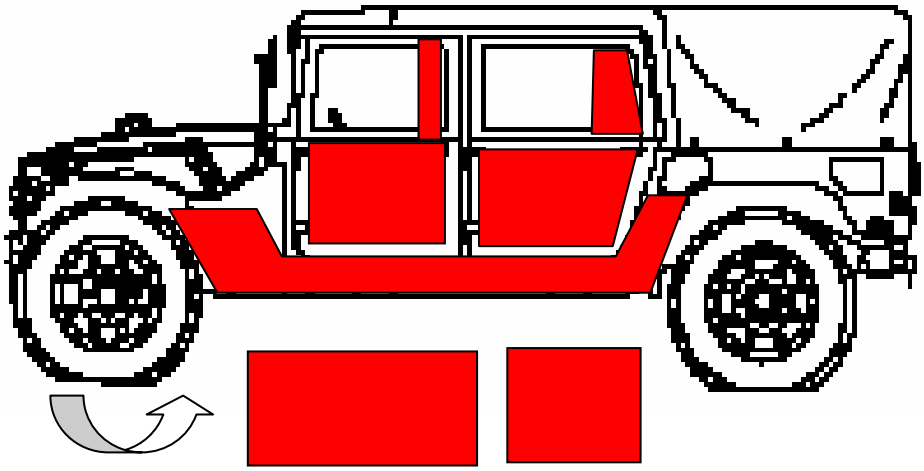


M998-Series Armor Plate Proposal:

Increasing Crew Survivability in Iraq

Executive Summary

The purpose of this document is to describe in detail an armor plating modification that can be applied to the M998-series vehicle in order to increase crew survivability. The intent is that the plating be manufactured by Iraqi machine shops and then installed by US personnel. This proposal discusses the design, technical considerations, pricing and installation of these modifications. All the information needed to implement this project is contained in this proposal.

The modification kit contains a total of 14 steel plates per vehicle: two pieces per door, a running board plate for each side and four pieces that bolt underneath the vehicle. The door plates are made from 4mm thick steel, while the running board and underside armor plates are made from 12mm thick steel. All the panels are held in place using holes drilled into the skin on the M998, or in the case of the doors, the fiberglass. The required mounting hardware can be ordered through the army supply system.

Installing the hardware is straightforward and requires no special tools. Removing the doors, lining up the armor plate, drilling the holes and then fastening the nuts and bolts are the only tasks required to install the door armor. For the running board and underside armor, they key is to use a jack to position to the plates, mark where to drill the holes and then drill the holes after removing the plate. Once the holes are drilled it is simply a matter of repositioning the plate and installing the fasteners.

While a number of holes are drilled into the skin of the vehicle, no damage is done to any structural or automotive component. Furthermore, the addition of the plating does not in any way impede normal operations or vehicle maintenance. The total weight of the armor (~800lbs) is well within the max payload of the vehicle. Also, the weight is well distributed between the two axels.

There are some disadvantages to the adding the plating. Riding with closed doors decreases situational awareness. Furthermore, the weight of the doors will put additional stress on the hinges and handles, which could cause difficulties closing and locking doors over time. Likewise, there is a danger of increased corrosion by having two dissimilar metal bolted together (steel and aluminum). Lastly, the added weight increases wear and tear on the vehicle suspension and brakes.

This design was motivated by my battalion's experience with improvised explosive devices, or IEDs in Baghdad, Iraq. At this stage in the war, the most lethal threat tactic is IEDs. I have personally inspected 6 M998s after they were hit by IEDs - resulting in a total of 4 KIAs and 8 WIAs. In each case, most of the shrapnel impacted the running board, the underside of the vehicle and the doors. This is because most IEDs are placed along the sides of roads at ground level. This vulnerable area is precisely where the plating is added.

Recommendation: The armor plating when used in conjunction with Kevlar blankets greatly increases crew survivability without degrading vehicle performance or impacting accomplishment of the tactical mission. Careful crew and organizational level maintenance can minimize corrosion and automotive wear problems. The major advantage of this design is that units on the ground can protect their soldiers from a deadly threat now with minimal expenditure and manpower.

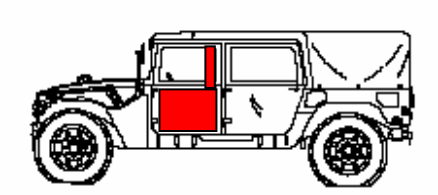
Table of Contents

Description

For technical drawings, see Annex A.

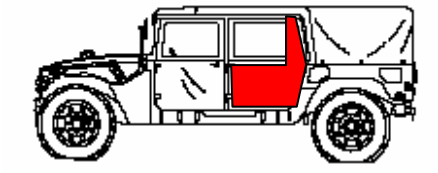
Front Door Armor

The armor bolted on the front door is made of 4mm steel plates. It comprised of two pieces. A bottom piece covers most of the door. A second piece is mounted adjacent to the window on the upper half of the door. By using two pieces we eliminate the need for right and left hand versions of the plating. It is held in place using holes drilled in the fiberglass door. Because the nuts are fastened on the outside of the door window operation is not affected. This modification can only be applied to vehicles with hard fiberglass doors.



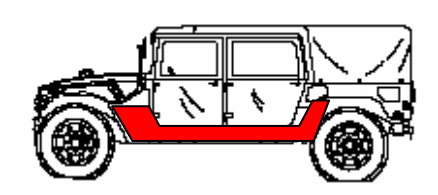
Rear Door Armor

The armor bolted on the rear door is also made from 4mm steel plates. Like the front door, it consists of two pieces and is held in place using holes drilled in to the door. This armor can only be installed on vehicles with hard fiberglass doors.



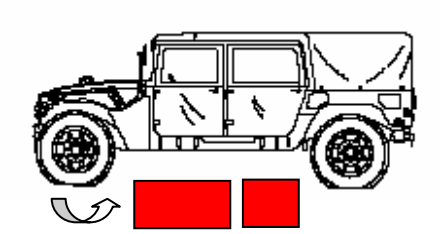
Running Board Armor

The running board armor is made from 12mm steel plates. It is bolted vertically against the running board, directly under the front and back doors. It follows the contour of the vehicle. There is no difference between the driver and passenger side plates.



Underside Armor

The underside armor comes in two rectangular piece of 12mm steel plates. This armor runs horizontally underneath the front and back seats. The front piece extends from the front edge of the leg compartment to just beyond the battery box (on the TC's side). The rear piece abuts the front piece and continues to where the rear leg compartment angles upward.



Mounting Hardware: CL IX Requisition

The mounting hardware required to mount all the plates is given below:

Noun	NSN	Purpose	Req.	UI	Order
SCREW,CAP,HEXAGON HEAD	5305-00-068-0511	Doors, Running Board	86	HD	1
SCREW,CAP,HEXAGON HEAD	5305-00-846-5703	Underside	30	HD	1
SCREW,CAP,HEXAGON HEAD	5305-00-782-9489	Running Board, Underside	15	HD	1
NUT,SELF-LOCKING,HEXAGON	5310-00-087-4652	All	131	HD	2
WASHER,FLAT	5310-00-809-5997	Underside	45	HD	1
WASHER,FLAT	5310-01-306-1624	Underside	135	HD	2

Although Iraqis can supply nuts, bolts and washers, they are generally of low quality. If the decision is made to local purchase mounting hardware, use the NSNs provided above and view their characteristics using FEDLOG. This information can then be used to find appropriate substitutes for the recommended hardware.

In addition to the nuts, bolts and washers listed above, 20 spacers approximately 1" thick are required to mount the underside armor. This is because the plate is seated against the battery box and a steel bracket that is ~ 1" away from the actual floor of the vehicle. If a spacer is not introduced in this gap, any torque applied to the bolt will deform the aluminum floor. In the prototype model we used M923 (5-ton truck) lug nuts. Almost any large truck lug nut will work, as will a tank wedge bolt. Iraqi contractors can also manufacture spacers. Also, pieces of felt or cut up pieces of tire inner tube should be used as part of the bolt-washer system on the underside armor. This is a corrosion prevention technique that might also help dampen vibration.

Contracting

Finding a Contractor

Units stationed in urban areas of Iraq can easily find a metal working shop capable of producing the plates. However, insist on them producing one prototype prior to completing the whole order. Some contractors will make claims about their capabilities that are not realistic. To produce the plating the contractor should be able to cut and grind steel plate, drill holes and weld. They also have to have fairly skilled workers who at a minimum can read plans and execute a simple pattern. The contract itself should specify exact expectations. At a minimum there should be mutual agreement on the work to be done, delivery location and time, painting, mounting hardware (if any) and payment.

Payment

To pay for the plating, a unit in Iraq has two options - they can submit a PR&C (Project Request and Commitment, DA Form 3953, then DD 250) or use FOO money. The advantage of FOO money is that it is very fast. The downside is that FOO purchases must be under $2,500 per project. Depending upon how the money is accounted for, the money available through FOO is probably enough to equip a line company but not enough for an HHC. The other option is a PR&C, which is time consuming and more bureaucratic. The project must be approved first and then money is made available (unlike FOO money which is spent at the unit's discretion). On the upside, much more money can be spent on a single project. Basically, each unit needs to decide which method is best for them, given their number of vehicles and how quickly they want to field the plating.

For an initial prototype $500 is probably a reasonable price. This should include painting and delivery. If this prototype meets expectations you can negotiate a per vehicle price for much less money (~$350-450).

Installation

Tools Required

Heavy Duty Drill w/ metalworking bits. All holes are 10mm in diameter.
Jack - preferably a transmission jack with a large, flat surface area
Ratchet, sockets and wrenches - 3/8"

Procedures

Door Armor (Front and Rear)

Remove door from the vehicle. Place the armor plate on top of the door. Line up the holes in the door with those in the plate. Add the bolts, nuts and washers. Re-hang door.
Estimated Time: 10 minutes per door.

Running Board Armor

Line up armor with contour of vehicle by jacking it into place. Once the plate is lined up, drill holes into the skin of the vehicle using the plate holes as a guide. Add bolts to the holes and tighten as soon as they are drilled. This ensures all holes line up because the plate will not shift after two or more bolts are tightened.
Estimated Time: 30 minutes per side

Underside Armor

Remove all matting and Kevlar blankets from the floor of the vehicle. Remove the front vehicle seats. Place the front underside armor piece on the jack. Jack the plate into place. The front plate should just clear the battery box. Using a punch or spray paint, mark where the holes need to be drilled. One technique is to push the punch through the hole and then spray in the hole with a light colored paint. This will leave a light colored mark with a dark center (where the punch blocked the paint) that is exactly where the hole should be drilled.

Once the holes are marked, remove the plate and drill all holes. Next, place the spacers (lug nuts, tank wedge bolts etc.) on the plate and jack into place. Emplace the bolts, nuts, washers and piece of felt. Tighten the bolt-nut system. Repeat the same procedure for the rear underside plate. It should be placed so that it abuts the first plate.
Time: 30 minutes per side

Manpower

Although one soldier can install the plating, it is preferable to have two. With all the proper equipment available, two mechanically inclined soldiers should be able to modify two to three vehicles per day. Although not strictly necessary, at least one of the soldiers should b[illegible]63-series.

Maintenance and Retrograde

PMCS

As part of the PMCS for vehicles with the plating, crews should look for the following faults and execute the prescribed corrective actions or notify organizational maintenance:

1) F: loose bolt	CA: replace or tighten nut
2) F: damaged bolt head esp. on undercarriage	CA: replace bolt
3) F: severe corrosion	CA: scrape off and re-paint
4) F: cracks in the door hinges	CA: weld a bead / order new
5) F: spreading cracks in the fiberglass door	CA: use fiberglass repair kit

Service and QA/QC

At a periodic interval, maintenance personnel should check for the above faults as well as the following more intensive checks:
1) Check the aluminum skin of the vehicle for signs of deformation, particularly on the underside armor. If any of the bolts appear to be pulling through, it may be necessary to use a large plate washer to span the deformed area.
2) Check for unusual wear on the tires, brakes and vehicle suspension.

Retrograde and Removal

Ideally the plating can be removed and transferred to a new unit that needs them. The only pieces that are not re-usable are the self-locking nuts, which are technically for one-time use (though if you have lock washers they would be fine to use again). A jack should be used to remove the plating in the same manner as it was used for installation. This will prevent injury and damage to the vehicle. The holes that remain can either be patched or left alone. Due to the wear and tear placed on the doors, it is preferable to order new doors and leave the modified doors with the replacing unit (or just swap doors).

If the decision is made to leave the plates on during shipping to home station, each company Unit Movement Officer (UMO) needs to consider the added weight (~800lbs) when using TC-AIMS / ALPS, especially if any air load operations are expected. For most units the method of transport will be by sea so the added weight is insignificant. The vehicle-cube dimensions are not modified.

Misc.

History

This design was created in November / December 2003 in response to the threat from IED attacks. A prototype was constructed and tested. After testing the prototype, our commander made the decision to equip all the M998s-series in 1-37AR with the plating. As of mid January 2004, approximately half of 1-37AR M998s have received the modification.

Approval

As of late January 2004, US TACOM (US Army Tank and Automotive Command) has not approved this design. However, civilian representatives from TACOM serving in Iraq have inspected this design said it is the best unauthorized modification they have seen. Although TACOM can advise for or against modifications, the ultimate authority lies with unit commanders responsible for their vehicles and soldiers.

Contact Information

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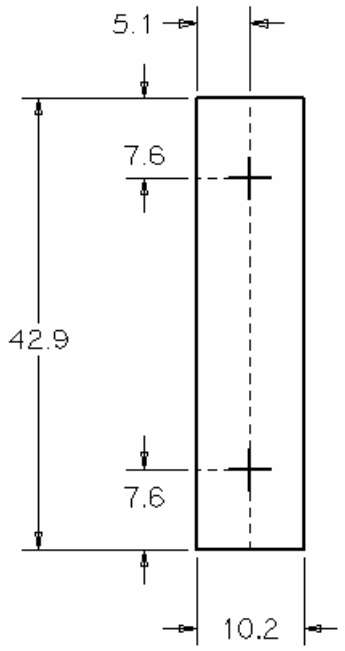
CMR 453, BOX 71
APO AE 09074

Please send me all questions, comments and suggestions. In particular, I would like to know about:
- Recommendations for improvement in design, installation or maintenance
- Results of vehicles with plating hit by explosive devices / small arms fire
- Maintenance problems

Annex A: Technical Drawings

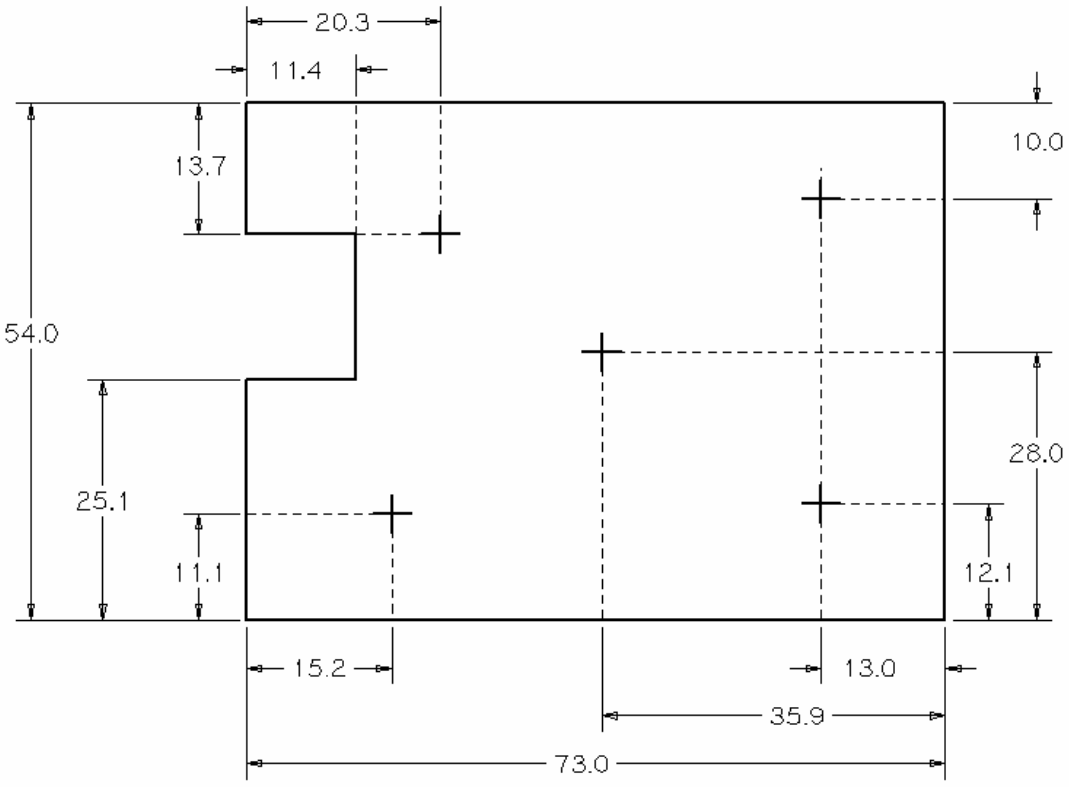
(all dimensions in centimeters, "+" indicates center mass of hole)

Front Door Armor

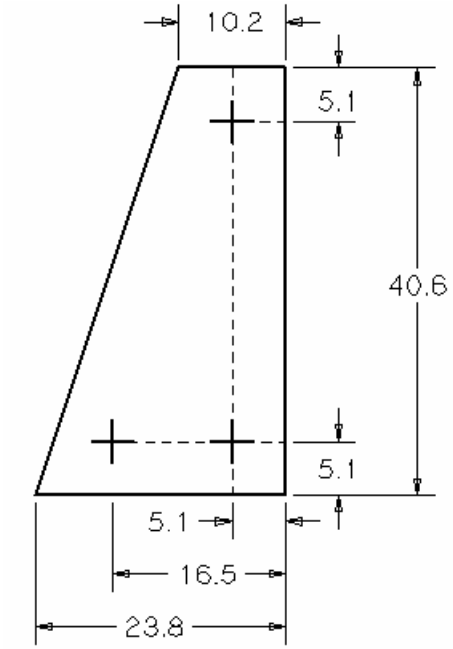


Front Door Panel, Upper Piece	
Number per Set	2
Steel Thickness	4mm
Hole Diameter	10mm

Front Door Panel, Lower Piece	
Number per Set	2
Steel Thickness	4mm
Hole Diameter	10mm

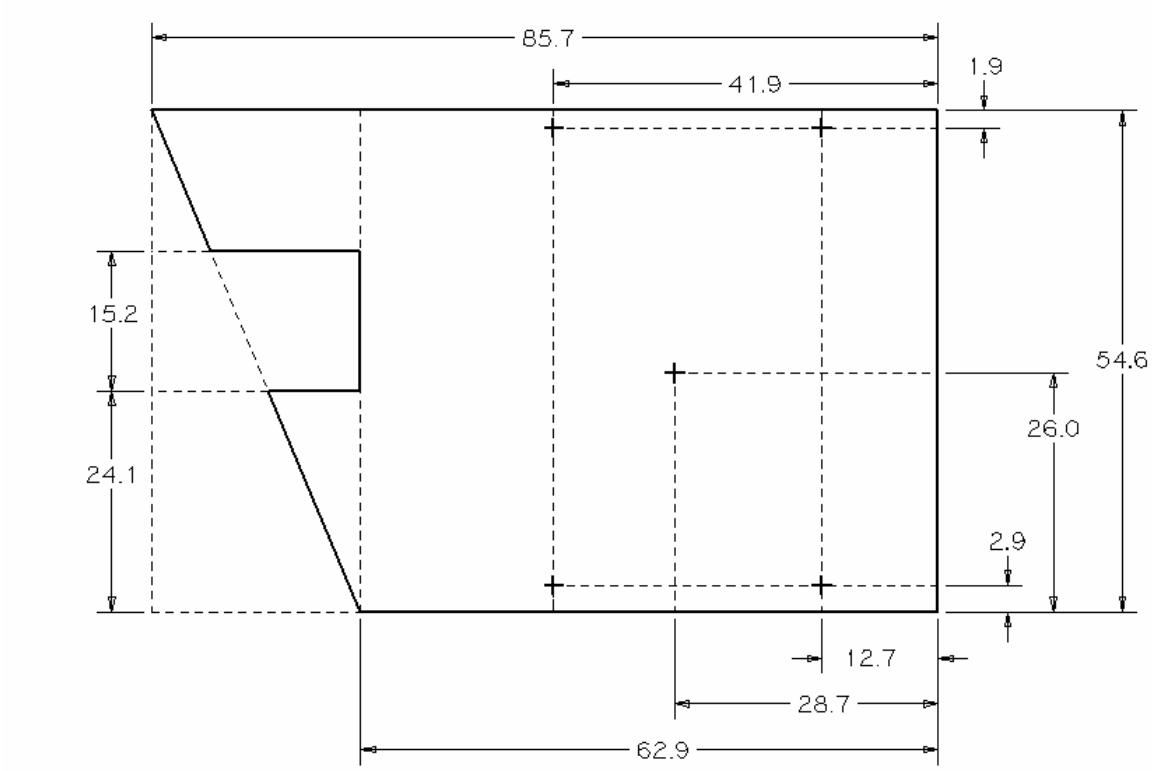


Rear Door Armor

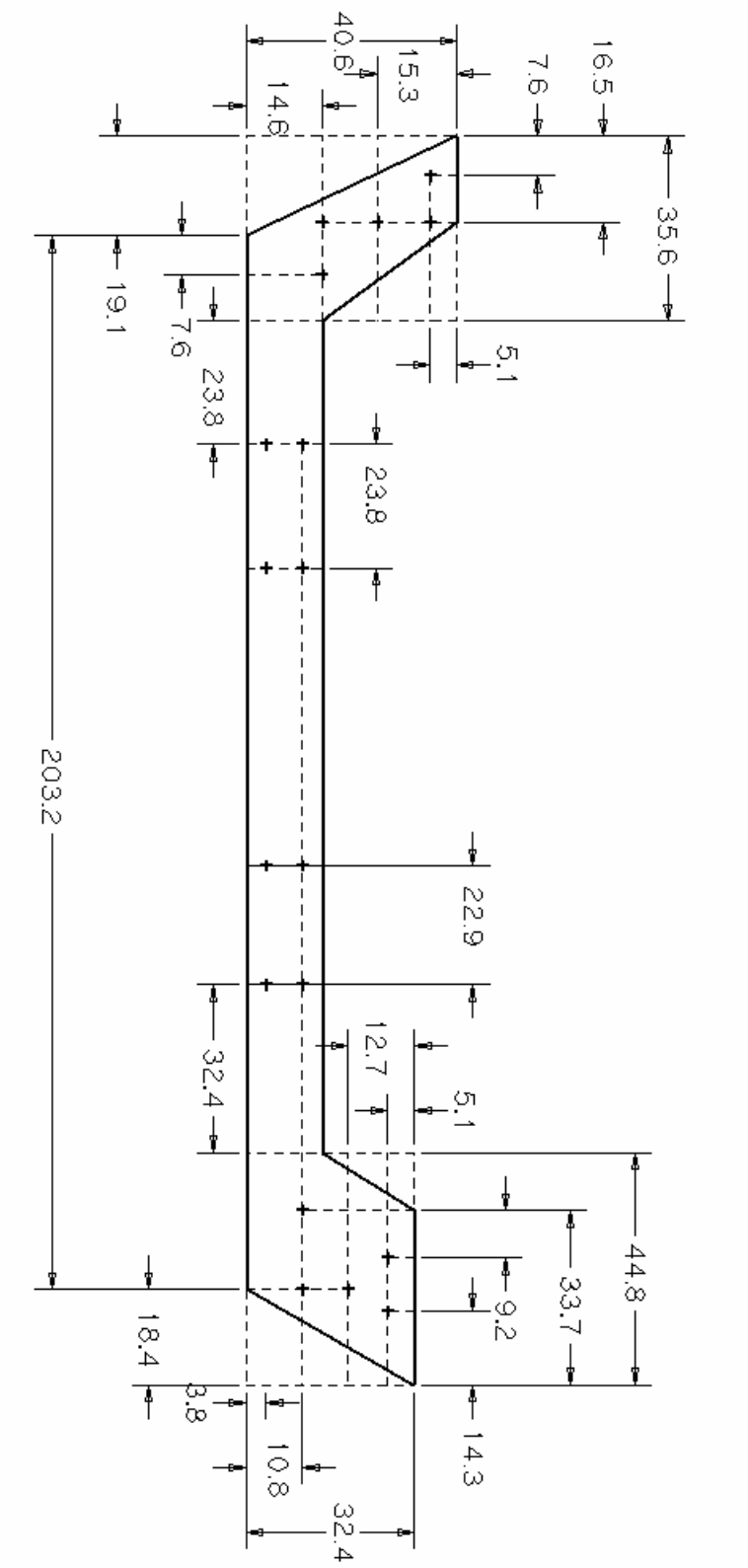


Rear Door Panel, Upper Piece	
Number per Set	2
Steel Thickness	4mm
Hole Diameter	10mm

Rear Door Panel, Lower Piece	
Number per Set	2
Steel Thickness	4mm
Hole Diameter	10mm

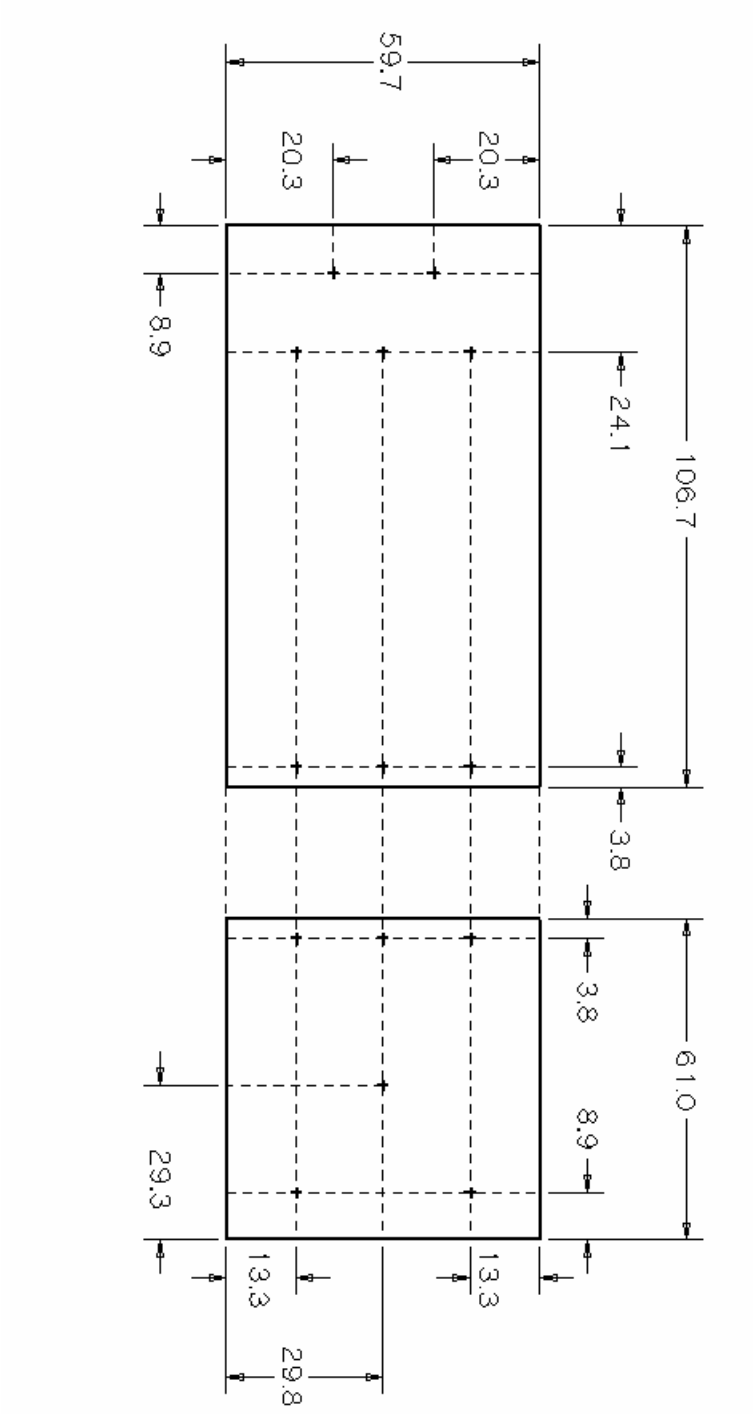


Running Board Armor



Running Board Panel	
Number per Set	2
Steel Thickness	12mm
Hole Diameter	10mm

Underside Armor



Underside Armor, Front Piece	
Number per Set	2
Steel Thickness	12mm
Hole Diameter	10mm

Underside Armor, Rear Piece	
Number per Set	2
Steel Thickness	12mm
Hole Diameter	10mm