Chapter 5- Vehicles

Chapter 6- Spaceship Design and Construction

Chapter 5- Vehicle Rules

Within a science fiction campaign, adventurers will likely travel to a great multitude of worlds and environments, encountering a wide range of vehicles along the way. Whether on land (automobiles, horse drawn carriages, motorcycles, tanks, etc.), in the air (such as airplanes, grav vehicles and helicopters), in the oceans (with boats, hovercraft and submarines) or even through the earth itself (moles), adventurers are likely to find many novel means of transportation. This chapter provides rules for the design and construction of such vessels for use in ClusterRPG campaigns.

> If you can walk away from a landing, it's a good landing. If you use the airplane the next day, it's an outstanding landing.
>
> *Chuck Yeager*

When designing a vehicle, it is important to consider two things: the vehicle's purpose, and the Tech Level at which it will be produced. Vehicles in combat operate under the personal combat rules system but take damage more like starships using their own hit location table. Hand weapons are quite able to damage most vehicles, while highly destructive fusion and plasma weapons outmatch anything not using high tech or spacecraft grade armor.

This system assumes that the vehicle designs are based on humans or humanoid creatures with similar physiological constraints as humans. Alien vehicles typically follow the same design process as humans, but exceptions, particularly in accommodations, may exist based on differences in physiology. The Referee is the final arbiter on those differences. Note that humans may not fit into vehicles designed for tiny sophonts.

Vehicles vs. Spaceships

Compared to spacecraft, personal scale weapons are substantially weaker than ship based weapon systems, but this does not make civilian spacecraft invulnerable to low or mid tech level weapons. Starship scale weapons are 12x more powerful than vehicle scale weapons, so that a spacecraft beam laser which normally does 1d6 damage does 12d6 against vehicles or people. Note that this is roughly as powerful as TL14/15 level personal weapons. This is reasonable given the dramatic difference in tech levels. It also allows vehicular scale weapons to damage spacecraft. A 127mm howitzer (typical size shell fired from a main battle tank) does 12d6 of damage, or 1d6 on spacecraft scale. A 400mm shell (roughly 16 inches, or the largest shell used by WW II American battleships) does 24d6 personal or 2d6 spacecraft damage, the same as a typical spacecraft missile. A heavily armored spacecraft may have enough armor to block a one ton projectile; most civilian spacecraft will not. It seems reasonable that a TL6 military battleship can damage a TL9 free trader.

Vehicle Design Checklist

This checklist is not meant to describe every nut and bolt, nor is it meant to create fine distinctions between Ford and Chevy pickup trucks. The intent of these rules is to create a playable level of detail which captures the essence of the vehicle in as few decisions as possible. The steps are as follows:

0. Imagine the final vehicle
1. Choose a chassis, with configuration and modifications
2. Choose locomotion/propulsion
3. Choose power supply
4. Determine fuel requirements
5. Choose vehicle's controls
6. Choose vehicle's communications system (optional)
7. Choose vehicle's sensor package (optional)
8. Choose vehicle's computer system (optional)
9. Assign living areas based on intended duration
10. Determine additional components (optional)
11. Determine weapon mounts and weapons

12. Allocate remaining space to cargo
13. Calculate final price and construction time
    a. Apply Std Design Discount of 10% (optional)

Step 0: Imagine the Final Vehicle

It doesn't make sense to start designing something until the approximate purpose of the vehicle is determined. Is it going to be a low or high tech transport? Is it meant for civilian or military use? Does it have lots of bells and whistles or is it rudimentary transportation? Is it intended to be cheap, or spare no expense luxurious? Once the general form of the vehicle is imagined, the following steps will convert the idea into game terms.

Step 1: Vehicle Chassis

The vessel's chassis is the shell in which all other components are placed. For normal sized vehicles (20 tons or less), it takes 9 hours per ton to construct an unarmored vehicle at a workshop or small factory. For each point of armor added, the time multiplies. Thus a 1 ton armored car with 6 points of added armor will take 9+ 9*6 = 63 hours to build. Some vehicles (small planes, motorcycles, etc) can be purchased as kits from manufacturers.

For larger vehicles between 20 and 1000 tons, assume it will take 9 hours per ton to build at a single dedicated factory. Therefore an unarmored 800 ton coastal freighter would take 7200 hours or 100 days working two shifts per day. Multiply the hours by (1+ 1/2 the additional armor value) for military craft. Thus an 800 ton frigate with 10 additional armor points would take 600 days (85.7 weeks) to build.

For truly huge vehicles (supertankers, floating cities, etc), it takes approximately (square root of the displacement tons)/2 weeks to construct and requires a large factory complex to accomplish. For armored vessels, multiply by (1+percentage of spaces taken up by armor/5); ie. 5% armor doubles (1+1) the construction time, 10% armor triples it, etc. Thus a 2000 ton vessel (unarmored) takes about 22 weeks (157 days) to build, while a supertanker of 100,000 tons takes ~158 weeks to build (a bit over 3 years) or a 1 million ton flying city would take 500 weeks (9.62 years) to get off the ground.

All vehicles have chassis cost based upon the size of the vehicle and the strength of the chassis. The heavier the chassis, the more expensive it is. The vehicle has 12 spaces per ton for adding components (minus chassis space used for support), with hull rounding down, and structure rounding up. Heavier builds allow vehicles to tow larger trailers or carry additional armor as well as providing more hull and structure points.

chassis type	chassis Cr/ton	max armor	tons per 1 hull	tons per 1 struct	max towing	chassis space used
open	1500 Cr	0	15	15	0	0
light	2000 Cr	no added	12	12	1	0
standard	2500 Cr	2x added	10	10	2	0
heavy	5000 Cr	4x added	9	9	5	5%
extra heavy	7500 Cr	8x added	7	7	10	10%

Closed Vehicles: Closed vehicles (any chassis strength other than open) grant cover to the occupants – unless the description mentions otherwise, civilian vehicles grant ½ cover and military vehicles full hard cover. Only a few people in a closed vehicle can shoot out, depending on the number of windows or other firing ports and the internal space available. Unless the description mentions otherwise, up to two people can fire into each arc from a civilian vehicle and one person in each arc in a military one. Note that closed vehicles are **not** sealed or airtight. They are just enclosed, offering some basic protection to the occupants within the vehicle. In order to provide complete atmospheric protection, an appropriate Environmental Protection System must be installed, as found under Vehicle Configuration Options. All vehicles with more than 5% added armor are usually considered military vehicles.

Open Vehicles: Open vehicles possess an open passenger and cargo area which reduces the final price by 40% compared to the standard chassis. Vehicles traveling over 150 kph cannot have an Open configuration. as they grant no cover to the passengers. Any passenger in an open vehicle can shoot (or otherwise attack) in any direction. Open vehicles may not be streamlined or armored.

Vehicle Configuration Options

The following are options that can be added to a vehicle's configuration.

configuration option	tech level	Cost (Cr)	# spaces used	effect
corrosive EPS	9	1,000/space	6% of chassis	excellent protection
hostile EPS	5	200/space	2% of chassis	good protection
insidious EPS	10	2,500/space	8% of chassis	excellent protection
vacuum EPS	6	500/space	4% of chassis	good protection
hydrofoils	7	300% chassis	0	100% speed increase, -2 agility
offroad suspension	6	50% drive	0	reduces effect of poor terrain
pontoons	4	250/space	1/ton	allows aircraft to operate on water
self sealing	7	100/space	0	reduces effects of punctures
streamlining	5	300% chassis	5% of chassis	300% speed increase
submersible	5	500% chassis	8% of chassis	allows underwater travel
tilt jets	5	300% chassis	0	allows vertical takeoff and landing
wave piercing hull	6	50% chassis	3% of chassis	50% speed increase

Corrosive Environmental Protection System (TL 9): The Corrosive Environmental Protection System can be installed in any vehicles with a closed chassis to safeguard the vehicle and its crew in corrosive environments. Corrosive Environmental Protection protects against corrosive environments, vacuum environments, very hot or very cold environments, radiation, leaks, poisons and bacteriological threats. This system uses 6% of the chassis space and costs Cr1000 per Space of chassis. This system includes the purchase of Life Support.

Hostile Environmental Protection System (TL 5): The Hostile Environmental Protection System can be installed in any vehicles with a closed chassis to safeguard the vehicle and its crew in hostile environments. Hostile Environmental Protection protects against very hot or very cold environments, radiation, poisons and bacteriological threats. This system takes up 2% of the chassis space and costs Cr200 per Space of chassis.

Insidious Environmental Protection System (TL 10): The Insidious Environmental Protection System can be installed in any vehicles with a closed chassis to safeguard the vehicle and its crew in insidious environments. Insidious Environmental Protection protects the vehicle and crew from actual insidious atmospheres for 5 days, before Hull/Structure integrity begins to fail at one point per day, as well as providing protection against corrosive environments, vacuum environments, very hot or very cold environments, radiation, leaks, poisons and bacteriological threats. This system takes up 8% of the chassis and costs Cr2,500 per Space of chassis.

Vacuum Environmental Protection System (TL 6): The Vacuum Environmental Protection System can be installed in any vehicle with a closed chassis to safeguard the vehicle and its crew under vacuum conditions. Vacuum Environmental Protection protects against vacuum conditions, very hot or very cold environments, radiation, poisons and bacteriological threats. The system uses 4% of chassis space and costs Cr500 per Space of chassis.

Hydrofoils (TL 5): Hydrofoils may be applied to any aquatic surface vessel. Hydrofoils increase the chassis price by 300%, and multiply the base speed of the vehicle by 2 but decrease agility by -2. Hydrofoils may not be combined with streamlining, submersible or wave piercing hulls.

Off Road (TL4) The listed movement rate for any wheeled vehicle is its on-road movement. If a normal ground vehicle goes off-road, it suffers a –2 DM to Agility, its Movement rate is reduced to 25% of normal and rough terrain cannot be crossed. A wheeled vehicle designed to be off-road capable loses 10% of its maximum speed but does not suffer the –2 DM to Agility off road, and its movement rate is only reduced to 50%. Off-road vehicles can cross rough terrain with a –2 DM to Agility and movement over rough terrain is reduced to 25%. Adding off road movement costs 50% of the drive cost.

Pontoons (TL 3) This allows the aircraft the ability to land and take-off from water. This is a removable component and can be added at any time. It costs Cr250 and one Space per ton of the aircraft's chassis, reduces an aircraft's Base Speed by 10% and gives -1 DM Agility. Floats break streamlining. Water movement is at 1/2 the rate of a screw propeller.

Self-Sealing (TL 7): A self-sealing chassis automatically repairs minor breaches, and prevents chassis hits from leading to explosive decompression in vacuum environments (if the Vacuum Environmental Protection System is installed). It costs Cr100 per space of chassis and is included in the corrosive and insidious atmosphere protections. It is often added to water craft, vacuum EPS systems, and high altitude aircraft.

Streamlined: Streamlining a thrust-based vehicle increases the chassis price by 300%. Streamlining multiplies the Base Speed of the vehicle by 3 and 5% of the chassis hull becomes unusable. Streamlining can only be applied to vehicles with a closed configuration and a thrust based propulsion system that does not push through the water. Streamlining may not be combined with hydrofoils, submersible or wave piercing hulls. Streamlining may not be retrofitted; it must be included at the time of construction. Streamlined vehicles may not carry externally mounted equipment or tow another vehicle; these break streamlining. Internal bays, fixed mounts and popup turrets do not break streamlining.

Submersible: Submersible may be applied to any grav or screw propeller vehicle to allow travel underwater. Screw propellers move at full speed underwater, while grav vehicles move at 1/5 of their maximum airspeed. The Submersible configuration option increases the chassis price by 500% and may not be combined with streamlining. Submersibles are rated by their Safe Dive Depth and Crush Depth, as determined by the vessel's Tech Level and chassis. These values are calculated for a Size 8 world and standard chassis. For every point of world size difference, up or down, add or subtract (respectively) 10% from the Safe Dive and Crush Depth values. Light Chassis reduces both depths by 20% and open chassis by 50% each, while heavy chassis increases them by 10% and extra heavy increases them by 25%. An open chassis submersible, such as a dive sled, does not protect its drivers or passengers from the pressures of the depths of the ocean, nor does it provide an atmosphere for breathing. All closed chassis submersibles require at least Hostile Environment Protection. Self sealing must be purchased separately (but is recommended). May not be combined with wave piercing hull, hydrofoils or pontoons.

Table: Submersible Safe Dive Depth and Crush Depth by Tech Level

Tech Level	Safe Dive Depth (m)	Crush Depth (m)
5	50	150
6-8	200	600
9-11	600	1800
12-14	2000	6000
15+	4000	12,000

Because submarines travel underwater, low TL vessels sometimes have a problem with lack of air for their engines. One solution is to have a second power source (usually a battery) for the propeller. A second option is to use a snorkel, basically a tube that reaches the surface to provide air for the power plant. Snorkels are available for 2000 Cr and use 1 space, but safe dive depth becomes limited to 25m and they may be seen on the surface. Longer snorkels create too much drag to be useful below 25m.

Tilt Rotors/Jets: Aircraft equipped with tilt rotors gain the ability to takeoff vertically and hover like a helicopter. Once the rotors or jets rotate forward, the aircraft flies normally. Adding this component triples the price of the Thrust-based drive but increases the versatility and speed of the aircraft.

Wave-Piercing Hull: The Wave-piercing Hull puts the payload of a watercraft on streamlined pillars above the water that connect to power/fuel modules that run underwater. Interface friction is reduced, allowing the Wave-piercing Hull to be much more efficient and stable. This increases its Base Speed by 50%. The Wave-piercing Hull uses 3% of a vehicle's Spaces (round up) and costs 50% of the chassis price. Wave-Piercing hulls may not be combined with hydrofoils, submersible or streamlining.

Increased Agility: Each +1 to Agility costs 50% of the base chassis price. The maximum increase to a vehicle's Agility is +3.

Decreased Agility: Vehicles can be built with lowered Agility, normally done for reasons of cost. Each reduction of –1 Agility reduces the chassis price of the vehicle by 25%. The maximum decrease to a vehicle's Agility is -2.

Steps 2+3: Choose Locomotion/Propulsion and Power Plant

All vehicles are generally built with at least one source of power (commonly referred to as the engine or power plant) and one or two sources of propulsion to provide movement for the vehicle. Propulsion is defined as either contact-based or thrust-based. All propulsion systems that create movement are considered drives.

Power Plants

Power plants are the devices which generate the energy used to power the drive. Within this design system, the values of the **Vehicle Drive Costs** tables make certain assumptions. The base power plant expectation is the early fusion engine consistent with an average tech level of approximately 9 or 10. The **Vehicle Power Plant Types** table offer adjustments to various other types of power relative to the early fusion reactor. Power plants also have minimum size requirements based on the type of technology.

Propulsion Systems

The contact-based propulsion system values represent the transmission and suspension of wheeled vehicles. The thrust-based propulsion system values represent the suspension of grav vehicles. The **Vehicle Propulsion Types** table offers adjustments to represent alternate propulsion systems. Different types of propulsion have various advantages and drawbacks.

Airships and balloons require a lift envelope to hold the lower-density gasses that allow the vessels to fly. Hydrogen and helium balloons can stay aloft almost indefinitely. Hot-air balloons have a duration equal to their Tech Level x 2 hours. The inflated size of an envelope in Spaces depends upon the gravity of the planet, its atmospheric density, and the gas being used to support it. The general formula is g (m/sec^2) * # chassis spaces * atmo, where atmo= 100 for very thin, 25 for thin, 10 for standard, and 5 for dense atmospheres. If using hot air instead of a hydrogen or helium envelope gas, double the size. The envelope is not considered part of the chassis itself, but can be stored away in a space with a displacement volume equal to one percent (1%) of its inflated size. All non-explosive weapons inflict only 1 point of damage to the envelope for each hit. Automatic weapons inflict damage equal to their Auto Rating. Once the lift envelope has taken an amount of Structure damage equal to one point per 60 Spaces of lift envelope size, it loses integrity.

Aircraft operations also depend upon gravity and atmospheric density. Aircraft operating outside of their design codes suffer a –1 to Agility per 15% off from their home gravity and -2 per difference in atmosphere pressure (ie. thin to very thin). If the agility penalty is more than -3 they may not operate safely unless they are designed with a wider operation range. In any case, all aircraft require at least a very thin atmosphere in order to function. Aircraft descriptions should include the world gravity and atmosphere codes for which it is designed. Aircraft requiring runways need 200m per ton divided by their power rating up to 5 tons, 100m per ton between 5 and 20 tons, and 50m per ton when over 20 tons.

Extended Operational Environment Range: Aircraft can be designed with a wider operational environment range. This costs 100% of the Base Chassis Price of the aircraft, takes no space, and negates 3 points of agility loss due to environmental differences (gravity or atmosphere combined). These aircraft suffer a –1 to Agility in all environments but are equally capable in a wider variety of conditions.

Non-Powered Vehicles

Some vehicles do not have a power plant or a powered propulsion system. These rely on three forms of external force to provide movement: towing, animals or the wind. These forces must be able capable of moving the vehicle under normal conditions.

Animal-Powered Vehicles: Some vehicles, particularly at very low Tech Levels, are powered by living creatures. An animal-powered vehicle requires one point of Strength (Str) per Space of chassis to move at the animal's base walking speed. (Ground vehicles that run on rails halve the required Strength for movement.) For every five fewer points of Strength, Speed and Range decrease by 20%. There is no lower limit, and Speed can be reduced to 0. Animals may walk for endurance x 3 minutes before requiring 15 minutes of rest. Animals may pull a vehicle at a run for endurance/2 minutes before requiring 30 minutes of rest. Speed decreases going uphill and increases going downhill depending upon the slope being traversed. Brakes are a good thing when going downhill, even for wagons. Oars on boats are equivalent to animal power.

Table: Sample Terran Animals Used to Power Vehicles

animal	Strength	Walk/Run (km/hr)	Endurance
elephant	24	6/24	15
horse	10	7/28	12
human	7	5/20	7
mule	11	6/24	14
ox	18	5/20	18

Wind-Powered Vehicles: Often called sailing vessels, wind-powered vehicles depend on the wind and weather to provide the force necessary to move. Ground based sailing vessels move at 20% of wind speed, fluid based sailing vehicles move at 30% of wind speed, and air based sailing vessels move at 40% of wind speed when moving in the direction of the wind. Speed at an angle to the wind will be reduced by 50% for every 90 degrees they are off from the wind direction, so that sailing against the wind will reduce speed over water by 75% and require tacking back and forth.

Sailing vessels also require more crew than typical vehicles do. Early sailing vessels lacked modern conveniences and required several sailors to work the many individual sails. As an approximation, each sailor can handle (10 + 2*TL) tons of sailing vessel. Thus a TL2 250 ton merchant vessel would require 18 crew, while a TL5 clipper of the same size would only need 13 crew, and a TL13 sailing yacht would need 7 crew to handle the same vessel. Warships might carry many more crew, with the remainder being old school 'marines'.

Table: Power Plant Size per Power Level

Power Level	Base Percentage of Chassis
1	2%
2	3%
3	4%
4	5%
5	6%
6	8%

All power plants are approximately based on an early fusion plant of tech level 9 or so. The base size of the powerplant depends upon the power level and base speed desired. The size is then then adjusted by the space modifier depending upon the type of power plant being used. The base cost of a powerplant is 1500 Cr/space, which is then adjusted by the price modifier of the chosen power plant type.

Table: Vehicle Power Plant Types

power plant type	TL	min size	Space Mod	Price Mod	Fuel
external combustion	3	1 space	x15	x0.2	coal or wood
internal combustion	4	none	x6	x0.25	hydrocarbons
battery-5	5	none	x6	x2	rechargeable
fission	6	none	x2	x2	radioactives
gas turbine	6	none	x4	x0.5	hydrocarbons
fuel cell (closed)	7	none	x1.5	x2.5	hydrogen
fuel cell (open)	7	none	x1	x1	hydrogen
battery-8	8	none	x3	x2	rechargeable
early fusion	8	4 spaces	x1	x1	hydrogen
battery-10	10	none	x1.5	x3	rechargeable
battery-12	12	none	x0.75	x4	rechargeable
fusion	12	1 space	x0.75	x1	hydrogen
battery-14	14	none	x0.5	x5	rechargeable
advanced fusion	15	0.25 spaces	x0.5	x2	hydrogen

Vehicle Drives

Contact drives require some type of physical contact between the vehicle and the substance over which it moves. Drives such as wheels, legs, or tracks would be contact based drives. Contact drives take up 1.3% of the chassis per speed level desired and cost 1000 Cr per space of drive. A 1 ton ground car, for example, would use 5.2% of its chassis (0.624 spaces) to move at speed 4, and the drive would cost 624 Cr. Note that the ground car must also have a level 4 powerplant of some form and fuel for that powerplant.

Other types of drives such as gravitic drives or jet engines push against some other force and do not require direct contact with that substance to generate thrust. These drives are somewhat smaller and take up only 1% of the chassis per speed level but are far more expensive, costing 50,000 Cr per space of drive. Thus a 1 ton grav car would use 4% of its spaces for the gravitic drive (0.48 spaces), but the drive would cost 24,000 Cr. As with a regular groundcar, the grav car still needs a powerplant and fuel for the powerplant.

Table: Vehicle Propulsion Types

Propulsion Type	TL	Type	Space Mod	Price Mod	Examples

Sails, non-powered	1	thrust	x2	x0.1	sailing ship
boat/barge	1	contact	x1	x0.1	rowboat, ore barge
trailer, non-powered	1	contact	x1	x0.5	stagecoach
rails	3	contact	x2	x1	train
screw propeller	3	thrust	x1	x0.1	motorboat
wheels	3	contact	x1	x1	groundcar
airship	4	thrust	x1	x0.5	dirigible
rotor	4	thrust	x2	x0.5	helicopter, biplane
tracks	4	contact	x1	x2	tank
jet	5	thrust	x2	x2	twin engine jet
air cushion	7	thrust	x1	x0.5	hovercraft
mole	7	contact	x3	x8	boring machine
hypersonic	8	thrust	x1.5	x4	airliner
grav	8	thrust	x1	x1	air raft, speeder
legs	8	contact	x2	x4	walker
advanced grav	12	thrust	x0.75	x2	grav bike
extreme grav	15	thrust	x0.5	x4	G-Carrier

Base Speed

The base maximum speed of a vehicle is determined by its drive performance and its propulsion type, as outlined in the **Vehicle Max Speed by Drive Performance** table. Base speed is measured in kilometers per hour (kph), unless otherwise specified. A vehicle with a propulsion system must have a power level equal to the base speed level desired.

Table: Vehicle Max Speed by Drive Performance

Propulsion Type	TL	1	2	3	4	5	6
sails (unpowered)	1	10	20	30	40	50	60
barge (unpowered boat)	1	10	20	30	40	50	60
trailer (unpowered wheels)	1	30	60	90	120	150	180
Rails	3	40	80	120	160	200	240
Screw Propeller	3	20	40	60	80	100	120
Airship	4	20	40	60	80	100	120
Rotor, horizontal	4	100	200	300	400	500	600
Rotor, vertical	4	50	100	150	200	250	300
Tracks	4	25	50	75	100	125	150
Wheels	4	50	100	150	200	250	300
Jet	5	150	300	450	600	750	900
Air Cushion	7	50	100	150	200	250	300

Mole	7	0.005	0.01	0.015	0.02	0.025	0.03
Hypersonic	8	300	600	900	1200	1500	1800
Grav	8	100	200	300	400	500	600
Legs	8	30	60	90	120	150	180
Advanced Grav	12	200	400	600	800	1000	1200
Extreme Grav	15	400	800	1200	1600	2000	2400

Tracks vs. Wheels

The two predominant ground contact based drives are Wheels and Tracks. Militaries have spent many years evaluating the two technologies, and both have certain advantages over the other. Wheels are less expensive, more fuel efficient, and generally allow higher speeds given a flat terrain such as a road. Most civilian vehicles use wheels for these reasons. Tracks, on the other hand, have outstanding stability and are excellent over irregular terrain. All tracked vehicles are able to travel off road at full speed, and they provide a solid firing platform even when moving while firing. They are, however, 30% less energy efficient than wheels are. In addition (although not reproduced well within these rules), tracks spread the weight of a vehicle over a larger surface area, preventing them from getting bogged down in sand or mud the way wheeled vehicles (even 4 wheel drive trucks) have a tendency to do. Militaries in the 2020's have both wheeled and tracked vehicles in their arsenals, allowing them to choose the most appropriate compromise for individual missions.

Additional Drive Notes

Several types of surface drives (screw propellers, wheels, rails, and tracks) can tow non-powered units (cars, barges, etc) as a way of providing more efficient (if often slower) transportation. Towing capacity is controlled by the build of the powering vessel, with tougher builds increasing the towing capacity. Towing reduces the maximum speed based on the formula 1.5*max speed*tow vehicle tons/ towed tons, rounding down to the maximum speed of the vehicle. Towing also reduces the agility of the hitched units by -1/2 (rounded up) per multiple of the towing unit size. Thus a 20 ton tugboat with an extra heavy chassis and max speed of 60 kph could tow or push 200 tons at 9 kph with a -5 DM on agility.

Rails have few advantages over other types of ground transportation, but starting at TL4 power can be carried through the rails to the individual cars, allowing them to function without fuel as long as a central power source is available. Secondly, because of the mode of transport, it is particularly efficient for powerful drive units or locomotives to tow non-powered cars along the tracks. For this reason, towing capacity of railed vehicles is doubled and the agility penalty is halved to show this efficiency.

Step 4: Choose Vehicle Fuel

Every vehicle carries fuel, unless it derives its power from an external source. All fuel calculations are based on the power plant's Drive Code and Power Plant Type, as well as the expected period of operation without refueling. The amount of fuel required by the power plant depends on the volume of the power plant itself, and is calculated from a base of 5% of the power plant tonnage per day. Vehicles are designed to operate for a variety of durations, ranging from a few hours to days or even years at a time without refueling.

Battery packs require no fuel and are rechargeable at any adequate power source. While saving space in terms of fuel, the listed battery size is only able to power the vehicle for 6 hours of operation. Doubling the operating time doubles the size of the battery. Recharge time is 1/2 of the operating time. Thus batteries work best in vehicles which are designed for local, short range operations.

Range and Cruising Speed: The amount of fuel a vehicle carries determines its Range at its maximum speed. The cruising speed of a vehicle is assumed to be 75% of the vehicle's maximum speed and if the vehicle maintains this rate of movement, its Range will increase by 50% due to fuel efficiency.

Table: Vehicle Fuel Consumption by Power Plant Type

Power Plant Type	TL	Fuel Mod	Price/Space (Cr)	Notes
external combustion	3	x5 or x3	300 or 540	wood or coal
internal combustion	5	x3	830	hydrocarbon
fission	6	x0.04	83000	based on a standard trade price of 1MCr/ton
fuel cell (closed)	7	x25	40	does not require external O_2 source
fuel cell (open)	7	x5	40	requires external O_2
gas turbine	7	x3	830	hydrocarbon
any battery	8-14	0	n/a	must increase size of power plant
early fusion	9	x1	40	hydrogen
fusion	12	x0.75	40	hydrogen
advanced fusion	15	x0.5	40	hydrogen

Vehicle Drive Options

The following options are available as modifications on Vehicle Drives.

Additional Drive Systems: A secondary drive system can be installed in a vehicle by purchasing a second propulsion drive. The secondary drive system's performance is limited to one less than that of the primary drive system. The vehicle's Agility suffers a –1 penalty due to design accommodations required to support the additional drive system, but no additional powerplant is needed.

Decreased Fuel Efficiency: Vehicles can be built with decreased fuel efficiency, relying on cheaper parts or less efficient engines to cut costs. Fuel inefficient vehicles multiply the Fuel Mod on the Vehicle Fuel Consumption by Power Plant Type by 1.25 (increasing the fuel consumed by 25%). This reduces the final price of the vehicle by 25% of its power plant price.

Extra Leg(s): Walkers are typically assumed to have two legs. Additional legs can also be added to improve mobility in rough and uneven terrain. Each additional pair of legs costs 25% of the vehicle's Contact-Based Drive Price and takes up an additional 25% of the vehicle's Contact-Based Drive Space. Every pair of additional legs reduces any terrain-based maneuver penalties by 1 to a maximum of 3. This cannot be used to provide a bonus, only to negate a penalty. In addition, any walker with four or more legs gains a DM+1 on attack rolls made with the vehicle's built-in weapons due to the flexibility and stability of the firing platform. Normal penalties for firing while moving still apply (although may be reduced by using extra legs above).

Extra Pair of Wheels: Wheeled vehicles are typically assumed to have four wheels (except for small vehicles of less than 1 ton in size, which may have two or 3 wheels at the designer's discretion). Additional wheels can be added to improve cross-country mobility. Each additional pair of wheels costs 25% of the vehicle's Contact-Based Drive Price, takes up 25% of the vehicle's Contact-Based Drive Space, and reduces any terrain-based Agility or movement penalties by 1. This cannot be used to provide a bonus, only to

Vehicle Agility Table

vehicle type	modifier
horiz. rotor aircraft	-1
airship	-4
grav vehicle	0
vert. rotor aircraft	-2
hovercraft	0
hypersonic	-2
jet	-1
mole	-4
watercraft < 5 ton	+1
watercraft > 100 ton	-1
sailing ship	-2
submarine	-2
tracked vehicle	-1
train	-2
walker	+1
wheeled vehicle	+2

negate a penalty and works with both normal and off road vehicles. Extra wheels also reduce the firing penalty while moving by 1 for each extra pair of wheels (up to 3).

Increased Fuel Efficiency: Vehicles can be built with increased fuel efficiency. Fuel efficient vehicles multiply the Fuel Mod on the Vehicle Fuel Consumption by Power Plant Type by 0.9 (reducing the fuel consumed by 10%). This costs 50% of the power plant price.

Vehicle Agility

Some vehicles are easier to drive than others. The Agility rating reflects how easy a vehicle is to operate, and is expressed as a DM to the appropriate skill check. A vehicle's base Agility is determined by a number of factors, including the size of the vehicle's chassis and its primary propulsion type. To determine a vehicle's Agility rating, consult the Vehicle Agility Modifiers table, and sum up all appropriate modifiers.

Vehicle Agility Size Modifiers

vehicle type	agility modifier
non-powered	-1
small (2 tons or less)	+1
large (10-20 tons)	-1
huge (20-99 tons)	-2
gargantuan (100+ tons)	-3

Install Armor

All vehicles start with a base amount of armor, depending on their construction materials, as outlined in the **Vehicle Armor by Type** table. Additional armor is added per point, with higher tech armor being more expensive but lighter. The chassis type determines how much additional armor may be added. A vehicle's armor decreases ambient radiation exposure by 10 rads per point of armor. (This does not apply to meson attacks which bypass the armor and breach the chassis to deliver their radiation hits.) Note that these armor values are measured on the Personal Combat scale. The maximum armor a vehicle can carry is 40% of the chassis (in addition to the protection provided by the chassis).

For example, a lightly armored TL14 AFV with a standard chassis might take Bonded Superdense armor twice. This would take up 10% of the chassis volume (in spaces, minimum 2 spaces) and cost 1000% of the base price of the chassis, but provide 12 additional points of armor, giving 18 points of armor total. To add even more armor it would have to first upgrade its chassis to at least heavy.

Table: Vehicle Armor by Type

Armor Type	Tech Level	Base	Additional	Price	Max Armor
wood	1	1	1 per 5% of chassis	50% of chassis	9
iron	3	2	2 per 5% of chassis	100% of chassis	18
titanium composite	6	3	3 per 5% of chassis	100% of chassis	27
crystaliron	10	4	4 per 5% of chassis	200% of chassis	36
superdense	12	5	5 per 5% of chassis	350% of chassis	45
bonded superdense	14	6	6 per 5% of chassis	500% of chassis	54

Vehicle Armor Options

The following are options that can be added to a vehicle's armor, but only one coating may be added.

Applique Armor (TL4): This armor is essentially plates of ceramics, sand, metals, and other fibers added to the outside of a vehicle which disperses incoming damage but breaks streamlining. Each time the vehicle is hit, one charge of applique armor is used and damage is reduced by 5 points before it reaches the armor. Applique armor may be applied to any vehicle with standard or better build and at least 1 point of added armor. Each

charge takes up 0.5 spaces per ton of vehicle, takes 6d6 minutes to replace and the number of charges are limited to the number of added armor points.

Electrostatic Armor (TL 9): This armor can be set to generate an electrostatic field that, when triggered by a person or creature, inflicts 6d6 electrical damage on anyone within 3m. If it is triggered by a weapon hit doing more than the armor's protection, the capacitor also discharges and reduces damage by 6 points by disrupting the weapon's released energy. The armor may discharge twice per space of capacitor before needing to recharge. Electrostatic Armor requires one Space for the associated electronics which costs Cr5,000 and Cr5,000 per space of capacitor. 1 space of capacitor takes 3/power level minutes to recharge.

Reactive Armor (TL 7): This armor uses explosive charges to reduce the armor penetrating ability of kinetic weapons. It is not effective against beams or energy weapons. When activated by a kinetic strike sufficient to penetrate the armor, the damage from the incoming projectile is reduced by 10 points to a minimum of zero. This uses 1 charge. A vehicle may have any number of reactive armor charges, but only 1 charge may be used per hit. Each charge takes up 0.25 spaces per ton of vehicle. Reactive armor costs 2000 Cr per space and it takes 2d6 minutes to replace a charge. If all charges are expended, reactive armor provides no additional benefit. Reactive armor breaks streamlining.

Reflec (TL 10): Reflec coating on the chassis increases the vehicle's armor against lasers by 6. Adding Reflec costs Cr10,000 per ton of chassis and can only be added once.

Stealth (TL 11): A stealth coating absorbs radar and lidar beams, and also disguises heat emissions. This imposes a –2 DM on any Sensors rolls to detect or lock onto the vehicle. Adding Stealth costs Cr100,000 per ton of chassis, and can only be added once.

Improved Stealth (TL 14): A more effective version of the lower tech stealth coating, this advanced material more effectively absorbs radiation and internally generated heat. It gives a -4 DM on any Sensors roll to detect or lock onto the vehicle. Improved Stealth costs 300,000 Cr per ton of chassis.

Step 5: Vehicle Controls

Unlike starships, vehicles require a particular control system to allow crew members to control the vehicle. More advanced systems can be installed. Vehicle control systems are integrated into the chassis, power, and drive systems and cannot be changed afterwards.

> The driver of a racing car is a component. When I first began, I used to grip the steering wheel firmly, and I changed gear so hard that I damaged my hand.
>
> *Juan Manuel Fangio*

Primitive Controls (TL 1): Primitive controls reflect the crudest of methods used to direct the motion of a vehicle.

Basic Controls (TL 4): The default control set-up, having some form of basic steering and a throttle for controlling speed. This is the minimum for any autopilot assistance

Advanced Controls (TL 8): This is usually advanced drive-by-wire systems with heads-up displays. This is the minimum for any robotic control.

Exo-skeleton Linkage (TL 10): The exo-link is a system for translating body movements into vehicle actions. No additional special equipment or cybernetic modifications are required.

Neural Link (TL 12): The neural link is a true mind-machine linkage operated through a helmet or waferjack and allows a user to control the vehicle with their mind alone. No additional special equipment or cybernetic modifications are required. This is the minimum for cyborg control of a vehicle.

Table: Vehicle Control Systems

Interface	TL	Price (Cr)/ton	Agility	Initiative	Notes
primitive	1	-20% chassis	-1	0	-2 DM at speeds over 50 kph
standard	4	--	0	0	included in chassis price
advanced	8	5,000	+1	0	
exo-skeleton linkage	10	20,000	+1	+1	
neural linked	12	50,000	+2	+2	

Unmanned Vehicles

All unmanned vehicles require additional mechanical circuitry to control the vehicle. Replacing a crew with electromechanical equipment uses 0.02 spaces of equipment per space of vehicle. This is a generally a significant space savings as no accommodations are required. Weapons, however, require the same space with or without a manned crew. The equipment for unmanned control costs Cr10,000 per space installed.

Radio controlled vehicles known as drones require at least basic controls and some form of communications system. One (or more) operators use the Remote Operations Skill to control the actions of the drone from a terminal located elsewhere. A drone vehicle requires as many remote operators as it would crew. Drones are dependent upon their operators to make command decisions and perform basic operations. Should control be lost due to electronic countermeasures, moving too far away, destruction of the remote terminal, etc., the drone will perform its last instructions and then immediately return to its home location as a default operation.

The use of human (or sometimes animal) brains to control a vehicle is known as a cyborg and is possible at TL12 and higher. The organic brain and its support systems take up one Space in the vehicle, and require Neural-linked Controls. An organic brain costs Cr25,000 and otherwise operates as an independent entity. The skill set that the organic brain had before it was transplanted into the vehicle is what it has available after transplantation. Cyborg controls require additional life support for the organic components. One cyborg brain can replace 2 standard crew members.

Organic Core Extended Life Support: Organic Core Extended Life Support provides a month's worth of nutrients and filtration for organic brains and biological support systems. It is available at TL 12, takes up 1 Space, and costs Cr2,500 per space. Cyborgs do not require other life support systems.

Completely independent automated systems are known as robotic controls. These require at least advanced controls and integrate the AI programs which motive the entire system. For simplicity, all of the skills required by the AI are at the same skill level and includes the cost of skill programs. The table to the right shows the combined cost of computer + skill program for each required crewmember, and each computer + 0.5 spaces per robot brain interconnected. Note that robotic crews do NOT need additional computers- computer and skillsofts are included in the price.

Robot Crew Costs

Skill Level	Cost/Crew
0	2400 Cr
1	7600 Cr
2	17,000 Cr
3	45,000 Cr

Vehicle Control Supplement

Autopilot: Autopilot 0 becomes available for aircraft and sea vessels starting at TL 5 and increases at +1 per 3 tech levels. Ground vehicles gain Autopilot 0 at TL 9 and increase by +1 for every 2 tech levels. The maximum autopilot skill at any TL is +3. Autopilots cost Cr2,000 + Cr5,000 per skill level. Autopilot works as an assist to a sophont crew, not a replacement, and is generally unable to react independently when things go wrong. While autopilot 0 can be achieved mechanically, everything above 0 requires an appropriate computer to run. Autopilot requires at least standard vehicle controls to function.

Step 6: Vehicle Communication Systems

Installing a communication system allows the crew to interact with others. The following systems are assumed to use radio for communications. Alternate approaches to communication are covered in the **Alternative Communicator Types** table. Vehicle communication systems are optional, but often highly recommended, particularly for military vehicles. Note that the alternative communication types also include standard radios. All systems include a transponder that may be programmed or silenced as appropriate.

Table: Vehicle Communication Systems

System	TL	Spaces	Price (Cr)	Range
Class I	5	0.01	500	distant (5 km)
Class II	5	0.02	1000	very distant (50 km)
Class III	6	0.05	2000	regional (500 km)
Class IV	7	0.10	4000	continental (5000 km)
ECM-A	6	2	20,000	distant, -1 DM + effect
ECM-B	9	3	50,000	distant, -2 DM + effect
ECM-C	12	5	100,000	v distant, -3 DM + effect
ECM-D	15	8	200,000	v distant, -4 DM + effect

ECM, or **electronic countermeasures**, are a communications tool designed to fool enemy sensors or smart weapons. When successfully employed, ECM causes weapons to miss or scatter randomly from their intended target. Only electronic targeting is affected, so ECM cannot be used against simple weapons fire. ECM use is a significant action and requires an operator with the comms skill. ECM may also disrupt nearby drone controls (although not cyborg or robot commands). Note that a failed ECM use gives a guided weapon an additional signal for navigation to the target. Active use of ECM negates stealth coatings.

Table: Alternative Communicator Types

Type	TL	Space Mod	Price Mod	Notes
satellite	7	2	1,000	allows communication with orbital ships and comm satellites
laser	8	x2	x3	requires clear line of sight between communicators
maser	10	x3	x6	works like lasers, but can cut through smoke and aerosols
meson	11	x5	x20	cannot be jammed or blocked using ECM

Step 7: Vehicle Sensors

Vehicle sensors allow the crew to identify, track and jam other vehicles. These sensor systems operate similarly to those installed on a starship or small craft. The type of sensor package installed can impose a DM on Sensors skill checks when using the system to perform sensor-related tasks. Vehicle sensor systems are optional, but often highly recommended, particularly for military vehicles.

Underwater Sensors: Sensor packages intended for use underwater must be purchased separately. Surface sensors cannot be used underwater, and vice versa. Underwater sensors cost the same as standard vehicle sensors and take up the same space, but their Max Range drops by one category to a minimum of Very Long (500m). Modern underwater sensors are not as obvious as sonar, however, and do not announce their use as clearly.

> Mars has been flown by, orbited, smacked into, radar examined, and rocketed onto, as well as bounced upon, rolled over, shoveled, drilled into, baked and even blasted. Still to come: Mars being stepped on.
>
> *Buzz Aldrin*

Sonar is an early underwater sensing system using sound waves which travel underwater. Passive sonar is essentially a microphone system which can listen for propellers, etc and give a direction. Active sonar sends out an audible 'ping' which can reflect off of distant (5 km) targets and return both direction and distance. Active sonar is easily (+4 DM) detected by anyone underwater.

Radar/Lidar detects physical objects. If a vehicle is using active sensors, it is easier to detect objects (+2 DM to Sensors checks) and collects more information. A radar mast (TL6) increases range by 10x at 3x the cost and 2x the spaces, or high intensity radar (TL7)has 40x the range, 10x the cost and 4x the spaces.

Densitometers can determine the internal structure and makeup of an object as well as location and velocity.

Neural Activity Sensor detects neural activity and intelligence of sophonts. Robotic AI systems are not detected as neural activity, but cyborg brains register as their original species.

Table: Standard Vehicle Sensors

Sensors	TL	Spaces	Price (Cr)	Sensors DM	Max Range	Includes
sonar	4	1	10,000	-	distant (50 km)	underwater only, targeting
towed sonar	6	3	25,000	+1	distant (50 km)	underwater only, targeting
target scope	4	0.1	500	-	distant (5km)	magnifies visual light only
radar	5	3	10,000	-	regional (500 km)	airborne objects only, targeting
thermal scope	6	0.1	1000	-	distant (5 km)	magnifies visual + IR (heat)
standard	8	3	5000	-1	v distant(50 km)	full radar, lidar
basic civilian	9	6	10,000	0	regional (500 km)	radar, lidar
basic military	10	12	20,000	+1	regional (500 km)	radar, lidar, targeting
densitometer	11	3	25,000	+1	regional (500 km)	objects with mass, targeting
advanced	11	18	50,000	+2	continental(5000)	radar, lidar, targeting, densitometer
very advanced	12	30	100,000	+3	continental (5000 km)	radar, lidar, targeting, neural activity sensor, densitometer

Step 8: Vehicle Computer System and Software

The vehicle computer is identified by its model number; the Vehicle Computer Models table indicates details of price, rating, and tech level available. The Model number is the computer rating, which determines the power of a computer. Rating measures the complexity of the programs a computer can run. (Storage space is effectively unlimited at TL 9 and above.) Programs are rated by the computer rating they require. A system can run a number of programs up to its rating, minimum of one (for Model 0 computers). Vehicle computers are optional, but often highly recommended at higher tech levels. Vehicles may run any of the software listed under computers in Chapter 4: Equipment of the Cluster Variant core rules. All computers are assumed to take up 0.01 spaces (approximately 1 kg).

Computer Table

model	TL	cost (Cr)
0	7	100
1	9	400
2	10	800
3	11	1600
4	12	3000
5	13	5000
6	14	12,000
7	15	25,000

Hardened Systems (fib): A computer and its connections can be hardened against attack by electromagnetic pulse weapons at TL10. A hardened system is immune to EMP, but costs 50% more.

Step 9: Vehicle Accommodations and Equipment

Vehicles require a crew to operate and maintain the vehicle. For small civilian vehicles, that is typically one operator or driver. Military vehicles also require one gunner per weapon and one commander if three or more crew members are required. Every manned vehicle requires at least simple seating to interface with the vehicle's control, communication and sensor systems. Standard seats instead of a cockpit give an extra -1 DM to perform more than a single action in a turn. Larger vehicles that are expected to carry out various functions while underway will require enough crew to man all operating stations. For larger vessels with long term accommodations such as staterooms, control areas are often referred to as the bridge and take up 2% of the total space.

Many systems and equipment aboard a vehicle require crew to operate them. Medics for treating wounded are needed to operate in sickbays, for example, while scientists crew laboratory space for making scientific discoveries. Vehicles of 100 tons or more require at least one engineer to operate and maintain powerplants and drives. One engineer can maintain 50 tons of machinery. If repairs are to be made while underway, additional engineers and operators are needed. Sensor stations and communications require personnel as well, and weapons often require specialized operators for them to function. The more complicated and diverse operations a vehicle is expected to carry out, the larger the crew needed for the vehicle to function effectively.

Short term accommodations (seats, cockpits, etc) are meant to be used for a relatively short time, approximately 12 hours maximum or so. While this can be extended, sophonts generally start objecting and find the experience unpleasant. Mid-duration accommodations are good for journeys that last up to about 2 weeks maximum. They provide some creature comforts, but are not designed for true long term use. Staterooms, on the other hand, are fully equipped to keep a sophont reasonably well for an indefinite period of time. Whenever the duration of a trip is extended (as judged by the referee) beyond the limits of the accommodations, everyone receives a -1 DM adjustment to all skill checks for the mental strain of living in stressful conditions. Parents who have traveled with children understand this phenomenon.

Individuals wearing armor require more room than regular people even for short range transport. Individuals wearing armor weighing 20+ kg or requiring the vacc suit skill uses two seats due to their bulk. Lightly armored individuals (ie. ballistic cloth, flack jackets, etc which may be worn under regular clothing) do not take up any extra space and may fit into cramped seats (uncomfortably).

Alien operators scale according to their size. Tiny or small creatures can fit comfortably into seats of 1 space in size, while large sophonts require 2 seats. For huge creatures, they require 3 seats and will only barely manage to fit into a normal stateroom or hallway. Smaller sophonts can always fit into vehicles designed for larger creatures; the same is not always true for large creatures going into vehicles designed for smaller ones.

Table: Vehicle Accommodations

Accommodation	Duration	Spaces	Price (Cr)	Notes
bunk	medium	12	5,000	supports one non-crew (cramped)
control cabin, basic	medium	24	10,000	supports one crew
control cabin, additional	medium	18	8000	supports one additional crew
control cabin, extended	medium	54	20,000	supports 2 crew plus one additional crew
low berth	long	6	50,000	holds 1 person in cold sleep
stateroom, economy	long	24	25,000	supports 1 person, cramped
stateroom, elite	long	72	75,000	supports 2 people comfortably

stateroom, standard	long	48	50,000	supports 2 people reasonably, 1 comfortably
cockpit, basic	short	3	1500	supports 1 crew
cockpit, extended	short	6	3000	supports 2 crew
seats, cramped	short	4	2000	supports 3 people cramped
seat, standard	short	2	1000	supports 1 person

Life Support (TL4) Whether underwater, in space, or in a military vehicle protected from gasses and radiation, sophonts require certain items (water, food, air, etc) that must be supplied through the vehicle. Life support is measured in people-days, so that a vehicle with 5 crew/passengers on a 2 week trip would require 14*5=70 people-days of life support. 1 space of life support provides 50 people-days of essentials and costs 250 Cr. Craft that are not sealed against hostile environments or better are open to contamination from the atmosphere.

Other Crew Equipment

Airlock (TL 5) Airlocks take up 12 Spaces each and cost Cr200,000. If a craft does not have an airlock, then the crew cannot leave the craft without opening the vehicle up to the outside environment, which can be dangerous in a vacuum or underwater.

Detention Cells (TL 3) Found primarily on military and government vessels, a detention cell is used to keep prisoners. A detention cell holds one prisoner in extremely cramped conditions, displaces 18 Spaces and costs Cr15,000. This item includes basic life support for the detention cell only.

Ejection Seat (TL 5) The ejection seat is added to normal seating and takes up 2 additional Spaces. It is designed to blast the occupant clear of a moving vehicle. At lower Tech Level this means a suitable height to open a parachute but at higher Tech Levels it is merely sufficient to get clear of the vehicle until a grav chute can deploy. An ejection seat costs Cr5,000.

Entertainment System (TL 5) Supporting both audio and visual entertainment, this system takes up no Space, and costs at least Cr200. Players intending to impress may want to spend more. Much more.

Fresher (TL 3) A Fresher, complete with toilet, sink and shower, takes up 4 Spaces and costs Cr1,500. Freshers are automatically included as part of any stateroom and can supplement short term seating options. Long trips without a fresher are not pleasant.

Crew Equipment Costs

Equipment	TL	Spaces	Price (Cr)	Notes
airlock	5	12	200,000	
detention cell	3	18	15,000	
ejection seat	5	2	5,000	
entertainment system	5	0	200	
fresher	3	4	1,500	
galley	3	4	400	
holosuite	10	3	15,000	
low berths	7	6	50,000	
low berth, emergency	12	12	100,000	4 sophonts
luxuries	2	3	25,000	
pool	6	1	3,000	

wet bar	2	1.5	2,000

Galley (TL 3) Galleys can be designed to serve any desired number of people at once and includes preparation as well as seating areas. It costs 400 Cr and 4 spaces per person capacity. Note that not all occupants must be fed simultaneously and staggered meals are very common on many vehicles. Galleys may also be converted into large meeting rooms when necessary.

Holo-Suite (TL10) This is advanced holographic projection suite. Often used on exploration vehicles as a large display unit, it also has other, less wholesome, uses. It takes up 3 Spaces and costs Cr15,000.

Low Berth (TL7) These are identical to low berths aboard starships. They take up 6 spaces (1/2 ton) and cost Cr50,000.

Low Berth, Emergency (TL12) A more advanced form of low berth, it will quickly reduce temperatures and more safely suspend those placed inside. Designed primarily for medical emergencies, they take up 1 ton (12 spaces) and cost 100,000 Cr but are able to hold 4 average sized sophonts.

Luxuries (TL2) These are the special fittings, trim, and ornaments that distinguish the upper end furnishings from their more pedestrian counterparts. They make regular living quarters more luxurious and provide steward 0 services for 1 traveler. These fittings take up 3 spaces per unit and cost Cr25,000 per unit.

Pool (TL 6) This takes up a minimum of one Space per person capacity and costs Cr3,000 per Space.

Wet Bar (TL 2) A basic wet bar, usually species-specific. It takes up 1.5 Spaces and costs Cr2,000.

Scientific and Medicine

Autodoc (TL 12) The Autodoc is a whole-body automated treatment system that is detailed in the Cluster Variant rules under robots. The Autodoc takes up 12 Spaces and costs Cr250,000 for robot and space. Each autodoc is able to care for up to 2 individuals, but there is no space for a sophont doctor to assist the autodoc.

General Purpose Lab (TL 6) A General Purpose Lab provides no bonuses but allows tasks to be performed with no penalty for missing tools/equipment. General Purpose Lab units consume 9 Spaces per researcher using the lab. Low tech labs cost Cr20,000 per lab unit, medium tech (TL10) cost Cr40,000 per lab unit, and high tech (TL14) labs cost Cr60,000 per unit. While a low tech lab might be able to measure the concentration of salt in seawater, it would be unlikely to help in determining the power of a meson device. Research activities and effectiveness will be determined by the referee.

Holding Tank (TL 8) Holding tanks can be built to any size, at the price of Cr1,500 per Space. Holding tanks can be designed to carry liquids or gases, which is determined at the time of installation and are meant to contain a sealed environment through nearly any calamity. These are considered secure storage facilities and are not meant for bulk liquid transfers.

Operating Theater (TL 5) An Operating Theater is a room equipped for use as an emergency medical clinic. Until TL 10, a vehicle under 200 tons must remain stationary in order for the Operating Theatre to be used. After that, the theater can be built on a stabilized bed that allows it to be used while the vehicle is in motion. An operating theater consumes 12 Spaces plus 9 Spaces per patient. It costs Cr6,000 per patient. An operating theater can serve as a mobile sickbay or hospital for surgery and medical care with a qualified medic.

Sickbays (TL9) are intended to treat injured passengers and crew. A sickbay gives a +1 DM to medics working there and takes up 24 spaces per individual being treated. They may not be used for surgeries.

Improved Sickbays (TL12) provide a +2 DM for medics working there and may also be used for surgery.

Specialized Lab Space (TL 6) Specialized lab space includes analytic equipment, computer workstations and equipment appropriate to the discipline it is focused on, defined during construction. It provides a bonus of +1 for low tech labs costing Cr10,000, +2 for medium (TL10) tech labs costing Cr20,000, and +3 for high (TL14) tech labs costing Cr30,000 each. Specialized labs take up 9 spaces per researcher. Types of lab include: Physics, chemistry, biology, geology, psychology, structures and materials. Other types are possible.

Survey Sampling Equipment (TL 5) Low tech labs are more limited in what they can analyze, while medium tech (TL9) and high tech (TL13) are much more capable instruments. Medium tech samplers cost twice as much as low tech ones, while high tech samplers are 3x more than low tech ones. Sizes do not vary.
Atmosphere Sampler: A system of collectors, pipes and filters for atmosphere sampling, including any particulates, taints and organic matter. It takes up 9 Spaces and costs Cr10,000.
Geology Sampler: An array of scooping devices for shallow ground testing along with a hollow-core drills capable of drilling down into the surface. It takes up 36 Spaces and costs Cr50,000.
Hydrology Sampler: This is a set of liquid sampling equipment, holding tanks and testing equipment. It costs Cr10,000, and takes up 15 Spaces.

Scientific and Medical Equipment

Equipment	TL	Spaces	Price (Cr)	Notes
autodoc	12	12	250,000	
general purpose lab	6	9	20,000	40k for TL10, 60k for TL14
holding tank	8	1	1,500	
operating theatre	5	12+9 per	6,000	cost per patient space
sickbay	9	24	500,000	
improved sickbay	12	24	750,000	
specialized lab	6	9	10,000	20k for TL10 +2DM, 30k for TL14 +3DM
atmospheric sampler	5	9	10,000	20k for TL9, 30k for TL13
geology sampler	5	36	50,000	100k for TL9, 150k for TL13
hydrology sampler	5	15	10,000	20k for TL9, 30k for TL13

Cargo and Miscellaneous

Cargo Hold (TL 1) The design plan must indicate cargo capacity. There is no price associated with cargo space, but cargo carried may not exceed cargo capacity. Cargo may be found in fractions of spaces or in tons.

Crane (TL 4) Cranes are machines generally equipped with a hoist rope, wire ropes or chains that can move equipment vertically and horizontally. They typically use extra bracing when moving equipment heavier than they are.
Light Crane: Light Cranes can lift up to 1000 kg and can be used as rescue equipment or for moving normal sized palettes. Light cranes cost Cr2,000 and take up 3 Spaces.
Medium Crane: Medium Cranes can lift up to 10,000 kg. They cost Cr10,000, and take up 9 Spaces. These are used as light wreckers or for loading medium sized trailers en masse.
Heavy Crane: Heavy Cranes can lift up to 100,000 kg. They cost Cr40,000 and take up 24 Spaces. These are used for heavy wreckers able to move free traders or modules.

Cutting Equipment (TL 4) Cutting equipment includes external heavy duty saws, water knives or plasma cutters, depending on Tech Level. The equipment takes up 15 Spaces and costs Cr10,000 at TL5, Cr20,000 at TL8, or Cr30,000 at TL11.

Digging Equipment (TL 4) Digging equipment includes external digging and scooping equipment. This equipment takes up 30 Spaces and costs Cr25,000 at TL5, Cr40,000 at TL8, and Cr50,000 at TL11.

Dozer Blades (TL 4) Intended to shove surface material to a new location. Small dozer blades take up 4 spaces and cost 1000 Cr, Medium dozer blades take up 12 spaces and cost 2000 Cr, while large dozer blades take up 36 spaces and cost 4000 Cr.

Drilling Equipment (TL5) Designed to make a small hole relative to the depth desired, drilling equipment is used in construction and mining operations. It takes up 24 spaces and differs from moles in that the drill itself stays at the top of the hole. TL5 drills cost 5000 Cr per 20cm wide capacity, TL8 cost 10,000 Cr and TL11 cost 20,000 per 6 inch capacity. Higher tech drills penetrate the same material at a more rapid pace. Drills penetrate to a max of 500x their tech level in depth vs width (1000m max per tech level per 20 cm width).

Fire Extinguishers (TL 4) Fire Extinguishers are designed to put out fires internal to the vehicle. They take up 0.05 spaces and cost Cr50 per ton. Starting at TL8, worlds with a Law Level of 5 or higher often require that these be installed on every civilian vehicle.

Hangars (TL 3) Hangars are used to provide space and basic maintenance for a smaller vehicle inside of a larger one. They may be used to support manned or unmanned vehicles as well as drones. Hangars must be 30% larger than the total size of all vehicles housed in the hangar and cost Cr200,000 per ton.

Hydrogen Generator (TL 9) This device is designed to turn water into hydrogen fuel, and because of power requirements it uses either renewable or fusion power; any other power source results in overall energy loss. Refueling stations require 12 spaces to generate one space of hydrogen per hour. They cost Cr5,000 per ton of generator.

Liquid Tank (TL3) These are designed to safely contain liquids during transport. Each space costs 25 Cr and may be made to any size.

Liquid Sprayer (TL 4) Liquid Sprayers are used for fire suppression, riot control and dispersal of chemicals. A liquid cannon costs Cr2,000, takes up 3 Spaces and requires 2 Spaces per minute's firing duration of liquid carried at Cr100 per space. A liquid cannon has a maximum range of Medium.

Manipulator Arms (TL 5) Manipulator Arms are remote appendages with claws or hands. Manipulator arms have a reach of 5 feet with a Str of 6 and a Dex of 6 and use the Remote Operations subskill to perform normal operations. This skill roll works as part of a task chain along with any normal skill rolls. For a task like opening a door, a failed remote operations roll means the task failed. Vehicles with manipulator arms must have standard controls or better due to the nature of the arms. Arms are normally retractable and do not break streamlining. Manipulator arms cost Cr10,000 and take up 6 spaces.

Pressure Tank (TL 4) These tanks are designed to maintain gasses or low vapor point liquids safely during normal travel. Each space costs 50 Cr and may be made to any size.

Pump (TL 4) Pumps move liquids from one place to another and cost 250 Cr and 1 space per 40L/min capacity.

Radio Jammer (TL5) A jammer is a strong, multi-frequency transmitter which disrupts (only) radio communications for everyone in the area, including the user. More specific disruption requires the use of ECM. *low power=500m, med power=5 km, high power= 50 km*

Refrigerated Cargo (TL 5) Refrigerated cargo holds allow material to be stored at an acceptable temperature and cost Cr100 per space protected.

Winch (TL4) Winches allow a vehicle to pull up to its own mass onto a cargo bed or out of a ditch. Trying to pull something too massive will cause the vehicle itself to move.

Cargo and Miscellaneous Equipment

Equipment	TL	Spaces	Price (Cr)	Notes
cargo hold	1	12	0	may be fractions of a space
light crane	4	3	2,000	1000kg capacity
medium crane	4	9	10,000	10,000kg capacity
heavy crane	4	24	40,000	100,000kg capacity
cutting equipment	4	15	10,000	Cr20,000 at TL8, Cr30,000 TL12
digging equipment	4	30	25,000	Cr40,000 at TL8, Cr50,000 TL12
dozer blades	4	4/12/36	5k/10k/20k	shove surface material around
drilling equipment	4	24	15,000	Cr30,000 at TL8, Cr40,000 TL12
fire extinguishers	4	.05/ton	50/ton	cost per ton of vehicle
hangar space	3	12	200,000	may be fractions of a ton
hydrogen generator	9	12	5,000	1 space/hour, fission, fusion, or solar power
liquid tank	2	1	25	may be fractions of a space
liquid sprayer	5	3+2/min	2000+100/min	medium range max
manipulator arm	5	6	10,000	str 6, dex 6, standard controls or better
pressure tank	4	1	50	for gasses, may be fractions of a space
pump	4	1	250	10L capacity
radio jammer	5	.1/.2/.5	300/600/2000	0.5 km, 5 km, 50 km ranges
refrigerated cargo	5	1	100	may be fractions of a space
winch	4	.04/ton	50/ton	cost per ton of vehicle

Step 10: Weapons and Weapon Mounts

Vehicle weapons and equipment are limited to TL15, as covered in all other areas of the rules. Values listed here are scaled to personal combat numbers, but the weapons here can also be used against spacecraft. 12 dice of personal damage is equal to '1d' of starship damage. Weapons must do at least 8 dice of personal damage to do '1d-1' of starship damage. Per 4 dice of personal damage add +1 to the starship damage. Thus a vehicular weapon doing 20 dice of damage would do '1d+2' starship damage. Whether weapon mounts are present on manned or unmanned vehicles, 2 spaces must be included for either a person OR electromechanical equipment used for firing the weapon. For example, if a large turret has a 10 person crew requirement, 20 spaces must be allocated in the large turret whether it is a manned, robot, or drone vehicle. Weapon mounts do not change size on unmanned vehicles.

Artillery Mounts

All mounted weapons require mounts in order to fire, but ammo may be stored outside of the mount allowing space inside the mount to be reserved for weapon operators and the weapon itself. Magazine storage space costs Cr500 per space. **Hard points** are places for weaponry carried on the vehicle. Vehicles may have 1 hard point per 5 tons of vehicle mass. External weapons reduce a flying vehicle's agility by 1 and break streamlining.

A **fixed hard point** is the simplest type of mount and holds the weapon in a constant direction (usually pointing forward). Fixed hard points may not have fire control added as they are directed by the orientation of the vehicle. Fixed hard points cost 1000 Cr per space of mounted weapon.

Gunports are essentially slits in the armor with sliding closures that allow passengers/gunners to fire hand weapons out of an armored vehicle. 4 gunports make up 1 hard point, although the gunports may be in different firing arcs. Gunports do not allow any fire control and are not permitted on any environmentally sealed vehicle. Gunports cost Cr500 and take up no additional space.

> If any foreign minister begins to defend to the death a 'peace conference', you can be sure his government has already placed its orders for new battleships and airplanes.
>
> *Joseph Stalin*

Small turrets may not be crewed and can hold up to 1 ton (12 spaces) of weapon. A small turret takes up 1 space + size of the weaponry installed+ fire control machinery. Each small turret occupies one weapon hard point on a vehicle and is available at TL 3. Small turrets cost 3,000 Cr per space plus the cost of weaponry and fire control. Ammunition and a specific weapon sensor do not have to be stored in the turret itself, but space for the ammo as well as weapon operators must be included in the vehicle.

Large turrets may be any required size starting at TL 4. Space in the turret must be allotted to the weapon as well as any required crew. A large turret requires 1 space per ton of weapon + fire control + size of weapon + 2 spaces/crew. Additional space for a magazine must be supplied but does not have to be in the turret itself. Large turrets cost 6,000 Cr per space plus the cost of weapons and fire control. Large turrets provide full cover for any crew inside. Large turrets occupy 1 hard point per 60 spaces, so massive turrets can take up more than 1 hard point.

Any turret may be made into a **pop-up turret**. Pop-up turrets are not easily detectable, giving a -2 DM to any recon or investigate check made on the vehicle. Popup turrets require twice as much space and cost an extra 3,000 Cr per space compared to a standard turret, but are counted as internal weapons. Pop-up turrets do not disrupt streamlining and are available starting at TL 6.

Specific bay weapons are internal spaces dedicated to carrying weapons inside the vehicle and may not have more than a 180 degree firing arc. Dedicated bays which carry a single type of weapon cost 4000 Cr per space (plus the weapon system) that it is designed to hold and are available at TL 4. Bays may be reloaded from a separate magazine.

General bays are available at TL 5 and are more flexible in that they may hold different sizes of weapons of the same type. Missile bays cost 20,000 Cr per space of weapons that may be released at once, while bomb bays cost 5000 Cr per space. Each bay takes up 1 hard point per 5 tons (60 spaces) of total space including magazine. Vertical launch systems on warships or submarines are equivalent to bay weapons. General bays require 1 crew per 2 spaces of missiles able to be released, while bombs only require 1 crew per 8 spaces released at a time.

Pintle and Ring Mounts take up no space by themselves and may be powered or non-powered. Powered mounts may have up to 4 spaces of weapons, are TL 5, may have additional fire control, and may be fired while the vehicle is moving. Non-powered mounts are TL 3, may only have 2 spaces of weapons and have a -2DM when fired while the vehicle is moving. Unpowered pintle and ring mounts cost 500 and 750 Cr respectively,

and must be moved by the gunner. Powered Pintle or Ring Mounts cost 1500 or 2250 Cr respectively and turn more rapidly with a mechanical assist to allow the gunner to switch targets more effectively (-2 recoil value on the weapon). A ring mount provides cover for the gunner at the same armor level of the vehicle while a pintle mount offers no protection. Pintle and Ring mounts are typically seen on lighter armored vehicles for close infantry support; any vehicle with a visible weapon mount will generally be considered military. Both types of mounts break streamlining.

In any given mount, multiple weapons may be housed. Most mounts may have up to 4 weapons, but bays may have an unlimited number. In many cases, the weapons are **linked**, or triggered to fire together, and all linked weapons fire at the same time at the same target. This substantially reduces the number of crew required. Weapons that are not linked do not have to fire at the same time unless desired. Unlinked weapons require more crew and provide more flexibility but end up taking more space (mostly for the extra crew).

Fire Control Systems

Fire control systems are specific for individual weapons and include all mechanisms for stabilizing the weapon, target tracking, and target acquisition. In general, improved fire control provides DM modifiers to hit. More advanced fire control mechanisms take up a larger amount of space due to the increased computational, mechanical and sensor requirements. Note that fire control modifiers are for direct fire weapons only. Missiles which have their own targeting or sensors cannot gain from weapon based fire control. Laser and Meson designator equipment are used in conjunction with guided munitions. When effective, designated targets are attacked with an additional +1 DM bonus but must be actively illuminated by the appropriate device. Designators are not associated with a particular weapon and do not take up any hard points.

Fire Control DM	minimum TL	Mass	Cost (Cr)
+1	6	25% of weapon	10,000
+2	9	50% of weapon	25,000
+3	12	100% of weapon	50,000
+4	15	200% of weapon	100,000
laser designator	6	.1 spaces	1,500
meson designator	12	.1 spaces	5,000

Firing Arcs

Just like the grenade scatter table, the circle around a vehicle is broken up into 6 equal firing arcs. Each weapon on a vehicle has a firing arc into which the weapon may operate. Fixed weapons operate in only 1 of the 6 possible firing arcs; usually they shoot into the forward firing arc, but rear firing weapons are not uncommon on certain types of vessels. Most weapons on larger vessels have a 180 degree range of fire, or 3 firing arcs. Essentially the vehicle itself prevents the weapon from firing in many directions. Some weapons (turret of a tank, for example) are able to fire in all 6 firing arcs. These are most common on smaller vehicles, but there is a limit on the number of weapons able to shoot in all directions. 1/8 of the hard points on a vehicle (rounded up) will be able to shoot in any direction, but any vehicle will have a minimum of 2 weapons (no matter the number of hard points a given weapon occupies) that can fire into all 6 firing arcs.

Missile weapons with active guidance are able to change direction after firing and therefore have slightly different rules for their firing arcs. For any target out to long range (250m), the weapon must be oriented in the proper direction to hit its target. For longer ranges, the firing arc is irrelevant and any missile launcher can hit targets in any firing arc.

Ordinance Types

Most military weapons are designed to use explosives, but this is not required. Even during World War I, smoke shells, poison gas, and incendiaries were common and used to sometimes catastrophic effect. Higher tech societies have only improved upon the ways weapons may overcome enemies. While some combinations of ordinance are nonsensical (an intercontinental smoke missile, for example), others are outright impossible (ie. thermobaric weapons used underwater). Some worlds may have historical reasons for adopting a particular technology in their weapons, or their environment (such as a water world) may encourage different weapons altogether. The referee has the ultimate say in whether a particular ordinance or weapon is available.

Weapons have a base cost determined by the size and destructive power of each weapon. Different types of ordinance have different cost multipliers based upon their nature as well. For example, a 75mm shell has a base cost of Cr240. A smoke shell (ie. multiplier 0.5 unit) costs 120 Cr, a standard HE/fragmentation shell costs Cr240, and a psi-blast shell with a multiplier of 10 costs Cr2400.

Extended Range projectiles sacrifice payload size for increased range and accuracy at long ranges but cost twice as much as normal range weapons. These weapons gain +2 DM on their two longest range categories and a 20% increase in their maximum range (ie. treat their longest range category as 20% longer), so 50 km becomes 60 km, but payload size is decreased 50%. For many weapons, being able to hit the enemy from further away is worth the trade off in damage.

Aerosol weapons cause no damage, but are composed of microscopic reflective particles that diffract and redirect laser weapons. They are more effective than smoke, blocking 6d of laser damage and providing -3DM against laser weapons and targeting.

Biological weapons are available early on and not very difficult to produce. They are very difficult to control, however, and far too many biological weapons have come back to kill the attacker. They are illegal almost everywhere, and merely possessing weapons specific for a particular race will often incite a preemptive strike to prevent their use.

Dyes are non-damaging marking weapons which coat everything in the area of effect with a colorful stain that is difficult to remove. It is useful for training purposes or to identify particular people/vehicles/objects at a later date. It takes 1 week for the dye to fade.

EMP weapons do not damage living creatures, but all electronics that are not hardened are immediately shut down. The effects last for 1 minute, and then devices may be rebooted. Most commercial grade transmitters, sensors, and robots fall into this category. Hardened systems or combat grade material are immune to EMP.

Fusion weapons are truly massive and terrifying weapons and 80x more damaging than standard explosives. Development and possession of such destructive devices is monitored and use of fusion weapons near populated areas is generally forbidden.

> I'm not afraid of the man who wants 10 nuclear weapons. I'm terrified of the man who only wants 1.
>
> *Dr. Julia Kelley*
> *The Peacemaker*

Gas weapons are completely ineffective against anyone with breathing filters or enclosed breathing apparatus. All gasses dissipate after 1d6+2 minutes or faster if high winds are present. Checks vs gasses are made every minute if travelers do not vacate the area of the gas effect.

Halon devices were originally designed as fire suppressant tools where a chemical gas reacts with the oxygen in the atmosphere to smother a fire. In an enclosed environment, however, the lack of oxygen can be deadly to

sophonts. Oxygen is reduced to trace levels within the radius of the grenade burst and depending upon the amount of air circulation it remains low for up to 10 combat rounds.

Illumination weapons are designed to be fired in a high arc over a target and to burn with a bright light similar to a flare but brighter. They are typically equipped with a parachute and will burn for 30 seconds per kilogram of projectile weight.

Incendiaries scatter flaming napalm in the blast radius. The napalm ignites flammable materials left in the area of effect. Anything that suffers damage from the incendiary will suffer half damage, rounded down, for the following round, 1/4 for the second round, etc, until the liquid is removed using a significant action (rolling on the ground works) or damage is reduced to 0. Armor reduces the amount of damage done each round.

Oil weapons create an aerosol of ultra-slippery oil that coats everything within the area of effect. Any movement or operation which requires friction (grabbing a handle, walking, changing weapons, etc) requires a dexterity check to succeed. The oily surface remains until removed using ordinary soap or equivalent.

Plasma weapons form a localized plasma field and do twice the damage of HE/fragmentation weapons. They are easy to conceal and very destructive, making them a common choice among high tech militants.

Psi-blast weapons throw out a psionic attack against all individuals within the blast radius. Psionics make an average PSI check or lose PSI and INT points. Non-psionic characters lose only INT points at 1/2 the damage done, round down, but have no natural defense. Psionic shielding or resistance to psionics blocks the effect. Inidividuals reduced to 0 Int become unconscious and regain 1 point of Int every 10 minutes.

Reactive explosives are higher tech equivalents to fragmentation grenades. They release 50% more energy than standard explosives used in common fragmentation grenades but are otherwise similar.

Smoke weapons are used to obscure vision and are available at low tech levels. They also block lasers, reducing laser damage by 3d and laser targeting by -2 DM.

Solidfoam weapons are an outgrowth of solidfoam used to seal leaks in spacecraft. The grenade fills the area of effect with a rapidly solidifying non-toxic foam that forms an impermeable barrier in one combat round. The material is relatively weak and may be broken through relatively easily (approximately the strength and consistency of typical styrofoam). The material must have solid anchors for it to remain supported, otherwise the foam forms small globules which drop to the ground.

Strategic Nukes have 2.5x larger explosions than tactical nukes (20x larger than HE) but are otherwise identical.

Stun weapons do no actual damage but the target must make an END check against the damage roll minus any armor protecting them. Success means no effect. Failure means stunned 1d6 combat rounds.

Tactical Nukes are some of the smallest nuclear weapons. They are 8x as destructive than HE/fragmentation warheads of the same size and throw out radiation 5x further than the explosion itself reaches.

Thermobaric explosives use a fuel-air mixture to amplify the power of the explosive by 25%. Unlike the other common types of explosives, thermobaric weapons cannot be used underwater.

Webs are a non-lethal restraint system which releases sticky, flexible conductive filaments encumbering anyone within the area of effect. All individuals coated have their movement rate reduced by 50% until the filaments are removed. Any changes in position (opening a pack, changing weapon targets, etc) require a strength check

to succeed at the task or gives a -2 DM to hit. Web strands are easily dissolved by any solution containing 50% or better alcohol, while lower alcohol concentrations take much longer to dissolve the fibers.

Ordinance Types

Type	TL	Radius	Cost Multiplier	Effect
HE/fragmentation	4	stnd	1	explosive
thermobaric	8	stnd	4	25% greater explosive, not underwater
reactive	11	stnd	8	50% greater explosive
plasma	14	stnd, 2x	20	100% greater explosive + radiation hit
smoke	5	2.5x	0.5	-3d for lasers, obscures vision
stun	6	stnd	1	End check or stun 1+effect min
improved stun	10	stnd	2	End check at -2DM or stun 1+effect min
aerosol	9	2x	0.5	-6d for lasers
incendiary	6	stnd	1.5	ignites flammable material
halon	8	2.5x	1	reduces oxygen to trace levels
oil	8	stnd	1	makes things very slippery
web	10	stnd	1.5	reduces movement
dye	5	1.5	0.5	colors everything in area
solidfoam	10	stnd	2	creates weak barrier
illumination	5	10x	2	provides light to see targets
tear gas	5	1.5x	1	End check vs no effect
tranq gas	8	1.5x	3	End check or pass out d6+3 min
poison gas	5	1.5x	3	End check vs no effect
biologics	7	1.5x	10	depends upon agent
psi-blast	12	1.5x	10	damages Psy and Int
EMP	11	2x	10	shuts down most electronics
tactical nuke	6	stnd, 5x	5	8x HE explosive, radiation 5x farther
strategic nuke	6	stnd,5x	10	20x HE explosive, radiation 5x farther
fusion	7	stnd,5x	50	80x HE explosive, radiation 5x farther

Cluster Munitions

Larger shells may be used to disperse smaller, grenade-sized explosives over an area. These weapons are known as cluster munitions (not having anything to do with the Cluster RPG!) and are used for area denial attacks. They are particularly useful for destroying larger structures such as runways and factories as they can scatter explosives over several football pitches (whether European or American football). Optical and infrared sensors can even be used to specifically target these cluster munitions against particular types of vehicles such as tanks or locomotives. While adding guidance modules to these bomblets is expensive, the weapons become far more effective. When combined with alternative payloads such as incendiaries or poison gas, cluster munitions are exceedingly deadly (and hence heavily restricted on Earth).

In general, cluster munitions are available 1 tech level after the base munition. 1 grenade sized bomblet is available for each kg weight of munition, with missiles using the equivalent size warhead since much of their mass is taken up by propellant and control surfaces. The cost of these munitions is determined by purchasing each bomblet as a standard grenade, then adding 50% of the price. Guidance and armor piercing enhancements are added afterwards and increase the price even further.

Armor Piercing Projectiles

Protecting individual soldiers, animals, or vehicles with armor has been common for many centuries. As technology develops better armor, ways are developed to better penetrate the common armor until a new approach comes along. Obviously a large enough explosive will destroy any target, but armor piercing rounds can allow a smaller weapon to take out even well protected targets. Armor piercing rounds are generally explosive by their nature and purpose.

Their are 3 levels of armor piercing ability. Basic AP is developed around TL6 and penetrates damage dice/2 (round up) points of armor and costs 50% more than a standard weapon of that type. Super (sAP) armor piercing is available at TL9, costs 100% more than a normal round, and penetrates damage dice of armor. Ultra armor piercing (uAP) is available at TL11, costs 200% more than base ammo, and penetrates 1.5 damage dice of armor (round up). While expensive, armor piercing weapons can allow a somewhat smaller explosive to damage even a heavily armored vehicle.

Guided Weapons

Bombs and bullets are not very accurate. Early in World War II, allied bombers at 6500m could only place about 16% of bombs dropped within 300m of their target. German anti-aircraft fire was no better- it required 16,000 shells to shoot down one aircraft. Actively guiding weapons to their correct target massively improves these results. There are a number of mechanisms that have been developed to aid targeting.

Guidance Table

Guidance Type	TL	cost modifier	effect	counter
heat seeking	6	3x	+1 DM to hit	flares
radar guided	6	3x	+1 DM to hit	chaff
acoustic guided	6	3x	+1 DM to hit	noisemaker
optical guided	6	3x	+1 DM to hit	smoke
inertial guided	7	3x	+1 DM to hit	decoys
laser guided	7	3x	+1 DM to hit	smoke, aerosol
2 combined systems	8	7x	+3 DM to hit	decoys,
meson guided	12	9x	+2 DM to hit	

Once weapons are able to be shot down by specialized anti-projectile weapons, designers developed several methods to counteract these defenses. While this makes individual projectiles more expensive, they also become more effective and reduce the number of rounds required to destroy a target. All avoidance and guidance costs are multiplied together, making more advanced guided weapons with avoidance very expensive per use.

Weapons Avoidance Table

Avoidance Type	TL	cost modifier	effect
irregular flight	TL8	+25%	-1 DM to intercept
stealthy coating	TL11	+100%	-2 DM to intercept
improved stealth coating	TL14	+250%	-4 DM to intercept

Types of Munitions

There are 4 main types of munitions: energy, projectiles (broken down into grenades, shells, and kinetic rounds), bombs, and missiles. Energy weapons do damage by direct energy transfer from beam to target. Projectiles use a propellant provided by the launcher to strike a target. For kinetic rounds, the more energy provided by the launcher, the more damage is done. Grenades are small weapons of limited range and sometimes incorporated into simple projectiles to increase their damage. Grenades may be carried by larger ordinance and used as cluster bombs or area denial weapons. Shells are projectiles hurled by a launcher which can carry a variety of ordinance including clusters of grenades. Bombs are non-powered weapons which must be carried near their target by another mechanism. Depth charges, mines, and air dropped weapons are examples of bombs. Missiles are powered projectiles which accelerate toward their target and may strike well beyond visual range. They often have guidance mechanisms to increase their accuracy given their long range.

Artillery Distance Scale and Scatter

When powerful weapons are used, the energy must go somewhere. Depending upon the range to the target, the weapon can miss by an increasing distance. Guided weapons have a maximum scatter of medium range unless they have been deceived by ECM or decoys in which case the standard scatter rules apply. The table below details which direction and how far away a miss lands when fired from a given the range.

Scatter Tables

d6 to determine distance

range	distance		
close	1.5m		
short (d6)	1-2:1.5m	3-4:3m	5-6:4.5m
medium	d6 x 3m		
long	d6 x 6m		
very long	d6 x 9m		
distant	d6 x 15m		
very distant	d6 x 30m		
extreme	d6 x 90m		
intercontinental	d6 x 150m		

d6 to determine direction

	6	1
5	Hit	2
	4	3

Grenades

Grenades are the simplest projectile weapon which can use multiple types of ordinance. Because they are small and easily concealed, individual travelers often find uses for various grenades depending upon their purpose. The simplest grenades are hand thrown using a Dex + Athletics skill check. Harpoons and ballista may incorporate explosive heads which act like grenades. Minigrenades (not available for vehicles) are 80% smaller and available 2 TL later than standard grenades. They may be fired from a slingshot, and arrows and crossbow bolts may be built as minigrenades for twice the price. When used in this fashion, a Dex + Archaic Weapons skill check is used. Rocket propelled and RAM grenades are twice the size and cost of regular grenades but have a greater range. When combined with armor piercing ordinance, RPGs have been known to destroy moderately armored vehicles. Finally, regular mortar shells are basically high arc explosives used for close infantry support. They are designed to fall behind obstructions used to protect troops from direct fire weapons. They weigh 2 kg (4x that of a standard grenade) and cost 3x as much.

Weapon	Range	Mass (kg)	base Cost (Cr)	base Damage	special
thrown grenade or minigrenade	thrown	0.5 or 0.1	30	5d6 or 4d6	ordinance
arrow, or bolt minigrenade	pistol or rifle	0.1	60	4d6	ordinance
harpoon or ballista grenade	rifle or rocket	2	90	5d6	ordinance

RAM or RPG grenade	assault or rifle	1	60	5d6	ordinance
mini-RAM grenade	shotgun	0.2	60	4d6	ordinance
mortar grenade	catapault	2	90	5d6	ordinance

Projectile Weapons and Artillery

While passengers of vehicles are able to fire personal scale weapons from a vehicle, vehicles may carry far more weight than a person and the weapons a vehicle may mount are vastly more destructive. The smallest vehicle mounted weapons are among the largest that a person may use independently. Grenades, mortars, machine guns, and gauss guns are described in the personal weapons section and are able to damage or destroy small civilian vehicles. In fact, many vehicles mount such weapons to attack personal or small vehicular targets.

Artillery is rarely deployed by anyone not associated with the military. This is the heaviest of the heavy projectile weapons and direct hits from these explosives will destroy almost any non-fortified position or vehicle. Many weapons at this scale are indirect fire weapons and will affect an entire area. Burst radius varies based on the size of the shell where damage decreases at 2d per 1.5 meters from the hit location. Use the scatter table to determine the direction and distances for missed shots. Most artillery requires 2 or more people to operate it, particularly for reloading. Rate of Fire (RoF) refers to how many shots per round a weapon may take. For purposes of armor piercing, rockets and missiles are treated as direct fire weapons and spacecraft missiles are assumed to be sAP level munitions.

Ballista are essentially giant crossbows that shoot spears with incredible force. They are direct fire weapons.

Catapults are torsion weapons where an arm is cocked back into the firing position, the desired load is placed into a cup shaped barrel, and when the locking pin is released the arm flings forward, throwing the load at the enemy. Stone shot and fire pots are common weapons, but bundles of arrows, diseased livestock, and other unsavory things have historically been used by catapults.

Trebuchet are basically oversized catapults that throw heavier objects that cause more damage. They were often constructed in place as they were difficult to move.

Black powder cannon are an early gunpowder weapon that could fire either solid shot or explosive shells. They had a relatively restricted range and were slow to fire, but could be used to devastating effect against unarmored individuals.

Harpoon guns are similar to ballista but use compressed gasses to deliver their spears. They are often used underwater or for hunting very large sea creatures such as whales on 20th century Earth.

Grenade launchers use any of a variety of grenades depending upon tech level and intention. These are used as direct fire weapons that are particularly effective against lightly armored troops.

Heavy mortars are inexpensive ranged weapons generally used for infantry support and siege warfare. They are lower tech than howitzers and typically fire in a higher arc than artillery shells.

Autocannons are direct fire small artillery weapons which require a stabilized mount. They fire modest shells at a high rate of fire and are designed to take out small vehicles and fliers. Rotary autocannons have multiple barrels and autofeed mechanisms to shoot many shells in a burst.

AT guns (anti-tank) guns are heavier weapons designed to take out armored vehicles and fliers. These are direct fire weapons which require a stabilized mount to fire at all, and require 6 minor actions to reload or 2

minor actions if there is a dedicated reloader. AT cannons are automatic firing versions of an AT gun, and rotary AT cannons can saturate an area with explosive shells.

Howitzers are the traditional cannon initially developed at early TL5. They typically used rifled barrels to increase accuracy and vary greatly in size and destructive capacity. The largest cannon were typically deployed on ocean going vessels and included massive armored turrets to protect the guns. Shells for the larger guns were too big to handle physically and require extensive machinery to load and fire the weapons.

RaFE (Rapid Fire for Effect) Howitzers are autofiring cannons that can expend heavy ammunition at an extreme rate. Large magazines are needed to sustain their high rate of fire.

Gauss cannons use electromagnetic force to propel a small projectile at very high speeds. Because they do not have a propellant they have a high rate of fire and require a power level of 3 for the vehicle to use. It fires a projectile that is often armor piercing and quite destructive.

Projectile Weapons Table

Weapon	TL	range	crew size	spaces (12/ton)	RoF	cost(Cr)
ballista	2	rocket	3	6	1/2	200
catapult	2	catapult	6	12	1/3	250
trebuchet	2	catapult	12	60	1/4	2500
small black powder cannon	3	rocket	3	5	1/3	500
large black powder cannon	3	rocket	5	9	1/3	1000
mortar	4	catapult	2	0.5	1	3000
heavy mortar	4	very long	4	12	1/2	12,000
harpoon gun	4	rifle	2	3	1	400
repeating harpoon gun	5	rifle	2	5	4	1000
light machine gun (LMG)	5	assault	1	.25	8	3000
rotary light machine gun	6	assault	1	.5	16	12,000
very rapid fire (VRF) gauss gun	12	rocket	1	.25	12	12,000
heavy machine gun (HMG)	5	rifle	1	0.5	8	5000
rotary heavy machine gun	6	rifle	1	1	16	20,000
heavy VRF gauss gun	12	rocket	1	0.5	12	20,000
20mm autocannon	5	rifle	1	1	4	10,000
20mm rotary autocannon	6	rifle	2	2	16	50,000
55mm anti-tank (AT) gun	5	rocket	2	4	1	20,000
55mm AT cannon	6	rocket	2	6	4	40,000
55mm rotary AT cannon	7	rocket	2	12	16	160,000
grenade thrower	6	rifle	1	.5	4	5,000
RAM grenade launcher	8	assault	1	0.25	4	800
75mm howitzer	5	rocket	2	9	1	35,000
75mm RaFE howitzer	8	rocket	2	12	4	70,000
gauss cannon	11	very long	2	6	12	75,000
105mm howitzer	5	very long	3	24	1/2	50,000

105mm RaFE howitzer	8	very long	3	30	4	100,000
127mm howitzer	5	distant	4	40	1/3	90,000
127mm RaFE howitzer	9	distant	4	48	4	180,000
155mm howitzer	5	distant	6	72	1/4	150,000
155mm RaFE howitzer	9	distant	6	84	4	300,000
200mm howitzer	5	distant	9	200	1/4	400,000
300mm howitzer	5	distant	15	480	1/5	1,000,000
400mm howitzer	5	distant	20	1440	1/6	3,000,000

Projectile Prices

Weapon	Mass (kg)	Rounds per ton*	base Cost (Cr)**	base Damage	special****
harpoon, ballista ***	2	500	25	3d6+2	ordinance
catapault stone	25	40	50	5d6	
catapault firepot	25	40	200	3d6 fire,6m burst	
trebuchet stone	100	10	250	6d6	
trebuchet firepot	100	10	1000	4d6 fire,9m burst	
sm. cannonball	10	100	25	4d6	
sm black powd. shell	10	100	50	3d6, 6m burst	
lg. cannonball	20	50	100	5d6	
lg black powder shell	20	50	200	3d6, 12m burst	
LMG slugs	.02	50,000	5	3d6	
VRF gauss	.01	100,000	2	6d6	
HMG slugs	.05	20,000	8	4d6	
heavy VRF gauss	.02	50,000	4	8d6	
RPG grenade	1	1000	60	5d6	ordinance
mortar bomb	2	500	90	5d6	ordinance
20mm autocannon	.2	5000	45	5d6	ordinance
55mm AT round	.5	2000	90	6d6	ordinance
heavy mortar bomb	12.5	80	240	10d6	cluster ordina nce
75mm howitzer	3	333	240	8d6	cluster ordinance
105mm howitzer	12.5	80	600	10d6	cluster ordinance
127mm howitzer	25	40	1000	12d6	cluster ordinance
155mm howitzer	50	20	1600	14d6	cluster ordinance
200mm howitzer	125	8	3600	16d6	cluster ordinance
300mm howitzer	250	4	7800	20d6	cluster ordinance
400mm howitzer	1000	1	21,000	24d6	cluster ordinance
gauss cannon	0.5	2000	100	14d6	
flamethrower	1	1000	90	4d6 fire	

*if ammo is mechanically assisted into the weapon, the loading machinery adds 50% to the mass of the system.

**Guided artillery rounds are available at TL 6 and above which have the same mass but cost 300% of the price for +1 DM to hit the target. Meson targeting costs +900% but cannot be jammed and work underwater.

*** Modern harpoons and ballista bolts may incorporate any type of standard grenade into their construction. This can be particularly useful on high law, low tech or water worlds where weapon options may be limited. Modern harpoons and bolts cost 100% more than the listed type of grenade (ie. same as a RPG) and use the same range table as normal harpoons and ballista bolts.

****Cluster weapons may alternatively have 1 bomblet per kg that act like grenades. Ordinance means that the effect of the weapon scales according to the damage but may have any of a variety of effects based upon the type of ordinance carried. This varies from improved explosives to illumination to psionic attacks.

Energy Weapons

Vehicles may also mount energy weapons that are in many ways more sophisticated and reliable than projectile weapons. As long as the vehicle has enough power, it may fire its energy weapons. It does not have to carry or resupply ammunition, a significant space and cost savings over the longer term. Energy damage effects, however, may not be specialized the way an artillery shell can be customized. They are somewhat less flexible, but can do extreme amounts of damage at higher tech levels.

Flamethrowers are devices used to throw flaming, sticky liquid at an opponent. Flammable material will be ignited. Anything that suffers damage from a flamethrower will suffer half damage, rounded down, for the following round, 1/4 for the second round, etc, until the liquid is removed using a significant action (rolling on the ground works) or damage is reduced to 0. Armor reduces the amount of damage done each round. A flamethrower 'round' weighs 1 kg and costs 90 Cr.

A **sonic cannon** is specifically a non-lethal anti-personnel weapon which projects an ultrasonic vibration into an area. It does no physical damage, but is a powerful stun weapon that armor is only 50% effective at blocking. This means that the armor value is halved against this weapon.

Beam lasers are powerful turret weapons which require a minimum power level of 2 to operate.

Stutter lasers are repeating lasers which can fire at high speed but have less power behind each shot. Stutter lasers require a minimum power level of 3 to operate.

Plasma guns are large energy weapons that release a burst of energetic plasma that coheres for only a short period of time before transferring its energy to a target. They may fire as long as they have energy available and are the larger cousin to the man portable version. Plasma guns require a power level of 4 or better.

Fusion guns are the larger version of FGMPs, firing a directed nuclear explosion at the target. The target receives a dose of ionizing radiation equivalent to the damage, and the radiation spreads from the center, losing 2d6 per 1.5 meters traveled. Fusion guns require a power level of 5 or better.

Meson guns are designed to only interact with matter or energy at the target, making them nearly impossible to block. They are extremely heavy and bulky, and have only been 'miniaturized' to 10 tons by TL15. Meson guns require a power level of 6.

PGMP (plasma gun, man portable) is a heavy, bulky weapon that is typically used by a trooper wearing some sort of mechanical assist. For each point of STR less than 12, a -1 DM attack penalty is assessed. The weapon fires a beam of plasma energy at the target and carries extreme destructive potential and requires a power

level of 4 or better, while improved PGMPs require power level 5 or better. Treat normal cover as soft cover which reduces damage but does not block this weapon's force. PGMPs are heavily restricted on most worlds.

FGMPs (fusion gun, man portable) is the state of the art in energy weapon technology. It fires essentially a directed nuclear explosion at a target. As such, both the target and everyone within 6m of the FGMP when fired receives a radiation exposure equal to the damage. It requires a minimum STR of 9 to handle or a -1 DM to hit penalty per point lacking is assessed. The shooter typically wears some sort of radiation protection so they can survive using this weapon. It has a backpack fusion generator as its power source and may fire a virtually unlimited number of times. Treat normal cover as soft cover which reduces damage but does not block this weapon's force. FGMPs are heavily restricted on most worlds. FGMPs require a power level of 6.

Energy Weapons

Weapon	TL	Range	Damage	min power	Crew	Spaces	RoF	Cost (Cr)
flamethrower	5	shotgun	4d fire	0	1	0.25	1	2500
sonic cannon	10	rifle	5d6 stun	1	1	1.5	1	5000
laser rifle	9	rifle	5d6	1	1	0.1	1	2500
stagger laser	12	assault	4d6	2	1	0.15	4	5000
beam laser	9	very long	12d6	2	1	6	1	1,000,000
stutter laser	12	rifle	8d6	3	1	6	4	2,500,000
plasma gun	11	very long	18d6	4	3	48	1	8,000,000
fusion gun	14	very long	24d6	5	5	60	1	15,000,000
meson gun	15	very long	20d6	6	4	120	1	30,000,000
PGMP	12	rifle	10d6	3	1	0.5	1	65,000
improved PGMP	14	rifle	12d6	4	1	0.5	1	100,000
FGMP	15	rifle	15d6	5	1	0.5	1	250,000

Missiles

There are a huge number of possible missiles, anything from something carried by an individual soldier to multi ton monsters that are nearly immobile. This description is intended to simulate the major capabilities of missiles today and in the future (well, through TL15 anyway) and still allow relatively easy play.

> "Once the rockets are up, who cares where they come down? That's not my department!" says Wernher Von Braun.
>
> *Tom Lehrer*
> *"Wernher Von Braun'*

Note that most of the missiles described here will be for vehicles. Individuals are unlikely to be targeted by an ICBM, although spacecraft might be a different story. There is also no distinction being made between functionally very different types of missiles. Anti-tank and anti-aircraft missiles, surface to air, air to surface, etc are all quietly ignored to emphasize different effects. The same small, short range missile would be equally useful against a fighter jet, attack helicopter, medium tank, or fast attack boat. Naturally a referee may wish to specify different types of targets for different individual missiles- as always, it's your game.

Additionally, none of the individual missile descriptions include the description of a launcher. This is intentional to allow various combinations that any individual wishes to develop. Single use missiles, rotary launch bays,

vertical launch cells, multiple rocket pods, all are easily accommodated within the general rules given a large enough vehicle. Note, however, that streamlining requires the use of an interior ordinance bay or a popup turret; other weapon mounts break streamlining.

Missile Table

Type	Crew	Range	TL	Damage	Base Cost	Size	equivalent
short range, small	1	rocket	5	6d6	750 Cr	20kg, 0.25 spaces	55 mm shell
short range	2	very long	5	8d6	2100 Cr	83kg, 1 space	75mm shell
medium range	4	very distant	5	12d6	7200 Cr	330kg, 4 spaces	127mm shell
long range	5	extreme	6	18d6	24,000 Cr	1 ton, 12 spaces	500kg bomb
ICBM	8	ICBM	6	24d6	120,000 Cr	5 tons, 60 spaces	1000kg bomb

ClusterRPG missiles are defined by 5 major features: range, TL, damage, cost, and size. Range is based on range bands and will often be fired from 'over the horizon' where the launcher may not be visible to the target. Tech level determines what types of guidance and payload are available to the missile. Damage refers to the size and composition of the missile payload. This payload may be banned on Earth, but poison gas and nuclear weapons are available at relatively low tech levels and may be deployed by less ethically discriminating groups. Naturally cost is a factor when choosing a missile type and how many weapons a megacorp or system will deploy. Finally weapon size will limit how many or what type of missiles are carried on a vehicle. While most commanders would like an unlimited number of weapons, a 20 ton tank can only afford to carry so many shells. All will use some type of gunnery skill, either heavy weapon, turret, or bay weapon. Equating starship and missile bay weapons is clearly a stretch, but it does make bay weapons a more useful category for 'regular' adventurers.

Bombs

Bombs are basically unpowered explosives dropped from specialized vehicles. They are relatively inexpensive compared to rockets and because vehicles drop them they may be essentially launched from any distance away, unlike artillery. They always use the rocket range modifiers, and scatter based upon the height from which they are dropped. They were commonly used by aircraft against ground targets and by surface warships against submarines. Guided bombs are more expensive per unit, but they are substantially more likely to hit the desired target. Bomb tech levels vary by ordinance, but most sizes are available starting at TL5 with earthquake bombs starting at TL6.

Bomb Table

Weapon	Mass (kg)	Rounds per ton	base Cost (Cr)	base Damage	special
light	100	10	900	16d6	cluster, ordinance
medium	250	4	2700	20d6	cluster, ordinance
standard	500	2	7200	22d6	cluster, ordinance
heavy	1000	1	21,000	24d6	cluster, ordinance
earthquake	2000	0.5	45,000	28d6	cluster, ordinance

Note that any type of weapon 55mm or larger may use nonexplosive ordinance. An example of such a weapon would be a chemical weapon artillery shell used to devastating effect during World War I. While generally frowned upon, such weapons may be constructed at relatively low tech levels and are highly effective against soldiers not wearing masks or enclosed armor. Scale the cost and effectiveness of the weapon by comparing it to a standard fragmentation grenade (smoke shells cost half as much as standard shells, poison gas shells cost 3x as much, etc).

Underwater Weapons and Vehicles

Most vehicles humans use daily on Earth operate on land, air, or the surface of water. Underwater, many rules change because of the nature of the medium. Radio waves, for example, are not useful underwater and so alternative communications (meson, laser, etc) are important. Sensors that function underwater must be purchased separately. Most slug throwers and artillery will not function at all under water.

The most common underwater weapons today are torpedoes, missiles, and depth charges. Torpedoes are essentially underwater missiles and treated as the same size and price as other missiles. Missiles designed to be launched underwater and then travel into air or space require specialized housings to leave the water, but otherwise behave exactly like other missiles. Add 25% to their cost to account for the special conditions. Depth charges are essentially bombs that detonate underwater; again, they can be used pretty much as found in the air and are usually 100kg designs.

Future weapons that are most effective underwater are meson weaponry and lasers. As meson beams are designed to only become destructive inside their target, they are nearly the ideal underwater weapon. Lasers are very common, but water absorbs much of the energy they put out. Reduce laser ranges by 50% and lose 1d of damage per range increment to account for water absorption and scattering.

At the more primitive end, spearguns might be very effective against open frame vehicles such as dive sleds while underwater. Harpoon guns powered by compressed air could easily be used underwater. A thin skinned submarine penetrated by a harpoon would obviously start leaking badly. Explosive bolts are similar to the deadly harpoon guns used by whalers in the early 20th century and can increase the destructive power available. Other types of specialty bolts are equally useful: ink dyes to obscure vision, EMP bolts to disable underwater vessels, etc. Finally, nets can be used not only to capture sophonts underwater but have been known to entangle screw propellers of surface as well as subsurface craft. Other variations developed by races at home underwater are likely to be used wherever sophonts use vehicles in that environment. Merfolk, for example, are perfectly at home underwater and just as violent as humans so they can be expected to have weapons appropriate for their tech level and environment.

Defensive Technology

The best defense might be a good offense, but defenses are very useful in the heat of combat. Passive defenses are meant to be used continuously and offer ongoing protection against particular attack forms. Because they are left on, they are effective against surprise attacks. Stealth coatings (under armor options) could also have been included here, but these options are available in addition to armor.

Defenses fall into two major categories- responsive and static. Camouflage is typically established well before an attack comes and begins being used around TL3. More advanced camouflage is able to adapt to a changing environment by using video projection and computer screens to hide the presence of a vessel. Camouflage, however, works almost entirely on visual observations and does not affect more advanced sensors such as radar or densitometry. Nuclear Dampers are a powerful defensive technology which is able to stabilize unstable nuclei and prevent fission from occurring. Note that hgher technology fusion weapons do not require fission weapons to initiate the explosion. Thus plasma explosives and FGMPs are not blocked by nuclear dampers.

Camouflage uses coloring, netting, sound muffling, etc to try and reduce visual and aural signatures. It is environment specific and only works in that specific environment; ie. forest camouflage fails in the desert. It is available at TL3, uses 0.5 spaces per ton, costs 250 Cr/ton and gives -2 DM to visual detection.

Digital Camouflage uses an external adaptive coating and anti-vibration technology to give a vehicle -3 DM on a recon or sensors skill check for visual or aural detection. It loses effectiveness at -1 DM per hit inflicted. The system is available at TL9, takes 0.5 spaces per ton, and costs 2,500 Cr per ton.

Nuclear Dampers disrupt the weak nuclear force required for fission reactions to take place. While it blocks early fusion weapons as well (because they use fission bombs to initiate the fusion reaction), it does not directly block fusion and therefore does not inhibit fusion power reactors. They are, however, exceedingly useful against a lowish tech enemy who is counting upon nuclear weapons to win a battle. Nuclear dampers are available starting at TL12 and prevent fission devices from operating within 3 km of the damper. Some extremely large bombs may still destroy the target as they explode outside of the protected area. They cost Cr500,000 and require 1 ton of space. Note that these are slightly different from the version used on spacecraft in that they do not have to be targeted. The space versions are partially effective at longer ranges, however, and protect against radiation as well.

Psionic Shielding builds anti-psionic materials into the walls and structure of a vehicle. It does not block all psionic use, but will block psionic forms coming from a distance. Within the vehicle psionics of any type may be used by line-of-sight only; otherwise any psionic action automatically fails. While it does not block everything, it is extremely useful against spying or teleportation from a distance. Psionic shielding is available starting at TL12 and costs Cr250,000 and 0.5 spaces per ton of vehicle protected.

Active Defenses

Active defenses must be used immediately prior to an incoming attack to be effective. Smoke and aerosols reduce laser and energy weapon damage, while smoke also provides a -2 DM penalty for visual targeting of the vehicle. Chaff and flares attempt to distract radar or heat seeking projectiles, respectively. Noisemakers are useful underwater for distracting acoustic guidance systems. Decoys are perhaps the most sophisticated of the distraction weapons and attempt to duplicate the signature of the vehicle being protected. They are also the most expensive to employ.

Defense	TL	Spaces	# Reloads	Cost/Reload	Cost (Cr)	Effect
smoke discharger	4	2	6	100	1000	-2 DM visual, -2 DM laser designator, -3d laser damage
chaff dispenser	5	2	6	150	1500	-2 DM radar/lidar targeting
flares	5	2	6	200	2000	-2 DM infrared targeting
decoys	7	2	6	1000	10,000	-2 DM vs most guided weapons
noisemaker	6	2	6	250	2500	-2 DM vs acoustic targeting
aerosol	9	2	6	500	5,000	-3 DM vs laser designator, -6d laser damage

Dual Use Weapons

Some weapons may be used in either an offensive or defensive manner. For weapons to be used in a defensive, anti-projectile mode, several things must be present. First, the weapon must be located in a small turret whose fire arc covers the incoming ordinance; pintle mounts, ring mounts, and bays do not have the tracking adjustments required for this precision firing. Secondly, they must have at least +1 fire control to target the incoming weapon. The third requirement depends upon the weapon type. Energy weapons and missiles may always be used to target incoming projectiles, while projectile weapons require an auto rating of 12+ in order to be effective as a defensive weapon. Fourth, the weapon must be attached to sensors which can detect and target an incoming projectile. Sophonts do not have the reflexes to shoot down incoming projectiles. Finally, the weapon and sensors must be put on standby where they are tracking any incoming projectiles and waiting for their opportunity. Weapons may be switched between standby anti-missile defense and offensive mode each

round, but a weapon intended to fire at a small boat, for example, cannot be switched to fire at an incoming missile mid-round.

The sensor itself may be anything from a dedicated radar dish (which must be present for each anti-projectile weapon) to a very advanced sensor suite which can be used to direct 10 different turrets at once. If the sensors a weapon relies upon are destroyed or disabled, the weapon cannot be used to shoot down incoming ordinance. Sensors may directly control 1 anti-projectile weapon per 3 spaces of size; as sensors go up in size and complexity, more weapons may be used in a defensive role. Note that this is in addition to all other uses of the sensors. For a small dedicated anti-projectile turret, an independent radar or sonar system is often included as part of the system.

Although many different weapons can target incoming projectiles, the 3 most common types are energy weapons, high firing rate small cannons, and missiles. For vehicles intent on defeating incoming weapons, two different weapon systems may target the same incoming projectile. If they have the same range, both fire simultaneously while if they have different ranges the shorter range weapon only fires if the first misses. Any given turret may only fire at one incoming projectile per combat round. If 3 missiles are coming in when there are only 2 anti-missile turrets available, life may become unpleasant.

Military vs. Civilian Vehicles

In low law societies here on Earth, seeing a pickup truck mounting an autocannon in the back may not be a big deal; it may even be common in more lawless areas. That same pickup truck driving down Lakeshore Drive in Chicago or the Champs Elysees in Paris, however, would attract extra police attention. The same attitude would be true in most higher law areas. While it might be nice to have enough firepower to destroy an armored troop carrier, the local authorities may be more than a little concerned over who is wielding that weapon. Laws and regulations differ between systems, and every system expects visitors to follow the local laws.

So what characteristics define a military vehicle? The presence of armor is not sufficient, as armored cars and bulletproof vehicles, while not exactly common, are not exclusively military. However, if there is more than 5% additional armor a vehicle is likely to be viewed as military grade. In terms of weapons, nonlethal or defensive weapons are more likley to be acceptable than heavy offensive firepower. Weapons doing 4d6 or less damage and no auto fire might be acceptable for security contractors on most worlds. Very high law societies might consider any weapon, vehicle mounted or not, illegal so care should be taken with these general rules.

One way travelers can get around these rules is to hide the weapons internally. Pop-up turrets are one example of how a weapon system may be concealed. An inspection of the interior is likely to find the turret, but a casual glance from the outside is not likely to arouse suspicion in any but the most paranoid police. Another option is to have gun ports available for personal weapons. While these would likely be found if the vehicle is inspected, because it is owned by offworlders and has been used on many different planets most police might let them slide if illegal weapons are not actually present. After all, self defense in the lawless wilds of space is not unreasonable. Just hope they don't find the grenade launcher hidden under the back seat!

Vehicle Descriptor

TL: [tl] [Vehicle Name]

Using a [size] ton Standard chassis (hull [hull], structure [structure]) with [env. protection] environmental protection, the [name] designed by [designer] is intended to [description]. The vehicle has [fuel efficiency] [powerplant type] powerplant and a power level of [power level] for using a [drive type] drive at speed level [speed level] (max [max speed] and agility [agility]). The vehicle was purchased with an agility modifier of [agility mod] [submersible information]. [second drive information if present]. There are [fuel spaces] spaces of [fuel type] which give the vehicle an endurance of [endurance]. The chassis is protected by [armor]. The

[manning] vehicle uses [control type] controls and [command unit]. Electronics include a [pri sensors] as the primary sensors, [underwater sensors], [radio], [adv comms]. Countermeasures include [countermeasures]. This vehicle requries [crew size] crew to operate fully. There is room for [max occupants] people in [crew quarters and life support]. Crew amenities consist of [crew ammenitites]. Miscellaneous options are comprised of [misc options]. The [name] includes the following weapon(s):

##	System	Mount	Facing	Spaces	Firecon	Sensors	TL	Ammo	Hard	Crew	Cost(kCr)

List weapon information here

This vehicle costs [vehicle cost] kCr and will take [build time] to build.