

ROSCOMMON EQUIPMENT CENTER

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M548/M1015 Full Tracked Vehicle

Northeast Forest Fire Supervisors
in Cooperation with
Michigan's Forest Fire Experiment Station

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Cover Photo: An M1015 with full 800 gallon water tank traversing a wet leatherleaf bog.

Acknowledgements

Considerable help on this project came from others.

The Maine Forest Service provided the initial vehicle for REC's use. From Maine, Bill Hamilton, Roger Stanley, Tom Parent and their staffs also made technical contributions to the project.

North Carolina Division of Forest Resources, Arkansas Forestry Commission and the Department of Defense, Fort Polk, Louisiana, also contributed to this report.

Kirk Bradley led the REC design team. Prototype fabrication, vehicle testing and other logistics were provided by Don Duggar, Dale Eisbrenner, Greg Tate, Pat Mattingly, John Johnston, Dennis Fiebelkorn, Don Pillow, Rick Greenlaw, Paul Kamprath and Vickie Sheathelm.

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Introduction

U.S. Military M548, M548A1 and M1015A1 Full Tracked Vehicles are the “thin skinned” or unarmored versions of the M113 family of vehicles.

The majority of the M113 family are armored with configurations that make them generally impractical for forest fire control use. The unarmored versions are lighter weight and feature a more friendly operator and passenger cab. The unarmored versions, their availability through Federal Excess Personal Property (FEPP) and their applicability to fire control will be the focus of this report.

Basic chassis and layout of the M548, M548A1 and M1015 are the same. The M548 versions are cargo carriers, rated at 6 ton payload. The M1015A1 carries an electronic warfare shelter. Only a few hundred M1015A1s were made and some of the electronic equipment that they carried have been taken out of service. This means that many M1015A1s are retired and are usually in very good condition. Appendix A shows the military data sheet and National Stock Numbers (NSN) for these three versions.

These vehicles will have limited use in selected locations. Applications requiring a low ground pressure unit is one situation. This report will discuss our trials in marsh and bog type environments. These units also perform well in rugged terrain. Although the vehicle has tracks with street pads and a road speed of about 33 mph, a lowboy trailer will be needed for most transport.

The M548 was developed in 1965. In 1982, M548A1 production replaced the earlier model. The M548A1 had improved suspension and cooling system. The M548s had significant cooling system problems, but most if not all were upgraded to M548A1 status at Depots. The M1015A1 was developed in 1984 and includes the upgraded suspension and cooling system of the M548A1. The M1015, when available through FEPP, will not come with the

electronics carrier, however it’s likely that the generator system will be part of the acquisition. This equipment can be removed to reduce weight and complexity. In all, several thousand of these “thin skinned” track vehicles were produced. Intermittent availability through FEPP should continue for a number of years.

Several forest fire control agencies have obtained these vehicles and successfully used them, especially where low ground pressure vehicles are needed. Agencies that we obtained information from include the Arkansas Forestry Commission (Figure 1), Maine Forest Service (Figure 2) and the North Carolina Division of Forest Resources. Additionally the U.S. Army at Fort Polk, Louisiana, produced a design and report titled, Fire Track. For this project they used an M548A1 vehicle with 1,000 gallon water tank. Compressed Air Foam, front blade and a fireline plow were included on the Fort Polk version. Information has been available as the “Fire Track” vehicle from DPW/ENRMD/NRMB, 1843 23rd Street, Fort Polk, Louisiana 71459.



Figure 1 - An M548 fitted with a military 500 gallon fuel cell and compressed air foam system (CAFS). Completed by Arkansas Forestry Commission.

For this report REC tested and designed equipment for a vehicle provided by the State of Maine as well as one from the Michigan

Department of Natural Resources. The design includes three separate components:

- A bumper and limb rising system to protect the windshield and cab when working off road and in forested environments.
- An 800 gallon tank.
- A hard top cab. These units normally come with canvas cabs. The military also has a fiberglass cab with a gun turret opening. The fiberglass cabs are usually difficult to get.

The remainder of the report will use the term "M548" to mean any of the M548 or M1015 models.



Figure 2 - Windshield and cab protection on an M1015 unit produced by Maine Forest Service. The cab was a military composite material type with gun turret opening.

General Analysis

The Maine Forest Service loaned an M1015 to make an assessment of its' utility for forest fire control. Before obtaining any piece of equipment, an agency should determine its' usefulness. For a specialized piece of equipment like the M548 series this is extremely important. The M548 equipment is not for everyone. It is large which affects

how it can be transported. It will require special maintenance and should be operated by skilled personnel. The remaining sections will discuss various characteristics of the vehicle that will help agencies make a decision as to whether acquisition is proper for them.

Transportation of the Track Unit

The M548 has rubber pads on the track and a top speed of approximately 33 mph. This makes it possible to drive the vehicle at low to moderate speeds on hard surfaces without damaging pavement. There are obviously safety concerns about transporting the vehicle this way and it is expected that travel on improved roads would be limited. The vehicle does have the flexibility to move to different parts of the fire site without special transportation requirements. It also can cross paved roads without special provisions.

It is likely that an agency will transport the unit to a fire site with a semi and low-boy trailer. The need for a special transport unit makes the M548 an unlikely choice for local fire department use. As shown in the Appendix A, the vehicle is 105.75 inches wide. This is a "wide load" under normal transporting circumstances. The width of the vehicle is just under 103 inches if the two front track guard step plates are removed (Figure 3). Each plate is held by four bolts. Removal of these plates either temporarily or

permanently reduces the vehicle's width enough to be transported as a normal load on major highways.



Figure 3 - Removing the track guard step plates (shown installed near photo's center) reduces the overall vehicle width to under 103 inches. This eliminates the need for wide load permits.

Load Considerations and Center of Gravity

As we do with any military-obtained vehicle, REC stripped the M548 unit of items that we did not need. This included seats and the floor boards in the cargo unit and the auxiliary generator of the M1015. When this is done, the vehicle weighs approximately 14,300 lbs. This is about 2,000 lbs. less than the net weight for an M548 cargo carrier. The military designates 28,400 lbs. as the combat weight for the unit. Hence there is more than sufficient payload available for conversion to wildland fire fighting use.

Because the M548 has a large payload capacity, the limiting factor on how much load you carry will probably have more to do with your use. Much of the interest in using a tracked rather than wheeled vehicles has to do with the decreased ground pressure. The larger surface area of the tracks helps support

the vehicle above the ground in a marsh, bog or other low area. On paper the M548 actually has a high ground pressure for a tracked vehicle. At its' full combat weight, the ground pressure is listed at 8.6 psi. This is considerably more than even crawler dozers with standard width pads. However, the M548 does have a track system that gradually tapers up to the drive sprocket. As the vehicle sinks below the surface, it gains more track surface area. This reduces the ground pressure until the vehicle reaches the level of the upper (drive) sprocket. For the rest of this report we will refer to this as the "secondary" ground pressure. We will define the "initial" ground pressure as that calculated using the surface area of the pad that would contact the ground when the M548 sits on hard ground. In other words,

when the unit has not "sunk" down below the surface level.

help you plan a unit. The actual ground pressure will depend on the tank material weight and other items that you add. For a comparison, standard track, crawler dozers normally have a ground pressure of 6 to 7.5 psi. Low ground pressure or wide pad crawler tractors will typically exhibit ground pressures of 4 to 4.75 psi.

Figure 4 is an estimate of the ground pressure, both initial and secondary for various payloads added to the M548 stripped weight. Figure 5 is an estimate of the ground pressures for various water tank capacities. Keep in mind that this is only an estimate to

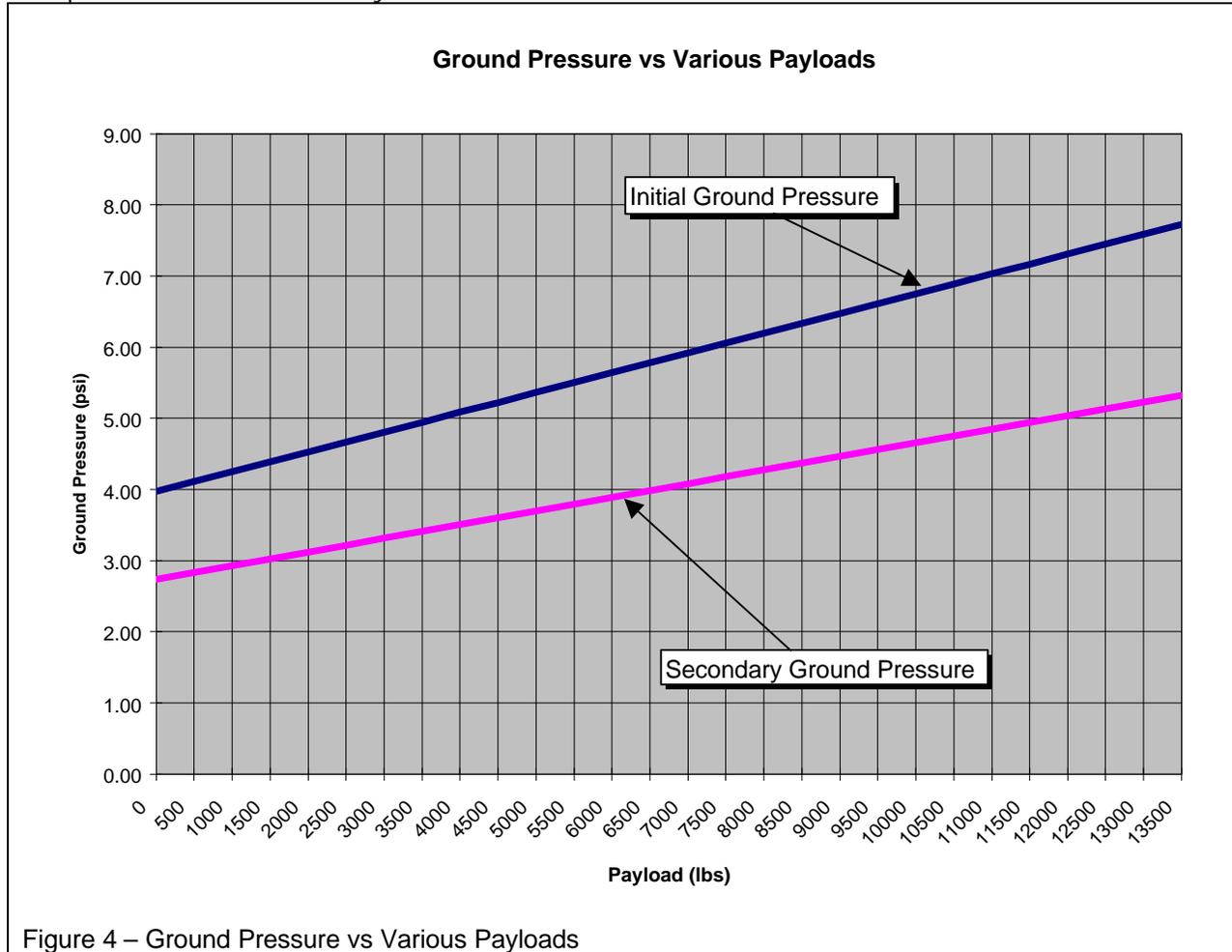


Figure 4 – Ground Pressure vs Various Payloads

The REC designed water tank for the M548 is about 800 gallons. We felt this would give the users some flexibility. Most users wanted large capacity available for use in areas where the soil structure was capable of handling the higher ground pressure. It was assumed that if lower ground pressure was required that the load could be reduced by hauling less water. The M548 vehicle is a good candidate

for doing this. It has a low center of gravity, very wide stance and the weight of the water is a fairly small compared to that of the vehicle. Hence, there is little or no affect from water shifting in a half empty, baffled tank. Additionally, M548 does not operate on public highways at normal highway speeds, thus the vehicle can operate with partial water loads in a safe manner.

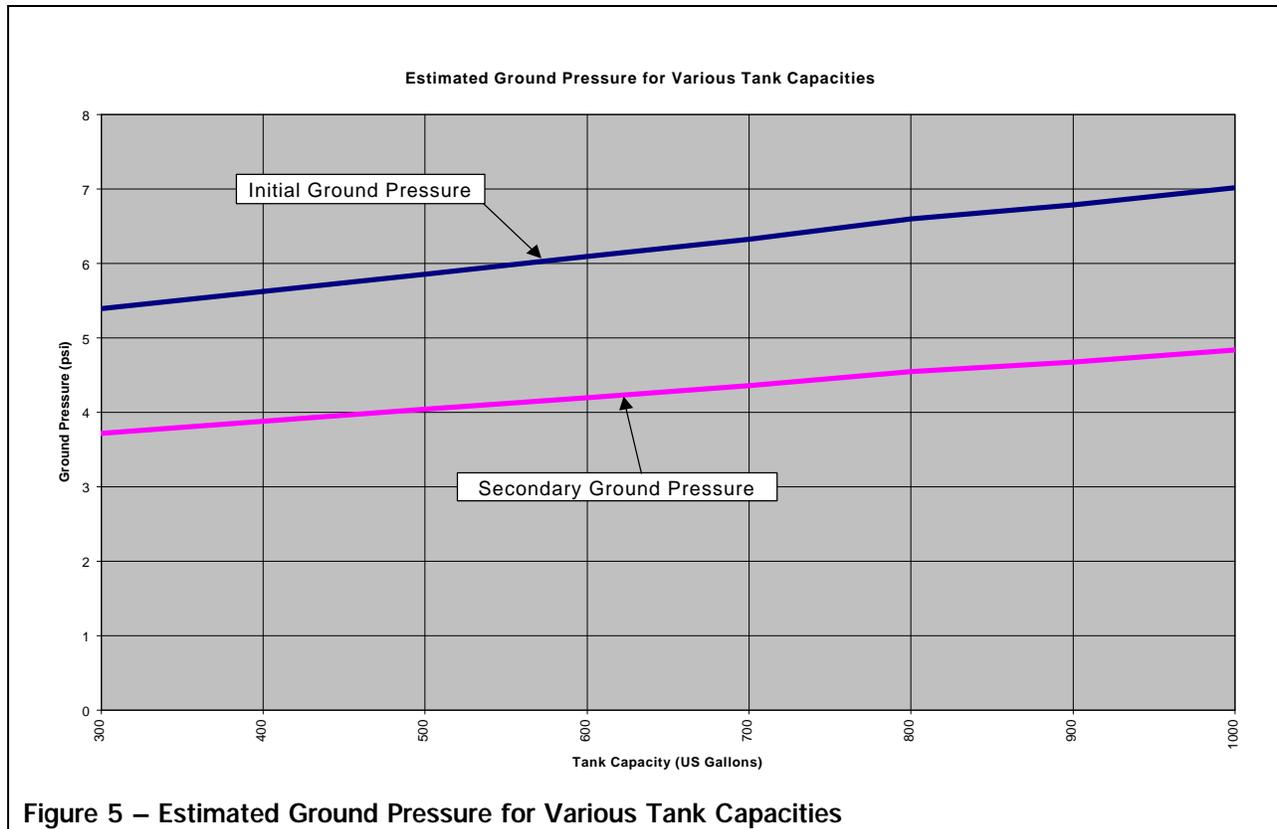


Figure 5 – Estimated Ground Pressure for Various Tank Capacities

As always, remember to consider other loads that will be placed on the vehicle. For example, REC’s hard cab design for this unit weighs 320 lbs. The heavy duty bumper and limb riser set adds another 600 lbs. Estimate the occupants weight at 200 lbs. each, then add in the weight for other items you plan to store or carry on the vehicle.

The vehicle’s performance will also be affected by its’ fore to aft balance. Figure 6 shows the center gravity location for the a stripped M548. It is about 2 feet in front of the center bogie wheel. Ideally you would like to operate with the vehicle’s weight centered directly above or slightly behind the center bogie. Because of the engine and cab weight, it is obvious that a large load in the rear would be necessary to shift the center of gravity to the center. Figure 7 shows the approximate center of gravity point of REC’s 800 gallon tank when full and empty. The tank design is discussed later in the report.

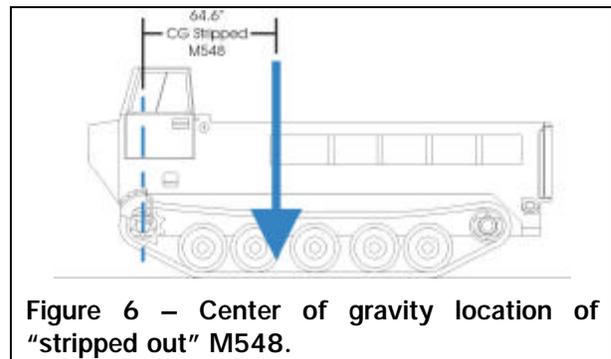


Figure 6 – Center of gravity location of “stripped out” M548.

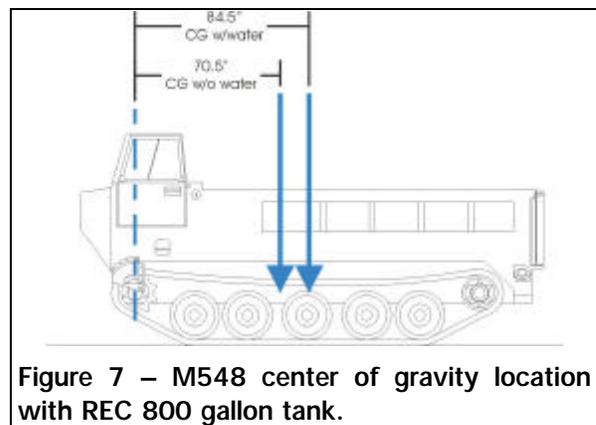


Figure 7 – M548 center of gravity location with REC 800 gallon tank.

Result of Field Trials

REC spent a considerable amount of time using and testing the M548. We have broken our observations into three areas. First is "usability and durability." The second, "performance and low ground pressure situations." The third is "operator comfort issues."

Usability and Durability – At first look, the M548 is big and it is especially wide. Despite this, it gets around off highway fairly well. The track system makes it maneuverable. The unit is generally durable, especially when fitted with a heavy duty bumper and some limb risers as illustrated in the REC drawings. The underbelly has no vulnerable parts. Lastly, the M548 has plenty of power. The Detroit Diesel 6 cylinder, 212 hp engine provides more than enough to move the M548 with a heavy payload. The unit can push over smaller trees and has plenty of ground clearance to climb over them. The unusual width does make traveling two-track roads a little more difficult. All in all, it performs well off the road.

The U.S. Army sets the maximum speed at 33 mph. We had no trouble reaching that speed on pavement. The rubber street pads prevented damage to the asphalt and provide the ability for the vehicle to cross highways without taking special precautions.

The unit handles slopes well. Its' center of gravity is relatively low compared to its' wide track. This makes it a relatively safe vehicle in steeper terrain.

Performance in Low Ground Pressure Areas – As mentioned previously, the ground pressure for this vehicle is relatively high for a tracked vehicle. We were surprised on how well it traversed low boggy areas. The M548 will sink somewhat in soft soil and marshes. This will especially be true if it carries a full water load. However, the vehicle has three things going for it. First, as mentioned previously, it gains more track surface as it sinks. Secondly, the flat belly pan that makes up the unit's bottom, will prevent it from sinking any

further. When it sinks to the belly pan, the ground pressure gets really low. Third, the engine has plenty of power. We found that the engine had no problems skidding the unit on its' belly pan, across leatherleaf bogs. With leatherleaf and similar such areas, there is generally plenty of root structure. If the structure is there, the tracks will get enough traction. If there is enough traction, we found that there is enough power for the unit to skid itself along. The caution is using it in areas that require low ground pressure but have little root structure and no bottom. Cattail marshes would be an example. In these cases, you will get stuck.

Operator Comfort Issues – The high noise level produced by its' power plant is another characteristic of the M548. We measured sound levels of 109 decibels while traveling the top speed of 33 mph on a paved road. Much of the noise comes from the fact that the occupants sit right over the diesel engine. Only a thin layer of sheet metal separates the engine from the occupant compartment. Secondly, it can pick up a fair amount of road noise at that speed. Hearing protection is an obvious necessity. Communications between occupants in the cab was difficult at high engine rpms.

<u>Engine RPM</u>	<u>Decibels</u>
700	91
1000	96
1500	100
2000	107
2500	108
Full Speed	109

Figure 8. Measured sound levels inside M548 cab while driving on pavement.

REC put sound insulation on the inside back of the cab under the seats and floor boards. By doing this we were able to reduce the sound level by nearly 10 decibels. Because sound is measured a logarithmic scale, 10 decibels is a very significant decrease. But 100 decibels is still very loud and requires

hearing protection if in that environment very long. Figure 8 shows the sound measurements taken at ear level of the operator inside an enclosed uninsulated M548 cab. The measurements were taken at various engine speeds while operating the vehicle on pavement.

The seats in the M548 are not comfortable. There is a bench seat for the passengers. The seat portion of the bench hinges open for engine service access. Because of the need for engine access, adding more comfortable seats would be a challenge. We did add a

molded off-road race vehicle seat for the driver. We also added a four-point seat belt harness for the driver to reduce the amount of fatigue from being jostled during operation. A grab handle was put on the inside of both doorways to help occupants get in and out of the cab easier.

Noise is the biggest comfort and safety issue that we found. Surprisingly the operators look past the noise issue and were impressed with the vehicle's ability to handle difficult off-road situations.

REC Designs

REC has created designs to modify the M548 for wildfire control. These designs fit five different categories.

- A steel cab to replace the canvas cab that typically comes with these units.
- A heavy duty bumper and limb riser system to help protect the front of the vehicle and its' windshield and cab.
- A 12-volt electrical system for running add on accessories. The 12-volt system is in addition to the vehicle's 24-volt system.
- An 800 gallon water tank that slips into the cargo area of the vehicle and is held in by four turnbuckles.

- Various accessories to help complement the vehicle's use. This included installation of the REC low-cost turret, steps for better access and side mounted hose reels.

Because the M548 will have limited use for fire agencies, this report includes only the overall drawings for the five design categories listed above. The drawings are meant to give a general idea about what we did. If you like what you see, please contact us and we will provide you with a packet of drawing details. Packets available are listed below.

<u>M548 Design Packets</u>	<u>Packet Number</u>
M548 Cab Design	#60A
M548 Bumper and Limb Risers	#60B
12V Alternator System	#60C
800 Gallon Water Tank and Mounting for M548	#60D
Other M548 Accessories	#60E

Appendix A

The following is data about U.S. Military M548A1 vehicles from the U.S. Army Tank Automotive Command, March 1993.

Description	Specification	Unit of Measure
Weight, Combat	28,400	Pounds
Weight, Net	16,390	Pounds
Length	226.5	Inches
Width	105.75	Inches
Height	105.5	Inches
Height, Min Reducible	76	Inches
Acceleration (0-20 MPH)	14	Seconds
Acceleration (0-30 MPH)	56	Seconds
Maximum Speed	33	Miles per Hour
Range	285	Miles
Ground Pressure	8.62	PSI
Width of Trench Crossing	66	Inches
Vertical Obstacle Crossing	24	Inches
Slope Capability	60	Percent
Side Slope Capability	30	Percent
Fuel Capacity	105	Gallons
Operator	1	
Passengers	3	
Engine	Detroit Diesel, 212 BHP, 6V53	
Transmission	Allison TX-100-1, 3 Speed, Automatic	
Controlled Differential	Single Speed, DS-200	
Amphibious	No	

National Stock Numbers (NSN)

M548	2350-00-078-4545
M548A1	2350-01-096-9356
M1015A1	2350-01-136-8745

Appendix B



Figure B-1 - Front view of an M1015 modified by REC. Limb risers and bumper were part of the modification.



Figure B-2 – The 800 gallon REC tank with pump and foam proportioner. The tank sets in four cradles (not visible). Enclosed storage is located below the pump apron, accessed by opening the lower tailgate.



Figure B-3 - The tank is held in the cradles by four turnbuckles. The right rear turnbuckle is shown in the center of the photo. It is attached to the tank and to a cargo tiedown ring in the M548.

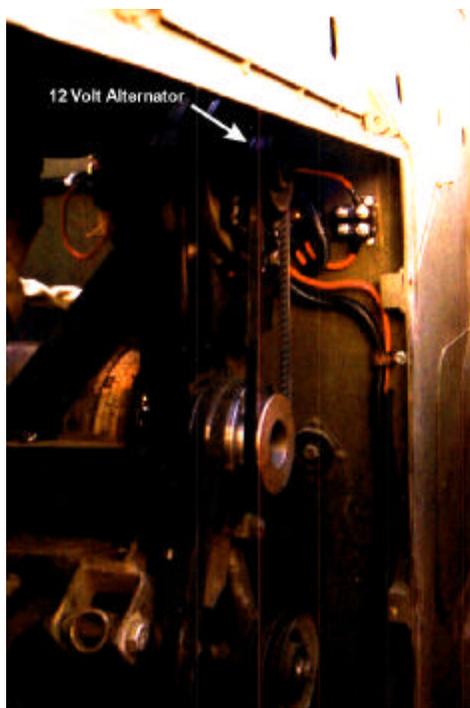


Figure B-4 - A 12-volt alternator and its' mounting bracket were mounted to the existing 24-volt alternator. This provided power to the fire related accessories. Drawings are provided (Appendix C).



Figure B-5 - View inside of the REC cab. A 1x1 inch square tube framework supports the 11 gauge steel skin. The rear windows were a clear polycarbonate.

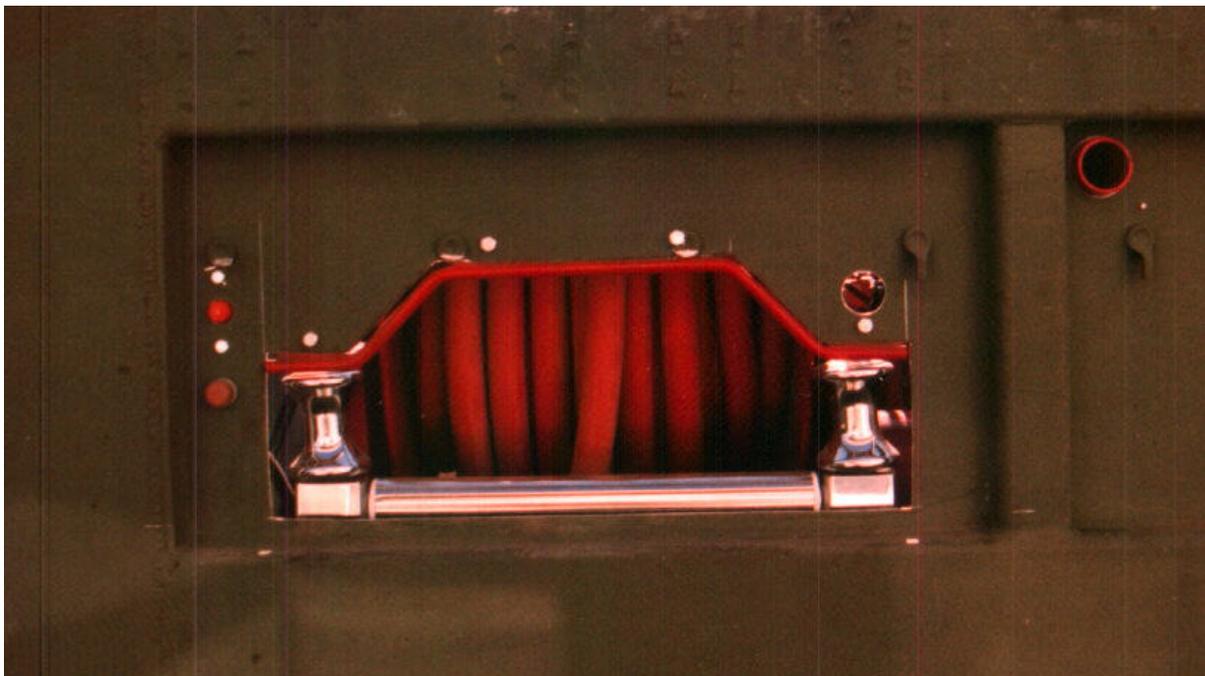


Figure B-6 - In one design version, REC cut out booster hose openings through the side walls (Design Packet #60E). Note the water tank overflow and vent tube outlet (upper right). This was a concept borrowed from Maine Forest Service.



Figure B-7 - The REC low cost turret was integrated into the front of the M548 (see REC Project #58). The turret provides water delivery when it is not practical to use booster lines.



Figure B-8 - Fold down steps were put at each rear corner to reduce the step up distance to the cargo area (Design Packet #60E).

Appendix C

REC M548 Component Designs

The online version does not include Appendix C drawings directly. Some M548 Component Drawings may be available online as individual files. Look at the "Online Reports" page of the REC web site for current listings.