (APR)*

EMPLACEMENT TYPE	POWER FEED TYPE	PEAK	STATIC LOAD	DESIGN LOAD
SAT with Thermal Blanket	120/240VAC Single Phase	2kVA While raising or lowering target. Add 1kVA if Thermal Blanket is utilized.	100VA	2.8kVA
Total Design Load 2.8kVA				

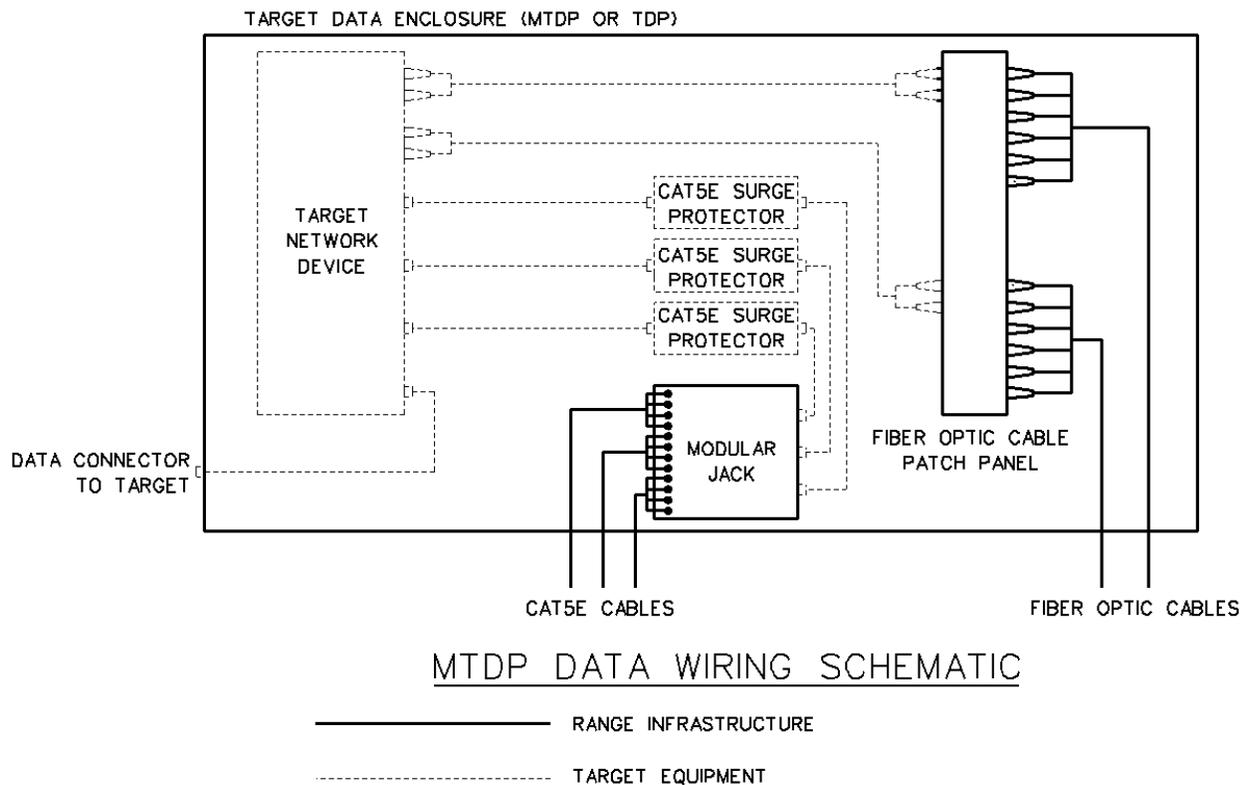
*SAT EMPLACEMENT TARGET POWER TABLE*

### Standard Target Interface

All targets operate at 240 V. Power is supplied to the target through a 120/240V cord and plug connection. The target emplacement shall be provided with a standard 120/240V receptacle that is supplied power through a circuit breaker that is located inside the target emplacement. An auxiliary 120 V outlet is provided in the target emplacement for additional devices or training

aids that may be added to the target mechanism. Thermal blankets are the most common devices that are added to the target mechanisms that utilize this power outlet. The specific components used to supply power to the target mechanisms installed inside each target emplacement is fully defined in the remaining sections.

Target and training device communication is accomplished by equipment installed inside the data enclosure located in each target emplacement. All networking equipment will be provided with the target mechanism when the target mechanism is purchased. The target mechanisms are normally purchased with Other Appropriations-Army (OPA) funded target installation contracts. The range data infrastructure should be installed with data cables to the target emplacement and these cables should be properly terminated inside the target emplacement data enclosures. These data enclosures are referred to as either a Target Data Panel (TDP) or a Master Target Data Panel (MTDP), and they are fully defined in other sections of this document. The target mechanism installer will interface with the data cables inside these enclosures during the installation of the targets. The schematic below provides an overview of the wiring responsibilities inside the data enclosures.



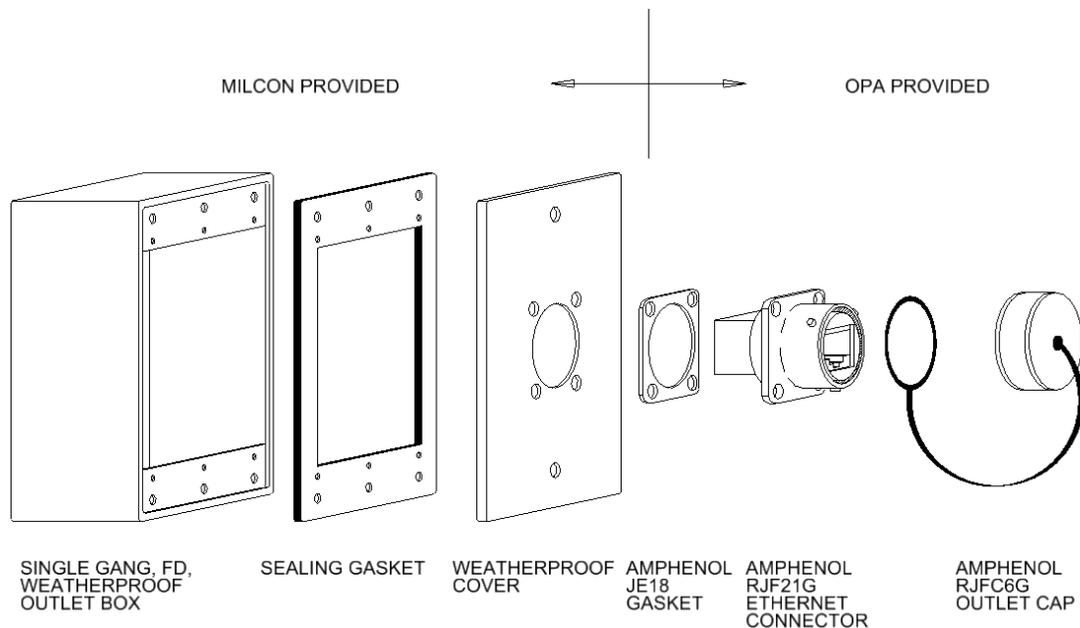
**MTDP DATA WIRING SCHEMATIC**

The Master Target Data Panel (MTDP), or the Target Data Panel (TDP) must be rated NEMA 4, 4X, or 6P depending on environmental conditions (refer to Conduit and Cable Fittings section below for connections). The MTDP/TDP contains the electronics for local target operation, including data cable splicing and terminations. Data cabling shall enter and exit the data panels through approved cable seal fittings (refer to Conduit and Cable Fittings below). All fiber optic cabling will be terminated with SC type connectors, and the network cables will be terminated

with CAT 5e or better rated RJ45 connectors. The MTDP and TDP provides space for Other Appropriations-Army (OPA) funded equipment which may include the fiber optic jumpers, switch/media converter, target data outlet, and network cables. The OPA equipment is installed by others and not the MILCON contractor. The designer must ensure the dimensions of the data panel are consistent with those dimensions stated on the detail plans for the MTDP and TDP equipment. A 120v AC power outlet is provided in the TDP for “Use by Others”. The TDP and the GFCI maintenance receptacle may utilize the same power circuit, but the TDP equipment must be wired ahead of the maintenance to ensure no nuisance tripping occurs. Reference the Electrical and Civil Details in the directory of the Range Design Guide for more information pertaining to the MTDP, TDP and their mounting requirements.

## Target Data Connection

All automated targets are connected to the data cable infrastructure through copper patch cables provided by the target vendor. The interface point between the facility infrastructure and the target installation occurs through the faceplate in the weatherproof outlet box installed immediately adjacent to the MTDP or TDP enclosure. The target vendor will penetrate the face plate on the outlet box and install a weatherproof coupling mechanism that mates with the patch cord provided with their targets.



**TARGET DATA CONNECTION**

## Environmental Limits

The temperature and humidity limits for electronic equipment are as follows:

- Non-operating and operating temperature: -34°C (-30°F) to 60°C (140°F).
- Humidity: 5% to 95% RH (non-condensing).

## Battery Operated Targets

Targets that are battery operated do not need any of the electrical equipment in the SIT. Depending on the soil conditions and other factors, a ground rod may be necessary; coordinate with the RTLP-MCX.





